OTPC

ONGC Tripura Power Company Limited

10th Floor, Core 4 and Central, SCOPE Minar, Laxmi Nagar, Delhi-110092, Phone : +91-11-22404700, Fax : +91-11-22017731, 22018831

Ref No: OTPC/Comml/T-8/2021-22/410

09th February 2022

Member Secretary,
North Eastern Regional Power Committee,
NERPC Complex, Dong Parmaw, Lapalang,
Shillong, Meghalaya – 793006

Sub: Supplementary PPA between OTPC and Power and Electricity Department, Government of Mizoram

Ref: NERPC/Committee/2021/1281-1285 dated 7th December 2021

Dear Sir,

Kind attention is invited to letter under reference wherein NERPC had advised OTPC to sign the supplementary PPA with the interested beneficiary states and to submit the same to NERPC for further needful action.

OTPC and Power and Electricity Department, Government of Mizoram have signed the supplementary PPA on 08th February 2022 and same is enclosed for your kind reference and further necessary action. The updated allocation of Mizoram from OTPC Palatana Project shall now be as below:

Mizoram Long Term Allocation as per Original PPA	Additional Long Term Allocation as per Supplementary PPA	Total Long Term Allocation of Mizoram from Palatana Project
22 MW	20 MW	42 MW

The revised percentage allocation of Mizoram from Palatana shall now be 5.785123%. Request NERPC to kindly allocate the additional power to Mizoram from OTPC Palatana Project on long term basis at CERC determined tariff so that this additional power may also be scheduled by Mizoram from 00:00 Hours of 15th February 2022.

Thanking you.

Yours faithfully,

Arup Ch. Sarmah
General Manager (Commercial)

C.C: The Engineer-in-Chief, Power and Electricity Department, Govt of Mizoram

भारत सरकार Government of India
विद्युत मंत्रालय Ministry of Power
उत्तर पूर्वी क्षेत्रीय विद्युत समिति
North Eastern Regional Power Committee
एन ई आर पी सी कॉम्प्लेक्स, डोंग पारमाओ, लापालाङ, शिल्लौंग-७९३००६, मेघालय
NERPC Complex, Dong Parmaw, Lapalang, Shillong - 793006, Meghalaya

Ph. No: 0364 - 2534039
Fax No: 0364 - 2534040
Website: www.nerpc.nic.in

No. NERPC/Committee/2021/12.81 - 12.85 Dated: December 07, 2021

To:

1. The Chief Engineer (T&G), Department of Power, Govt. of Nagaland, Kohima - 797001.
2. The Chief Engineer, Commercial & CEI, Department of Power, Govt. of Arunachal Pradesh, Itanagar - 799111.
3. The Managing Director, MSPDCL, Imphal, Manipur - 795001.
4. The Engineer – In- Chief, Power and Electricity Department, Govt. of Mizoram, Aizawl-796001

Subject: Allocation of OTPC Merchant Power on Long Term Basis at CERC Determined Tariff – Reg.

Sir (s),

Pursuant to the decision of the 21st TCC/RPC forum regarding the subject matter, interested utilities were requested to submit expression of interest and details of quantum to avail from the Merchant Power of OTPC Palatana on long term basis at CERC determined tariff.

In response to which, NERPC Secretariat has received consent for 58 MW of OTPC Merchant power from some of the beneficiaries of Palatana. The details of the interested entities are as below:

Sl. No.	Constituent	Power Quantum Requested	Reference Letter
1	Arunachal Pradesh	3 MW	SE (COM)/SLDC/56/2020-21/2774-77 dated 11-10-2021
2	Manipur	10 MW	2/29/2018/MSPDCL(Comml)/168-71 dated 20-04-2021
3	Mizoram	20 MW	T11022/01/17-EC(P)/Com/15 dated 01-11-2021
4	Nagaland	25 MW	CEL/TB/NERPC/2009-10/205(A) dated 01-03-2021

In view of the above requests, OTPC is advised to approach the interested beneficiaries for signing of supplementary PPAs for allocation/scheduling of requested merchant power quantum on long term basis at CERC determined tariff.

The copies of the signed supplementary PPAs may be submitted to NERPC for further needful action.

Thanking you.

भवदीय / **Yours faithfully,**

B. Lyngkhoi
Member Secretary

Copy to:

1. The Managing Director, OTPC, 10th Floor, Core 4, Scope Minar, Lakshmi Nagar, New Delhi -110092.

Annexure P-6

ONGC Tripura Power Company Limited

(JV Company of ONGC, IL&FS, IDFC and Govt. of Tripura)

6th Floor, A Wing, IFCI Tower-61, Nehru Place, New Delhi-110019 Phone: +91-11-26402100 Fax: +91-11-26227532/26227533

3rd September 2017

Shri Biswajit Biswas,
GGM, In-charge, North Eastern Regional Office
Engineering Projects India Limited
4th Floor, Hindustan Tower, Jawahar Nagar, NH-37
Guwahati - 781022

Sub: **Contract for civil construction work for construction of Township at Khilpara, Tripura**

Dear Sir,

This has reference to the discussion we had today morning wherein we informed you the following:

a. OTPC had awarded the construction contract to EPIL based on commitment from EPIL that work shall be completed within two years i.e. before 31st March 2018. It is essential for OTPC to capitalize the expenses towards construction of township by 31st March 2018 so that same may be allowed for inclusion in project cost by Central Electricity Regulatory Commission (CERC) for determination of electricity tariff of Palatana power plant.

b. Piling work was to be completed within 81 days as per MOM dated 1st July 2016. After resolution of piling design issue based on result of test piles and acceptance of quality control and assurance procedure by EPIL vide email dated 8th November 2016, final pile drawings were issued starting from 10th November 2016. Piling work was started on 6th January 2017 i.e. almost two months after drawings were issued. It is almost 8 months since start of piling and 10 months since piling drawings were issued and only 1038 piles (less than 70% of total 1559 piles) have been completed till 31st August 2017.

c. A review meeting was held with GGM, EPIL on 19th April 2017 in which following major commitments were made: (a) 4 Nos. additional rig shall be mobilized progressively by 10th May 2017, (b) 2 Nos. additional transit mixer shall be mobilized – one is existing, 2nd by 2nd May 2017 and date of 3rd to be advised, (c) 50 Nos. welder and bar binders shall be mobilized by 1st May 2017, (d) Rig operation staff shall be increased to 50 Nos., (e) Piling work in type-3 building shall be started immediately, and (f) piling work shall be completed by 20th June 2017. Minutes of Meeting dated 19th April 2017 is attached as Annexure-A.

d. Further, a review meeting was held between CMD (Addl. Charge) and Director (Projects)-EPIL and MD-OTPC on 30th May 2017 at OTPC Office , New Delhi for expediting the completion of piles by 30th June 2017 and pile breaking by 15th July 2017. Minutes of Meeting dated 30th May 2017 is attached as Annexure-B.

e. Even after intervention of Director(Projects), there was lack of progress, hence another review meeting was held at site on 28th June 2017 in the presence of MD-OTPC wherein following commitments were made by Director(Projects)(Minutes of Meeting dated 28th June 2017 is attached as Annexure-C):

- To expedite the tendering process and award the said work within 1st week of August 2017 and mobilize the contractor and start the work within 10 days of award of contract i.e. latest by 16th August 2017.
- To develop the approach road by 7th July 2017 so that type-2, 3, 4, 5, club house and other construction area may be approached even during rains or immediately thereafter.
- To take measures like using tarpaulin cover, bund wall around work area and proper and effective dewatering and continue work during rainy season.
- To mobilize 1 Concrete Pump with accessories and 1 no. 20 M^3/Hr. movable Batching Plant at site by 12.07.2017.
- To immediately mobilise additional 20 manpower for pile breaking and to expeditiously complete the balance Routine Tests.

f. We are highly disappointed and distressed to note that the above mentioned commitments given by Dir(Projects), EPIL to MD,OPC have not been fulfilled. Kindly refer the status of commitments given by EPIL as Annexure-D. Following is the summary of activities as on 31-Aug-17:

Piles	: 1038 completed out of 1537 (68% completed @ rate of 4.38 Pile/day since 6-Jan-17 and @ rate of 2 pile/day since 28-Jun17)
Vertical Load Test	: 15 completed out of 44 nos. (34% since 10-Mar-17)
Integrity Test	:27 completed out of 383 tests (7% since 29-Mar-17)
Dynamic Load Test	:Nil completed out of 46 tests
Pile Head Breaking Head /day)	: 301 completed out of 1537 (20% completed @ rate of ~3 pile
PCC	: 18 cum completed out of 212 cum (8% since 9-Aug-17)

g. We are apprehending that EPIL shall not be able to complete even the Pile Cap including above mentioned activities before 31st March 2018 at the pace with which EPIL is working, due to inadequate mobilization of manpower and T&P. No action has been taken by EPIL or its sub-contractor to repair the TMR, as only 1 TMR is in operation out of 3 TMRs since past one month.

Although, we have informed you at various levels that it is essential for OTPC to capitalize the expenses towards construction of township by 31st March 2018 so that same may be allowed for inclusion in project cost, yet, no corrective actions were taken despite the intervention of Director (Projects) and repetitive requests from OTPC for expediting the work in order to avoid financial loss to OTPC. Considering the criticality of timely completion of the project and that EPIL has not been able to adhere to the commitments made by their Director(Projects) regarding work progress and

tendering process for superstructure work of Type-II and Type-III, it has become imperative for OTPC to execute the work through alternate agency.

If you have any observation, please let us know and clarify why OTPC should not execute the balance work through an alternate agency.

Thanking you,

Yours faithfully,
for ONGC TRIPURA POWER COMPANY LIMITED

SAMARJEET THAKUR
DGM-CONTRACTS

Encl: MOM dated 19th April 2017, 30th May 2017, 28th June 2017

CC: MD, OTPC
CC: DIRECTOR (PROJECTS),EPIL
CC: VP (C&M/BD/IT),OTPC
CC: VP (PLANT),OTPC

Sl No	Name of the Building	Instalation of Piles		Vertical Load Test		Integrity Test		Pile Head Breaking		PCC (CuM)		Remarks
		Total Scope	Act. Progress as on 31.08.17	**Total Scope**	Act. Progress as on 31.08.17	**Total Scope**	Act. Progress as on 31.08.17	**Total Scope**	Act. Progress as on 31.08.17	**Total Scope**	Act. Progress as on 31.08.17	
1	TYPE-II	**278**	276	**8**	5	**69**	12	**278**	6	**41**	0	
2	TYPE-III	**443**	97	**13**	0	**110**	0	**443**	0	**64**	0	Out of 3 TMR only 1 TMR is in operation for last one month.
3	TYPE-IV	**360**	360	**10**	10	**90**	15	**360**	295	**44**	18	
4	TYPE-V	**280**	247	**8**	0	**70**	0	**280**	0	**45**	0	
5	CLUB HOUSE	**176**	58	**5**	0	**44**	0	**176**	0	**18**	0	
6	**TOTAL**	1537	1038	44	15	383	27	1537	301	212	18	
Progress as % of Total		**68%**		**34%**		**7%**		**20%**		**8%**		
Date of Start		06-Jan-17		10-Mar-17		29-Mar-17		14-May-17		09-Aug-17		
Progress per day		4.38		0.09		0.17		2.76		0.82		
Date of completion at the pace with which EPIL is working		**22-Dec-17**										

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TOWNSHIP PROJECT

Pile installationStatus as on from 28/06/2017 to 31/08/2017 at OTPC,Khilpara Site.

SL No	Date	TYPE-II (278)	TYPE-III (443)	TYPE-IV (360)	TYPE-V (280)	Club House (176)	Per Day Achivement	Remarks
	Up to 27-Jun-17	276	27	360	180	58	901	
1	28-Jun-17	0	2	0	5	0	7	
2	29-Jun-17	0	1	0	5	0	6	
3	30-Jun-17	0	1	0	3	0	4	
4	1-Jul-17	0	2	0	4	0	6	
5	2-Jul-17	0	1	0	1	0	2	
6	3-Jul-17	0	2	0	0	0	2	Rain
7	4-Jul-17	0	0	0	0	0	0	Rain
8	5-Jul-17	0	0	0	0	0	0	Water loggeg due to overnight rain
9	6-Jul-17	0	2	0	3	0	5	
10	7-Jul-17	0	2	0	4	0	6	
11	8-Jul-17	0	2	0	4	0	6	
12	9-Jul-17	0	2	0	3	0	5	Rain
13	10-Jul-17	0	0	0	0	0	0	Rain
14	11-Jul-17	0	3	0	0	0	3	
15	12-Jul-17	0	2	0	1	0	3	
16	13-Jul-17	0	2	0	0	0	2	
17	14-Jul-17	0	2	0	0	0	2	
18	15-Jul-17	0	2	0	2	0	4	
19	16-Jul-17	0	4	0	4	0	8	Rain
20	17-Jul-17	0	2	0	2	0	4	Rain
21	18-Jul-17	0	4	0	4	0	8	
22	19-Jul-17	0	0	0	0	0	0	Rain
23	20-Jul-17	0	0	0	0	0	0	Rain
24	21-Jul-17	0	0	0	0	0	0	Rain
25	22-Jul-17	0	2	0	0	0	2	
26	23-Jul-17	0	2	0	0	0	2	
27	24-Jul-17	0	0	0	0	0	0	
28	25-Jul-17	0	2	0	0	0	2	
29	26-Jul-17	0	0	0	0	0	0	Rain
30	27-Jul-17	0	0	0	0	0	0	Rain
31	28-Jul-17	0	1	0	0	0	1	
32	29-Jul-17	0	1	0	0	0	1	
33	30-Jul-17	0	1	0	0	0	1	
34	31-Jul-17	0	3	0	2	0	5	
35	1-Aug-17	0	3	0	0	0	3	
36	2-Aug-17	0	1	0	0	0	1	
37	3-Aug-17	0	1	0	1	0	2	
38	4-Aug-17	0	1	0	0	0	1	
39	5-Aug-17	0	0	0	0	0	0	
40	6-Aug-17	0	0	0	0	0	0	
41	7-Aug-17	0	0	0	0	0	0	
42	8-Aug-17	0	1	0	2	0	3	
43	9-Aug-17	0	1	0	0	0	1	
44	10-Aug-17	0	0	0	3	0	3	
45	11-Aug-17	0	0	0	0	0	0	
46	12-Aug-17	0	0	0	0	0	0	
47	13-Aug-17	0	0	0	0	0	0	Heavy Rain from 11/08/2017 to 14/08.2107
48	14-Aug-17	0	0	0	0	0	0	
49	15-Aug-17	0	0	0	0	0	0	
50	16-Aug-17	0	0	0	0	0	0	
51	17-Aug-17	0	0	0	0	0	0	Water logged in all area due Heavy rain
52	18-Aug-17	0	0	0	0	0	0	
53	19-Aug-17	0	0	0	0	0	0	
54	20-Aug-17	0	1	0	2	0	3	
55	21-Aug-17	0	1	0	0	0	1	
56	22-Aug-17	0	1	0	0	0	1	
57	23-Aug-17	0	1	0	0	0	1	
58	24-Aug-17	0	0	0	0	0	0	
59	25-Aug-17	0	1	0	0	0	1	
60	26-Aug-17	0	0	0	2	0	2	
61	27-Aug-17	0	2	0	2	0	4	
62	28-Aug-17	0	3	0	3	0	6	
63	29-Aug-17	0	0	0	3	0	3	
64	30-Aug-17	0	2	0	2	0	4	
	31-Aug-17	0	0	0	0	0	0	
	Total	276	97	360	247	58	1038	

Total No. of days from 28-Jun-17 till 31-Aug-17	65
Total No. of Piles installed from 28-Jun-17 till 31-Aug-17	137
Average No. of Piles installed from 28-Jun-17 till 31-Aug-17	2

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Weekly Pile Installation at OTPC Khilpara

Week	Date	Instalation of Piles during the week	Upto date piling done
1st	06/01/17 to 13/01/17	3	3
2nd	14/01/17 to 20/01/17	27	30
3rd	21/01/17 to 27/01/17	51	81
4th	28/01/17 to 02/02/17	60	141
5th	03/02/17 to 09/02/17	53	194
6th	10/02/17 to 16/02/17	67	261
7th	17/02/17 to 23/02/17	69	330
8th	24/02/17 to 02/03/17	73	403
9th	03/03/17 to 09/03/17	25	428
10th	10/03/17 to 16/03/17	23	451
11th	17/03/17 to 23/03/17	20	471
12th	24/03/17 to 30/03/17	38	509
13th	31/03/17 to 06/04/17	23	532
14th	07/04/17 to 13/04/17	28	560
15th	14/04/17 to 20/04/17	37	597
16th	21/04/17 to 27/04/17	11	608
17th	28/04/17 to 04/05/17	47	655
18th	05/05/17 to 11/05/17	53	708
19th	12/05/17 to 18/05/17	37	745
20th	19/05/17 to 25/05/17	25	770
21st	26/05/17 to 01/06/17	35	805
22nd	02/06/17 to 08/06/17	28	833
23rd	09/06/17 to 15/06/17	28	861
24th	16/06/17 to 22/06/17	20	881
25th	23/06/17 to 29/06/17	33	914
26th	30/06/17 to 06/07/17	19	933
27th	07/07/17 to 13/07/17	25	958
28th	14/07/17 to 20/07/17	27	985
29th	21/07/17 to 27/07/17	6	991
30th	28/07/17 to 03/08/17	14	1005
31st	04/08/17 to 10/08/17	7	1012
32nd	11/08/17 to 17/08/17	0	1012
33th	18/08/17 to 24/08/17	6	1018
34th	25/08/17 to 31/08/17	20	1038

Total no. of days	237
Avergae no. of piles per day	4.4

NOTE: Spending 34 weeks time only 1038 nos Piles installed at site i.e. average per week pile production 30.5 nos with aveg. 5 nos TMR available at site.

ANNEXURE-J09

STATUS OF MOM DATED 28/06/2017(WITH MD-OTPC , DP-EPIL & OTHER SENIOR OFFICERS OF OTPC, EPIL AND KNY) & 13/07/2017 (WITH VP(PLANT),EPIL,KNY AND SUB CONTRACTOR OF EPIL AT PLANT OFFICE)

Item Sl No	MOM Date& Sl No	Item Description	Target date	**Actual Status as on 31/08/17**
01	13/7/17 Sl-1	OTPC requested EPI to resume the pile breaking works and subsequent activities in Type-II & Type-IV buildings without wasting further time. As confirmed by M/s. ABC, EPI has assured to start the Pile breaking work from 16/07/2017 after dewatering the water logged area.	16/07/17	i) In Type-IV 65 nos Pile Head breaking balance (out of 360nos). PCC work-40% completed. ii) In Type-II Pile Head breaking (Total 278nos) & PCC not yet started.
02	28/6/17	OTPC requested EPI to resume disposal of sludge with immediate effect. EPI committed to resume the work immediately and dispose of entire sludge/bentonite mixed earth from site within 3 days. EPI requested for early finalization of rate for disposal of sludge. OTPC requested EPI to submit offer to VP (Plant), OTPC subsequent to which the rate shall be finalized by VP (Plant), OTPC on cost plus 10% basis.	By 1st July 2017	Action taken against removal of sludge is very slow. Target date for disposal to be finalized by EPIL. Disposal rate already commutated to EPI on 21/07/17 by VP(Plant)
03	28/6/17	OTPC requested EPI to expedite the tendering process for Superstructure work of Type-II & III Quarters. EPI assured to expedite the tendering process and award the said work within 1 stweek of August 2017 and mobilize the contractor and start the work within 10 days of award of contract i.e. latest by 16" August 2017. In order to expedite the work till new contractor is mobilized at site, OTPC requested EPI to get the Pile cap work of Type—II executed through existing contractor. EPI confirmed the same.	By 16th Aug 2017 Contract-or for (Type-II & III superstr-ucture work) to be mobilize	As per latest available information, tender not yet floated. EPIL to indicate new target date. Existing EPI's Sub Contractor not yet started Pile Cap work at Type-II.
04	13/7/17 Sl No-7	M/s. ABC has confirmed that the Concrete Pump is on transit and reached at Bengal & Assam Border. The same is expected to reach at site by 22/07/2017. Batching Plant ($20m^3$/Hr) is yet to be dispatched from source.	By 22.07.17	Conc. Pump reached site on 21/07/2017 and Batching Plant of 20M3/Hr reached site on 07/08/17, but both the plant are yet to install.

05	28/6/17	OTPC informed that for executing work during rainy season approach road needs to be developed immediately. EPI confirmed to develop the approach road by 7th July 2017 so that Type-II,III,IV,V & club house and other construction area may be approached even during rains or immediately there after	By 07.07.17	Recently main straight portion of the road upto Batching Plant have been developed, but other portion for Type-II, III, IV & V are yet to be developed.
06	28/6/16	OTPC requested that work of piling, testing, pile breaking and pile cap may be undertaken during rainy season by implementing suitable measures like using tarpaulin cover, bund wall around work area and proper and effective dewatering. EPI confirmed to implement these measures and continue work during rainy season.		EPI yet to comply.
07	13/7/17 Sl No-2	M/s. ABC has confirmed that Manpower Group for pile cap works at Type-II shall be mobilized at site by 23/07/2017. They have also confirmed shuttering material, Carpenter and reinforcement to be mobilize accordingly.	By 23/7/17	M/S ABC not yet mobilized for Type-II area for Pile Cap work.
08	13/7/17 Sl No-3	EPI has confirmed to complete balance piles (02 nos) in Type-II within 15 days from 13/7/17.	Both the pile by 27/7/17	Not yet done.
09	13/7/17 Sl No-4 & 5	M/s. AB has confirmed that Agency for Pile Dynamic Load test shall visit site on 17/07/2017 and action plan shall be prepared. Accordingly, development of Pile Head for the piles selected for pile dynamic test shall be taken up from 17/07/2017 onwards. M/s. KNY requested EPI to furnish the unpriced copy of work order between M/s. ABC and the Agency assigned for Pile Dynamic Load Test. M/s. AB confirmed that the same shall be submitted by 17/07/2017	From 17/7/17	Agency for Dynamic Load test initially visited the site on 18/07/2017. 1.8 MT hammer is almost ready at site. Tripod & winch mobilized at site. Confirmation is awaited from when the test will start. Rate for Dynamic test already finalized.

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Minutes of Meeting held at EPIL site office, OTPC Township Project Khilpara, on 28.06.2017

Members Present:

OTPC:	EPI:	KNY:
Sh. S Ganguly, MD	Sh. Vinoo Gopal, Dir(P)	Sh. U. Bhaduri, PM
Sh. S. Chottopadhyay, VP(Plant)	Sh. B. Biswas, GGM, I/C-NER	
Sh. Shree Narayan, GM	Sh. S. P. Roy, DGM-NERO	
Sh. A. Gupta, CFO	Sh. S. R. Lahiri, Sr. Manager	
Sh. C. Ravi, Advisor		

A meeting was held at EPIL Site Office, Khilpara between the officials of OTPC, KNY & EPI and the issues related to the project were discussed. OTPC expressed its deep concern about lack of progress even after seeking intervention of Director (Projects), EPIL. EPIL assured to take all possible action to expedite work. The following points were discussed in the meeting:

- OTPC requested to immediately mobilize manpower for Pile Breaking and complete the balance Routine Tests at the earliest for Type-II & Type-IV. EPI agreed to immediately mobilise additional 20 manpower for pile breaking. EPI also confirmed to expeditiously complete the balance Routine Tests.

- OTPC requested EPI to resume disposal of sludge with immediate effect. EPI committed to resume the work immediately and dispose of entire sludge/bentonite mixed earth from site within 3 days. EPI requested for early finalization of rate for disposal of sludge. OTPC requested EPI to submit offer to VP (Plant), OTPC subsequent to which the rate shall be finalized by VP (Plant), OTPC on cost plus 10% basis.

- OTPC requested EPI to expedite the tendering process for Superstructure work of Type-II & III Quarters. EPI assured to expedite the tendering process and award the said work within 1st week of August 2017 and mobilize the contractor and start the work within 10 days of award of contract i.e. latest by 16th August 2017. In order to expedite the work till new contractor is mobilized at site, OTPC requested EPI to get the Pile cap work of Type-II executed through existing contractor. EPI confirmed the same.

- EPI confirmed to mobilize 1 Concrete Pump with accessories and 1 no. 20 M^3/Hr. movable Batching Plant at site by 12.07.2017.

- OTPC informed that for executing work during rainy season approach road needs to be developed immediately. EPI confirmed to develop the approach road by 7th July 2017 so that type-2, 3, 4, 5, club house and other construction area may be approached even during rains or immediately thereafter.

- OTPC requested that work of piling, testing, pile breaking and pile cap may be undertaken during rainy season by implementing suitable measures like using tarpaulin cover, bund wall

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around work area and proper and effective dewatering. EPI confirmed to implement these measures and continue work during rainy season.

- EPI raised the concern regarding the huge time and cost implication in conducting the Dynamic Load Test on working piles @ 7% of total number of piles and requested OTPC to reduce the extent of dynamic load testing. OTPC accepted request of EPIL and advised EPIL to conduct dynamic load test at a frequency of 3%. OTPC requested EPI to submit a Building wise revised plan considering 3% frequency of test immediately. EPI confirmed to submit the same by 29/06/17. EPI requested OTPC to finalize the rates for Dynamic Test which has already submitted by EPI to OTPC. OTPC requested EPI to meet at OTPC, Delhi office on 04/07/2017 to finalize the Rate for Dynamic Load Test.

- EPI requested OTPC to release balance 50% of mobilization advance. OTPC informed that EPI has not fulfilled the condition for releasing mobilization advance. However, as a special case OTPC shall release remaining 5% mobilization advance to help EPI in expediting the work. OTPC advised EPI to submit invoice for remaining 5% mobilization advance. EPI confirmed submission.

- KNY placed the concern regarding the poor performance of Hydraulic Rig. EPI highlighted the matter about the huge expenditure being incurred for deployment of machineries like Hyd. Rig, Crane, manpower etc. without any effective output (only 44 nos. of piles have been executed in 90 days). Considering the above facts, EPI requested OTPC to consider release of Hydraulic Rig at the earliest and execute the balance piling works by engaging TMR. OTPC informed that mobilization of mechanical rig/TMR in place of hydraulic rig has financial implication.

Meeting concluded with good note to enhance progress and timely completion of works.

OTPC

EPIL 05/07/17.

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Samarjeet Thakur

From:	EPIL Udaipur <epiludaipur@gmail.com>
Sent:	16 June 2017 19:21
To:	Chinnasamy Ravi; Subir Kumar Saha; kny.otpcsite@gmail.com
Cc:	Sudin Chattopadhyay; Engineering Projects Agartala; Karan Bakshi; Samarjeet Thakur; EPIL NERO; Biswajit Biswas; sproy
Subject:	Reg. MoM Dtd. 14.06.2017 held at EPI site office
Attachments:	MOM_OTPC.pdf

आदरणीय महोदय/Dear Sir,

कृपया उपरोक्त विषय पर संलग्नित पत्र प्रेषित हैं।
May please find herewith the subject attachment.
सादर
/
With Regards,
इ.पी.आई-उदयपुर

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Minutes of Meeting Held at EPIL Site office, OTPC Township Project Khilpara, on 14.06.2017 in presence of OTPC, KNY, EPI, M/s. AB Construction & M/s. Apu Dey

Members Present:

EPI:	KNY:	M/s. ABC	M/s. Apu Dey
Sh. B. Biswas, GGM, I/C-NER	Sh. U. Bhaduri, PM	Sh. S. Bhattacherjee	Sh. Apu Dey
Sh. S.R. Lahiri, Sr. Manager, S/I	Sh. S. Dev, PE	Sh. S. Bandyopadhayay	
Sh. A.K. Raja, Manager-I			
Sh. A. Nandi. Manager-I			

M/s. A B Construction

- As requested by KNY official and GGM,I/C-NER, EPIL, M/s. AB Construction agreed to arrange concrete pump for casting of piles during rainy season as movement of TM & AJAX are difficult inside the work front due to soft soil condition after heavy rain. M/s. ABC has confirmed that the concrete pump shall be mobilized at site within 7 days.

- M/s. AB Construction will resume the balance Routine Tests for piling work at Type-IV immediately.

- M/s. AB Construction will take up the redevelopment of the service road upto required fronts with immediate effect.

- M/s. AB Construction will submit the rates for Dynamic Load Test & Sludge disposal by 16.06.2017 so that PO can be issued by EPI.

- M/s. AB Construction has confirmed to resume pile braking and balance excavation work at Type-IV area immediately. The date of start for PCC at Type-IV will be confirmed by the party on 16.06.2017.

- M/s. A B Construction has placed a request before KNY & GGM,I/C-NER for permission to withdraw the Hydraulic Rig from site as average daily production of pile by Hyd. Rig is not satisfactory. Till date it has produced around 40 no. of piles only in 80 days since 27-03-2017 for which they are facing huge financial loss for non-performance of the rig due to the existing soil condition of site. However, they have assured to mobilize an additional TMR for Club House in place of Hyd. Rig for smooth progress of work. In this regard, EPI mentioned that the matter will be raised in competent forum.

M/s. Apu Dey

- M/s. Apu Dey has expressed that he is facing problem for dewatering and bailing out accumulated water from work front of Type-II building area due to non-availability of any specific discharge point. The discharge point is yet to be confirmed by OTPC.

Continued to Page: 2

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- M/s. Apu Dey has assured to start the Pile Braking works of Type-II from 19.06.2017 after bailing out the accumulated water to designated area approved by OTPC, otherwise further works in Type-II cannot be taken up.

- GGM, EPI has requested M/s. Apu Dey for immediate mobilization of 4th TMR for Type-III. M/s. Apu Dey confirmed that the 4th TMR is now reached at Guwahati starting from Dibrugarh and expected to reach at Udaipur on 20.06.2017 for Udaipur. But M/s. Apu Dey has expressed his concern on working of 4th TMR in Type-III due to space constraint.

After review of the progress with the contractors, meeting continued among representatives of OTPC (Sh. C. Ravi, Advisor), KNY & EPI wherein following points were discussed:

- EPI has briefed to OTPC all the points discussed with sub-agencies i.e. M/s. AB Construction & M/s. Apu Dey.

- The matter of non availability specific discharge point for storm water was discussed with Advisor, OTPC. As advised, bailing out of accumulated water from Type-II building area was resumed through the location identified by him, but the operation was stopped after some period due to objections raised by adjacent locality as the bailed out water is damaging their cultivated lands/fisheries. The said incident was also witnessed by OTPC/KNY officials. However, no firm decision was received from OTPC/KNY for Disposal of bailed out water through specific discharge point(s). EPI expressed concern on Type-II balance work which was forced to stop due to rain water accumulation and non-availability of disposal point.

- As confirmed by sub-agencies, EPI/KNY has informed to OTPC about the use of Concrete Pump for piling work during foul situation when TM/AJAX cannot reach to work fronts due to soft soil condition resulted after rain. OTPC has agreed for use of Concrete pump provided all quality obligations are duly maintained. EPI has assured that in any case quality will not be compromised.

- 5th RA Bill which was submitted on 08/06/2017 has been checked by KNY and submitted to OTPC on 14.06.2017. EPI requested Sh. Ravi to forward one set of the bill immediately to OTPC New Delhi so that process of release of payment can be expedited as per discussion held during meeting dtd. 30.05.2017 at OTPC, New Delhi.

- GGM,EPI expressed concern on lack of Co-ordination at site level between EPI & OTPC Engineers and requested to resolve all site related issues cordially sitting together, not writing mails. But in no case issues related to quality, workmanship, safety, area lighting, approach road should be compromised.

Meeting concluded with good note to enhance progress and to achieve target as per commitment.

--- X ---

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Samarjeet Thakur

From:	Samarjeet Thakur
Sent:	02 June 2017 17:14
To:	'b.biswas@engineeringprojects.com'
Cc:	Shree Narayan; Satyajit Ganguly; Sudin Chattopadhyay; dp@engineeringprojects.com; 'neroguwahati@gmail.com'; 'epilagartala@gmail.com'
Subject:	RE: Release of Payment against RA 3rd (work done for the month of March 2017)

Dear Sir,

Kindly note that the issue of time extension was not at all discussed in the meeting. The meeting started with a note that there has been a delay in the past but we shall discuss only about expediting the execution of work.

We would like to inform you that there has been no delay on the part of OTPC and your claim is without any basis. Your claim submitted vide email dated 26th May 2017 shall be responded later as per the provisions of the contract, appropriately. In view of the above, and considering that changes requested by you for incorporating in the MOM are not relevant, we request you to sign and send the scanned copy of the MOM sent vide our email dated 1st June 2017.

Thanks & Regards
Samarjeet Thakur

From: b.biswas@engineeringprojects.com [mailto:b.biswas@engineeringprojects.com]
Sent: 02 June 2017 14:37
To: Samarjeet Thakur
Cc: Shree Narayan; Satyajit Ganguly; Sudin Chattopadhyay; dp@engineeringprojects.com; Jamshed Akhtar; neroguwahati@gmail.com; epilagartala@gmail.com
Subject: RE: Release of Payment against RA 3rd (work done for the month of March 2017)

Dear Sir

We are in receipt of the Minutes of Meeting Drafted at your end. We request you to kindly revise the MoM Draft as attached (PDF as well as DOC format provided for your easy working) to enable us to sign the same and put on record.

Thanks & Regards

B Biswas

GGM(I/C)-NER

EPI-Guwahati

On 01/06/17 06:18 PM, **Samarjeet Thakur** <samarjeet.thakur@otpcindia.in> wrote:
Dear Sir,

Attached please find the signed and scanned copy of "Minutes of Review Meeting held on 30th May 2017" for your

signatures .

Kindly sign and send the scanned copy for our records.

Thanks & regards

Samarjeet Thakur

From: Shree Narayan
Sent: 29 May 2017 10:12
To: Biswajit Biswas
Cc: Satyajit Ganguly; Samarjeet Thakur; Sudin Chattopadhyay; dp@engineeringprojects.com
Subject: RE: Release of Payment against RA 3rd (work done for the month of March 2017)

Dear Sir,

With reference to trailing mail we wish to inform you as follows:

1. As per work execution schedule provided by EPIL, piling work was to be completed within 90 days from the date of start of piling. Rate of piling was supposed to be more than 17 piles per day. However, actual rate of pile has been around 5.5 piles per day which is 1/3rd of the required rate.

2. During the meeting held on 19th April 2017, it was committed that piling work shall be completed by 20th June 2017 i.e. around 15 piles per day. However, since the meeting only 174 piles have been completed till 25th May 2017 (as mentioned in your trailing mail) at a rate of 4.7 piles per day. It shows that rate of piling has further slowed down since the review meeting held on 19th April 2017. No. of piles completed in last seven days are given below which shows alarmingly poor rate of execution and continuous decline in rate of execution of piles:

1.	26th May 2017	-	2 Piles
2.	25th May 2017	-	3 piles
3.	24th May 2017	-	5 piles
4.	23rd May 2017	-	1 pile
5.	22nd May 2017	-	3 piles
6.	21st May 2017	-	4 piles
7.	20th May 2017	-	2 piles

Total - 20 piles @<3 piles per day

3. Subcontractors of EPIL had never performed since beginning in terms of resource mobilization, manpower mobilization and piling rate. It is all matter of record. It is responsibility of EPIL to mobilize contractor so as to complete the work within scheduled time for completion. As regards deviation in quantity is concerned, all variations are within contract provision and hence can't be considered as an excuse. As regards delay, there has been no delay on part of OTPC. Rather, there has been delay by EPIL in execution of work due to following major reasons:

   1. delay in award of contract. While contract for piling was awarded for type-2 & 3, type-4, 5 and club house not awarded till 30th August 2016 (please refer MOM dated 23rd August 2016),

   2. results of test piles were accepted and final drawings were given to EPIL on 10th November however piling work started on 6th January 2017 i.e. almost 2 months after issue of updated drawings based on pile test results.

   3. delay in mobilization of resource required under contract (less than 30% resource have been mobilized). In spite of this delay and in spite of non-compliance of contract provision OTPC has released part advance payment,

   4. frequent shortage of construction material and perennial shortage of manpower has contributed to very poor progress,

   5. very poor, incomplete and delayed enabling work is adversely affecting the progress work. There is no temporary road, drain etc which is causing stoppage of work after short bout of rain.

4. While giving commitment in the meeting held on 19th April 2017, EPIL was aware of all the variables mentioned in trailing mail and hence same can't be consider for not fulfilling even a single commitment.

5. EPIL MUST give detailed action plan for completing piling work by 200th June 2017 along with resource requirement and mobilization plan.

6. No revised program has been received on 25th May 2017. Please note that any change in completion date is not acceptable. Please provide program for completing the piling work within 20th June 2017 and balance work within March 2018

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Regards

Shree Narayan

From: b.biswas@engineeringprojects.com [mailto:b.biswas@engineeringprojects.com]
Sent: Friday, May 26, 2017 4:23 PM
To: Shree Narayan
Cc: dp; Sudin Chattopadhyay; Samarjeet Thakur; Samarjeet Thakur; epiludaipur@gmail.com; j.akhtar@engineeringprojects.com
Subject: Regarding Reply of Email dated : 12.05.2017 and Email dated : 25.05.2017

Dear Sir

In response to your Emails Dated 12.05.2017 and 25.05.2017 followings are submitted for your information and record please:-

Regarding Email Dated : 12.05.2017

a) **Mobilization of Additional TMRs**:- You are kindly aware of the facts that the sub-contractor M/s Apu Dey who was allotted piling works of Type-II & III in the month of May'16 with completion time of 3 months, has expressed his inability to continue with works after completing piling works of Type-II because there has been huge deviation in piling quantities due to revision of design/drawings of piles and subsequent increase of prevailing market rate of construction materials such as steel, cement, coarse and fine aggregates etc. and also there has been considerable delays (more than 6 months) in issuing working drawings by OTPC.

Commitment for mobilization of additional TMRs was given during review meeting dtd. 19.04.2017 considering that piling works will be started in Type –III Quarter anticipating that EPI will be able to resolve the issue of M/s Apu Dey by 30.04.2017 and piling work in Type –III can be started from 01.05.2017 through other agency (M/s AB Construction, M/s Prabhu Agarwala). Contractual complication arises after surrender of Type-III piling work by M/s Apu Dey and we are in the process to resolve it at the earliest. EPI being a PSU cannot simply allot any works directly to anyone, but has to follow certain mandatory norms/ procedures for reallocating works.

b) **Mobilization of TM :** One TM was already available at site. Additional TM is required for Type-III works which will be mobilized as soon as work in Type-III Quarter is started. It is however vital to mention that, TM with full load is unable to move in the muddy condition of the pile construction areas and the works are being continued with 2 Nos Self Loading Four Wheel Drive Concrete Batchers (Ajax Flori).

c) **Welder/ Bar binder:** Commitments were made based on starting Type- III piling works. Present strength is sufficient to cater the requirements of the available 4 nos TMRs and 1 no Hydraulic Rig (13 to 14 cages per day being prepared presently). It shall be increased with mobilization of additional TMR with

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MINUTES OF REVIEW MEETING HELD AMONG M/s ONGC TRIPURA POWER COMPANY LIMITED (OTPC), AND ENGINEERING POJECTS INDIA LIMITED (EPIL) AT OTPC OFFICE,NEW DELHI ON 30.05.2017 FOR CONSTRUCTION OF. TOWNSHIP AT KHILPARA, UDAIPUR, TRIPURA.

Participants:

OTPC

1. Mr. Satyajit Ganguly, MD
2. Mr. Shree Narayan, GM(C&M)
3. Mr. Samarjeet Thakur, DGM(Contracts)

EPIL

1. Mr. Vinoo Gopal, CMD (Addl. Charge) and Director (Project)
2. Mr. Biswajit Biswas, ED(NERO)
3. Col. J. Akhtar, GM

The following points were discussed

i. OTPC informed that the contract for construction of Township was awarded to EPIL with completion date as 27th March 2018. OTPC also informed that it is essential for OTPC to capitalize the expenses towards construction of township by 31st March 2018 so that same may be allowed for inclusion in project cost by Central Electricity Regulatory Commission (CERC) for determination of electricity tariff of Palatana power plant.

ii. OTPC expressed concern about delay in installation of Pile before monsoon and informed that as per work execution schedule provided by EPIL, piling work was to be completed within 90 days from the date of start of piling with rate of piling as 17 pile/day. However, actual rate of pile has been around 5.6 piles per day (802 pile in 143 days), which is 1/3rd of the required rate.

iii. OTPC also informed that there has been no significant progress since the review meeting was held on 19th April 2017 at OTPC township, to complete the piling work by 20th June 2017 and mobilize the additional 4 nos. Rigs, 2 nos. transit mixer, increase the rig operation staff to 50 nos. EPIL accepted that there has been very slow progress since 19th April 2017, due to internal contractual issues and financial constraints.

iv. OTPC requested and EPIL confirmed the following:
   A. Completion of balance 738 Piles by 30th June 2017 and completion of Pile breaking by 15th July 2017.
   B. Rectification of Roads by putting WBM so that work is not hampered during monsoon.
   C. Mobilization of additional 4 nos. rigs, 50 nos. rig manpower, 50 nos. manpower for pile breaking for type –II & type-IV.
   D. Improvement in storage of material.
   E. Improvement in area lighting for working in night.

v. OTPC requested and EPIL agreed to submit the plan for completion of pile, pile breaking and pile cap within 2 days.

vi. EPIL informed that there has been delay in release of past payments to which OTPC responded that all payments has been released within due date which is 30 days as per the contract. However, in order to facilitate EPIL and ensure smooth construction at site, OTPC proposed that on EPIL's certification OTPC may pay directly to the sub-contractor's of EPIL. Appreciating OTPC's proposal EPIL requested to release 70% payment within 1-2 weeks of receipt of invoice (pending verification) and balance 30% payment within 30 days of receipt of invoice after verification by OTPC, directly to EPIL. In view of the request from EPIL and considering the requirement of the project, as a special case, OTPC assured to release part payment within 15 days of receipt of invoices along with all supporting documents and remaining payment as per the provisions of the contract. EPIL thanked OTPC for accommodating their request.

vii. EPIL requested OTPC to approve the rates for dynamic load testing (extra item rate) as they have already submitted rate analysis. OTPC informed EPIL that approval of rate analysis of extra items consume considerable time. In order to minimize the time for approval of extra item rates, OTPC accorded approval to EPIL to execute all extra items (not included in BoQ) on cost plus 10% basis.

viii. CMD-EPIL confirmed to take all possible action to expedite construction of OTPC Township to ensure capitalization of the expenses towards construction of township by 31st March 2018 so that same may be allowed for inclusion in project cost by CERC.

01.VI.2017

OTPC **EPIL**

(S. Thakur)

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Samarjeet Thakur

From: Samarjeet Thakur
Sent: 12 May 2017 13:02
To: 'dp@engineeringprojects.com'
Cc: Shree Narayan; Satyajit Ganguly; Sudin Chattopadhyay; Biswajit Biswas (b.biswas@epi.gov.in); karan.bakshi@otpcindia.in
Subject: Progress Review Meeting - Construction of OTPC Township- Palatana
Attachments: Agenda for Progress Review Meeting - OTPC Township - EPIL - 18.05.17.xlsx

Dear Sir,

We would like to inform you that a meeting was held with Mr. B. Biswas ,ED at site on 19th April 2017 in the presence of MD, OTPC for review of 'Construction of Township" at Palatana. There has been no progress and complete dishonour of the commitments made by EPIL. The present status of the commitment given by ED,EPIL on 19th April 2017 is also given below for your kind reference :

1. EPIL requested for the mobilization of following additional T&P's against 1 no. hydraulic rig. and OTPC agreed for the same and advised EPIL to adhere to the commitment. Following has been committed by EPIL:
   a. 5th TMR by 01.05.2017
      6th TMR by 07.05.2017
      7th & 8th TMR by 10.05.2017
      Status on 12.05.17: No progress with regards to the deployment of additional TMR's on site as on date.

   b. 2 nos. Transit Mixture (TM) : 2nd TM by 02.05.2017 and 3rd TM - EPIL to confirm the deployment date by 01.05.2017
      Status on 12.05.17: only 1 no. TM is operating at site as on date. No confirmation provided as yet by EPIL regarding the deployment date of additional 2 nos. TM.

   c. Welder and Barbinder: 50 nos by 01.05.2017
      Status on 12.05.17: As on date only 25 nos Welder and Barbinder are operating at site against the promised strength of 50 nos. manpower.

2. EPIL agreed and confirmed to increase the manpower associated with Rig operation to 50 nos competent workforce by 01.05.2017. OTPC instructed EPIL to mobilize the rigs which are presently under operation at Type-V building to Type-III building till the arrival of additional TMR's. MD OTPC desired the completion of piling work by 15.06.2017 (before onset of monsoon). ED-EPIL assured to complete the piling works by 20.06.2017.

   Status on 12.05.17:

   i. As on date only 28 nos manpower specialised with rig operation is operatong at site against the promised strength of 50 nos.manpower.

   ii. Piling work is yet to take a start at Type-III building. We understand an alternate vendor is yet to be finalized.

   iii. Pile completed by 19.04.2017= 596 /1539 ~ 38%
   Pile installed as on 11.05.2017 = 708/1539 ~ 46%
   Piling work that should have been completed by 13.05.2017 as per pile and pile cap construction schedule submitted on 19.04.2017 = 1010/1539 ~ 66% - 20% shortage in construction of Piles

In view of the non-fulfillment of the above commitment by EPIL, we seek your kind intervention in expediting the "Construction of Township" at Palatana and also invite you for a meeting to review the progress of 'Construction of Township' at OTPC office, 6th Floor, IFCI Tower, Nehru Place on 18th May 2017 @ 3:00 PM. Your kind confirmation in this regard shall be highly appreciated.

Thanks & Regards
Samarjeet Thakur

From: Shree Narayan
Sent: 09 May 2017 19:21
To: EPIL Udaipur
Cc: Sudin Chattopadhyay; Samarjeet Thakur; Karan Bakshi; kny.otpcsite@gmail.com; Subir Kumar Saha; Chinnasamy Ravi; Engineering Projects Agartala; sproy; Biswajit Biswas
Subject: Re: Good Excavated Earthen Material to taken outside-reg

Dear sir,

Your reply is not based on facts and inconsistent with decision taken in last meeting held with Mr Biswas.

Please takeout slurry from site before removing good earth. Any good earth removed prior to removal of slurry is not acceptable

Your all other points are without basis and shows complete dishonor of commitment given by EPIL in last meeting and hence completely rejected. Please immediately mobilize rigs and start work in type 3 failing which OTPC shall be at liberty to take necessary action as deemed appropriate to recover the progress.

Regards

Shree Narayan

On 09-May-2017, at 6:51 PM, EPIL Udaipur <epiludaipur@gmail.com> wrote:

> Dear Sir
>
> We have appraised your goodself that due to huge quantity variation and time over run in pile design revision, the sub contractor of piling work in Type-II & Type-III has expressed his unwillingness to work in Type-III. EPI higher authority is arranging to deploy alternate agency for the pile work in Type-III in top priority and to comply with the commitments of mobilizing additional TMRs, TM etc.
>
> All concerned are kindly aware that the huge bentonite sludge piled up at site before the decision taken on 19.04.2017 to remove the same has taken very bad shape in the incessant rain followed for next 10-12 days.
>
> After the rain, disposing the bentonite sludge has resumed as and when any portion of the same dries up and becomes suitable for carriage.
>
> Regarding Type-IV quarter, it requires approx. 1.6 M excavation further to reach to cutoff level to start PCC work for pile cap. Accordingly Excavation was started to remove the same, however stopped immediately on instruction.
>
> Request you to kindly demarcate the area of disposal/stacking of excavated earth.
>
> Thanking You,

MOM - Review Meeting for Township Project with EPILon 19th April 2017

Description	Description Meeting dated 28.03.17	Action by	Target Date	Present status	Review on 19.04.2017
zation for T&P	OTPC raised their discontent over non availability of 2nd hydraulic rig at site. EPIL assured OTPC that 2nd hydraulic rig shall be available at site from 15th April 2017 onwards. OTPC requested EPIL to mobilize one additional fully automatic batching plant of 30cum/hr capacity. EPIL agreed to mobilize the same by Apr-17.	EPIL	15.04.2017	No Progress	1. EPIL requested for the mobilization of following additional T&P's against 1 no. hydraulic rig. and OTPC agreed for the same and advised EPIL to adhere to the commitment. Following has been committed by EPIL: a) 4 nos. TMR : 5th TMR by 01.05.2017 6th TMR by 07.05.2017 7th & 8th TMR by 10.05.2017 b) 2 nos. Transit Mixture (TM) : 2nd TM by 02.05.2017 and 3rd TM - EPIL to confirm the deployment date by 01.05.2017 c) Welder and Barbinder: 50 nos by 01.05.2017 2. OTPC stated that, in case, EPIL is not able to mobilize the 2nd Batching Plant, it shall be arranged by OTPC and backcharged to EPIL. OTPC requested EPIL to provide the detail of probable suppliers.
rogress of work	OTPC raised the concerns regarding the slow progress of piling works. EPIL informed that 1st pile using Hydraulic rig has been completed on 26.03.17. EPIL also acknowledged OTPC's concern and stated that piling work shall be completed by June 2017	EPIL	30.05.2017	Extremely Slow Progress, monthwise breakup of pile installation is as follows:- Jan'17 - 121 Piles Feb'17- 267 Piles March'17- 125 Piles till 10thApril'17 - 36 Piles This is almost 6 piles /day against the EPIL commitment of installing minimum 11 piles/day.	EPIL agreed and confirmed to increase the manpower associated with Rig operation to 50 nos competent workforce by 01.05.2017. OTPC instructed EPIL to mobilize the rigs which are presently under operation at Type-V building to Type-III building till the arrival of additional TMR's. MD OTPC desired the completion of piling work by 15.06.2017 (before onset of monsoon). ED-EPIL assured to complete the piling works by 20.06.2017. EPIL presented **construction schedule for pile and pile cap** which has been discussed in detail and is attached as **Annexure-1.**
d BBS	EPIL requested OTPC to review and approve the revised Bar Bending Schedule (BBS). OTPC accepted to review the revised BBS	OTPC		To be approved after receipt of confirmation reg. Hydraulic Rig	OTPC informed that the revised BBS submitted by EPIL stands approved.
ite Slurry Disposal	EPIL requested OTPC to identify the disposal point for Bentonite slurry. OTPC advised EPIL to stack the slurry beside Rajshree. However, Disposal rate shall be finalized later on mutual agreement.	EPIL		EPIL to take action	EPIL informed that disposal of piling sludge outside the site boundary has been started on 19.04.2017. The quantity of sludge shall be considered as 4.5 cum/pile .

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MOM - Review Meeting for Township Project with EPILon 19th April 2017					
Description	Description	Action by	Target Date	Present status	Review on 19.04.2017
	Meeting dated 28.03.17				
rawings	EPIL requested OTPC to furnish the RFC drawings for Beams and structures. OTPC informed EPIL that drawings are in advance stage of approval and RFC drawings shall be submitted to EPIL upon approval by 31st March 2017	OTPC	31.03.2017	Type --II & IV -- 42 out of 51 RFC drawings are handed over to EPIL by OTPC site team.	EPIL confirmed the acceptance of 102/118 structural RFC drawings have been made available to EPIL.
ontractors /Vendor Documents	OTPC requested EPIL to submit the vendor documents pertaining to the contractor under finalization for super structure works. OTPC also expressed its reservation over the slow progress of works under existing contractors. OTPC further suggested thet no additional work shall be alloted to existing contractors .EPIL agreed to submit the vendor documents by 29.03.2017	EPIL	29.03.2017	No Progress	EPIL agreed to submit the technical evaluation report along with bidders credentials for review and approval of OTPC by 20.04.2017.
mic Load test	EPIL expressed their inability to conduct the Dynamic load test based upon the method described by M/s Fichtner. OTPC proposed EPIL for a Joint meeting with Fichtner and their soil consultant to discuss and resolve the issue. Date of the meeting shall be finalized later on mutually accepted date.	EPIL/OTPC	10.04.2017	OTPC discussed the matter dicussed with Fichtner. After reviewing the documents submitted by EPIL, Fichtner requested EPIL to submit two or three results of the tests conducted on 500mm bored cast-in-situ dia piles of roughly 20m long and having similar capacity, for their review. Request was forwarded to EPIL vide email dated 07.04.2017	Approval for using 1.8 T hammer for Dynamic Load testing given to EPIL vide email dated 13.04.2017.
cal Load test	OTPC requested to EPIL to conduct another vertical load test in cengrs supervision, considering the pile design capacity of 57T. EPIL agreed for the same.	EPIL		No Progress	EPIL to confirm the date by 30.04.2017
sit Mixture demobilization	OTPC expressed concern regarding removal of Transit Mixer (TM) from site without intimation to OTPC. EPIL was advised that demobilization of any equipment at site shall be done only with the approval of OTPC. EPIL confirmed to mobilize the TM by 01.04.17.	EPIL	01.04.17	No Progress	1 no TM mobilized at site on 15.04.2017.
r Hutment	OTPC informed EPIL that the labor hutment are very close to the construction site/ towers and hence, it should be moved away by at least 30 metres. EPIL agreed to shift the hutment	EPIL		EPIL to take action	EPIL to confirm action by 30.04.2017

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MOM - Review Meeting for Township Project with EPILon 19th April 2017

Description	Description	Action by	Target Date	Present status	Review on 19.04.2017
	Meeting dated 28.03.17				
›on Plan	OTPC requested EPIL to submit the construction plan including construction of store, Infrastructure, Temporary road, dewatering pumps for monsoon period. EPIL agreed to submit the same by 07.04.17.	EPIL	07.04.17.	No Progress	a) Material for temporary access road arrived at site on 19.04.2017. b) EPIL submitted the road and drains plan which shall be reviewd and approved by OTPC in consultation with KNY c) OTPC requested EPIL to arrange for temporary shed at the work locations so as to facilitiate the the construction work during monsoon period. OTPC also requested for proper site illumination.
Drainage	OTPC requested and EPIL agreed to furnish the sewage water discharge calculation for design of discharge pipeline upto Gumti.	EPIL		EPIL to take action	To be discussed
	Plan for preparation and development of Service Road for smooth movement Hyd.Rig ,Transit Mixer, Hydra Crane etc.	EPIL		EPIL to submit the Plan and take action	EPIL submitted the road and drains plan which shall be reviewd and approved by OTPC in consultation with KNY.
ssion of Deviation Sheet					EPIL agreed to submit the deviation sheet to OTPC wrt to Increase in concereting and reinforcement steel due to change in pile design by 25.04.2017
eview Meeting					Next review meeting shall be held at township site on 18.05.2017.
ers Present: yajit Ganguly, Sh. Sudin Chattopadhyay, Sh. Shree Narayan, ,Sh. S.K. Saha,Sh. C. Ravi,Sh. S Thakur lakshi h. Ravi Yadav, Sh. Utpal Bhaduri, Sh. Shovan Deb			Members Present: **EPIL:** Sh. B. Biswas, Sh. S.P.Roy, Sh. S.R. Lahiri, Sh. Abhijit Nandi		

ANNEXURE-1 - CONSTRUCTION SCHEDULE FOR PILE AND PILE CAP WORKS

ONSTRUCTION OF TOWNSHIP FOR OTPC AT KHILPARA, UDAIPUR, TRIPURA

19th April 2017

Sl. No	Description of Item	Agency	Unit	Quantity Required	Executed/Available as on date	Balance reqd as on 18.04.17	Start Date	End Date	Commitment/ Planning on 19.04.17	2017																			
										April		May				June				Jul				Aug			
										W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
1	**Release of Construction Drawings (Pile & Cap)**																												
1.1	Type-II Quarters							11-Nov-16																					
1.2	Type-III Quarters							18-Nov-16																					
1.3	Type-IV Quarters							02-Dec-16																					
1.4	Type-V Quarters							15-Dec-16																					
1.5	Club House							10-Mar-17																					
2	**Release of Construction Drawings (Column)**																												
2.1	Type-II Quarters						30-Jan-17	23-Mar-17																					
2.2	Type-III Quarters						30-Jan-17	23-Mar-17																					
2.3	Type-IV Quarters						30-Jan-17	23-Mar-17																					
2.4	Type-V Quarters						30-Jan-17	23-Mar-17																					
3	**Balance Mobilization for Pile & Cap**																												
1	Fully Automated Batching Plant, 30Cum/Hr		No	1	-																								
a	Batching Plants (20/18 Cum/Hr)		No	2	1	1			10-05-2017 - To be arranged by OTPC																				
b	Mobile Self Loding Batcher (Ajax)		No	-	2	0																							
2	Tower Crane 30-40m		No	1	-																								
a	Crawler Crane		No	-	1	0																							
3	Transit Mixer		No	3	1	2	01-May-17	15-Jun-17	2nd Transit Mixer to be deployed by 02-May-17																				
4a	Hydraulic Rigs		No	2	1	0		" "																					
4b	Truck Mounted Rig		No	8	4	4			To be mobilized by EPIL: 5th TMR -01.05.17 6th TMR - 07.05.17 7th TMR - 10.05.17																				
5	Shuttering, Steel/Ply		Sqm	5000	0	5000	01-May-17	07-Jul-17																					
6	Steel Props & Supports		Sqm	5000	0	5000	01-May-17																						
7	Needle Vibrator		Nos.	25	0	25		01-Jun-17																					
8	Plate Vibrator		Nos.	5	0	5																							
9	DG Set 250KVA		Nos.	2	-																								
a	DG Set 87.5KVA		Nos.	-	1	0																							
b	DG Set 125KVA		Nos.	-	1	0																							
c	DG Set 20KVA		Nos.	-	1	0																							
10	De-watering Pump		Nos.	10	2	8			30-04-2017- 1 Nos. by ABC and 1 No. Apu Dey, 31-05-2017- 2 Nos. By P. Aggarwal and 2 Nos. By P. Aggarwal																				
11	Steel Cutting Machines		Nos.	5	-																								
a	Steel Shear Cutting Machine		Nos.	-	1	0																							
b	Steel Wheel Cutting Machine		Nos.	-	5	0																							
12	JCB		Nos.	1	2	0																							

Sl. No		Description of Item	Agency	Unit	Quantity Required	Executed/Available as on date	Balance reqd as on 18.04.17	Start Date	End Date	Commitment/ Planning on 19.04.17	2017																	
											April		May				June				Jul				Aug			
											W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
	13	Tractor with trolly		Nos.	3	-																						
	a	Dumper		Nos.	-	2	0																					
	14	Hydra		No	-	1	0		NA																			
	15	Steel Bending Machine		No	-	1	0		07-Apr-17																			
	16	Concrete Pump		No	2	0	2		14-05-2017, 01-07-2017	14-05-2017- ABC , 15-06-2017- P. Aggarwal																		
	17	Welding Machine		No	-	12	0		NA																			
						3	2																					
4	Material Induction																											
	4.1	Cement (OPC-43)		MT	3343	130	3213				74	229	212	289	381	377	241	428	8	270	25	20	18	0	771	0	0	0
	4.2	Reinforcement Steel		MT	1116	180	936				34	102	110	148	202	138	133	10	12	32	33	37	35	30	0	0	0	
	4.3	Sand		CUM	3717	150	3567				83	261	242	332	434	424	274	449	23	297	40	34	18	0	806	0	0	0
	4.4	Coarse Aggregates		CUM	6363	350	6013				137	433	401	552	722	704	456	798	40	527	70	59	33	0	###	0	0	0
	4.5	Shuttering Plate/Ply		SqM	1080	0	1080						440						330		310							
5	Manpower Induction																											
	5.1	Rig Operator		Person	5	5	0			50 Rig people by 01.05.17																		
	5.2	Crane Operator		Person	1	1	0																					
	5.3	Batching Plant operator		Person	2	2	0																					
	5.4	Semi-skilled Mason		Person	6	2	4																					
	5.5	Welder		Person	9	9	0			Increase mobilization to 50 by 01.05.17																		
	5.6	Bar-Bender		Person	30	18	12																					
	5.7	Helper		Person	40	20	20																					
	5.8	Unskilled/Mazdoor		Person	30	15	15																					
	5.9	Carpenter		Person	10	0	10																					
6	Installation of Piles (500 Dia/21.0																											
	6.1	Type-II Quarter-Piles	Apu Dey	No	278	200	78	09-Jan-17	15-May-17	Completion by 15-May-17	30	30	18															
	6.2	Type-III Quarter-Piles	P. Aggarwal	No	443	0	443	08-May-17	10-Jun-17	Completion by 10-June-17		60	63	78	84	84	57											
	6.3	Type-IV Quarter-Piles	AB Const	No	360	360	0	06-Jan-17	08-Apr-17		COMPLETED																	
	6.4	Type-V Quarter-Piles	AB Const	No	280	30	250	29-Mar-17	20-Jun-17	Completion by 20-June-17	0	0	0	42	84	84	40											
	6.5	Club House-Piles	AB Const	No	176	0	176	19-Apr-17	20-Jun-17	Completion by 20-June-17	9	28	28	28	28	28	27											
7a	Routine Vertical Test of Pile (@3%)		CENGRS/R. Das	Nos	47	9	38	10-Mar-17	20-Jul-17		3	3	3	3	3	3	3	3	3	3	3	3	2					
7b	Dynamic Load Test (@7%)		Geotis	Nos	108	0	108	07-May-17	30-Jul-17				8	10	8	10	8	10	8	10	8	10	9	9				

Sl No	Description of Item	Agency	Unit	Quantity Required	Executed/Available as on date	Balance reqd as on 18.04.17	Start Date	End Date	Commitment/ Planning on 19.04.17	2017																			
										April		May				June				Jul				Aug			
										W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
8	Pile Cap																												
8.1	Type-II Quarter																												
8.1.1	Excavation & Pile breaking	Apu Dey	Cum	2220	0	2220	22-Apr-17	31-May-17		350	400	400	370	370	330														
8.1.2	PCC 1:4:8	P. Aggarwal	Cum	62	0	62	08-May-17	07-Jun-17					15	16	16	15													
8.1.3	Form work	P. Aggarwal	Sqm	290	0	290	15-May-17	20-Jun-17						70	70	70	70	10											
8.1.4	Steel binding	P. Aggarwal	MT	52	0	52	15-May-17	20-Jun-17						12	10	10	10	10											
8.1.5	RCC	P. Aggarwal	Cum	590	0	590	22-Jun-17	30-Jun-17											590										
8.2	Type-III Quarter																												
8.2.1	Excavation & Pile breaking	P. Aggarwal	Cum	2925	0	2925	25-May-17	07-Jul-17							425	500	500	500	500	500									
8.2.2	PCC 1:4:8	P. Aggarwal	Cum	85	0	85	24-Jun-17	14-Jul-17										20	22	23	20								
8.2.3	Form work	P. Aggarwal	Sqm	305	0	305	25-Jun-17	25-Jul-17											50	65	65	65	60						
8.2.4	Steel binding	P. Aggarwal	MT	91	0	91	25-Jun-17	25-Jul-17											15	16	20	20	20						
8.2.5	RCC	P. Aggarwal	Cum	1000	0	1000	01-Aug-17	05-Aug-17																1000					
8.3	Type-IV Quarter																												
8.3.1	Excavation & Pile breaking	AB Const	Cum	2245	0	2245	05-Apr-17	12-May-17		400	500	500	845																
8.3.2	PCC 1:4:8	AB Const	Cum	80	0	80	01-May-17	30-May-17				20	20	20	20														
8.3.3	Form work	AB Const	Sqm	140	0	140	16-May-17	21-Jun-17						20	30	30	35	25											
8.3.4	Steel binding	AB Const	MT	88	0	88	16-May-17	21-Jun-17						15	20	20	18	15											
8.3.5	RCC	AB Const	Cum	964	0	964	25-Jun-17	30-Jun-17											964										
8.4	Type-V Quarter																												
8.4.1	Excavation & Pile breaking	AB Const	Cum	1915	0	1915	01-Jun-17	12-Jul-17								250	350	350	350	350	265								
8.4.2	PCC 1:4:8	AB Const	Cum	75	0	75	20-Jun-17	14-Jul-17										18	19	19	19								
8.4.3	Form work	AB Const	Sqm	128	0	128	25-Jun-17	30-Jul-17											25	25	30	25	23						
8.4.4	Steel binding	AB Const	MT	70	0	70	25-Jun-17	30-Jul-17											15	15	15	15	10						
8.4.5	RCC	AB Const	Cum	745	0	745	01-Aug-17	06-Aug-17																745					
8.5	Club House																												
8.5.1	Excavation & Pile breaking	AB Const	Cum	2800	0	2800	08-May-17	14-Jun-17					500	500	600	600	600												
8.5.2	PCC 1:4:8	AB Const	Cum	30	0	30	01-Jun-17	30-Jun-17								7	8	7	8										
8.5.3	Form work	AB Const	Sqm	200	0	200	08-Jun-17	15-Jul-17									25	25	30	25	95								
8.5.4	Steel binding	AB Const	MT	8	0	8	15-Jun-17	15-Jul-17										2	2	2	2								
8.5.5	RCC	AB Const	Cum	110	0	110	01-Jul-17	25-Jul-17												40	30	40							

Annexure P-7

OTPC

ONGC Tripura Power Company Limited

(JV Company of ONGC, IL&FS, IDFC and Govt. of Tripura)

6th Floor, A Wing, IFCI Tower-61, Nehru Place, New Delhi-110019 Phone: +91-11-26402100 Fax: +91-11-26227532/26227533

Ref: OTPC/ EPIL/2017-18/050/366

12th Sep 2017

Shri N. Sivananda,
Joint Secretary (DHI) and CMD (Addl. Charge)
Engineering Projects India Limited
Core-3, SCOPE Complex,
7, Institutional Area, Lodhi Road
New Delhi - 110003

Sub: Contract for civil construction work for construction of Township at Khilpara, Tripura

Dear Sir,

At the outset we thank you for giving us time and opportunity to meet you in your office on 7th September 2017, explain our perspective regarding delay in construction of township by EPIL and seek your kind intervention for expediting the work. During the meeting we presented a brief status of the project (copy attached) and highlighted the following for your kind consideration:

a. **Pile Design**: There has been some delay in finalization of pile design for which responsibility does not lie primarily on EPIL.

b. **Pile Construction**: As per agreed program, piling work needed to be completed in less than 3 months. However, since finalization of pile design in November 2016, more than 10 months have passed but only 68% piling, 32% of routine test of piles and 2% of dynamic load test of piles has been completed and with current rate of piling, work is likely to get completed not before November 2017. Major reason for delay has been inadequate and delayed mobilization of (i) tools & plants e.g. rigs, transit mixers, batching plants etc, and (ii) manpower which continue even now.

c. **Pile Cap**: Pile cap work has not even started due to (i) delayed and inadequate mobilization of manpower for pile breaking, and (ii) delay in award of contract for pile cap of type-2 and type-3 buildings.

d. **Non-adherence of commitment**: None of the commitments related to completion has been fulfilled by EPIL which can be seen from the fact that on 30th November 2016, 19th April 2017, 30th May 2017 and 28th June 2017 commitment were made to complete the piling work by 5th May 2017, 20th June 2017, 30th June 2017 and 20th July 2017 respectively; however, till date only 68% piles have been completed.

T.C.

OTPC

e. **Delay in issue of tender and award of contract**: It is almost 18 months (with completion period of 24 months) since contract was given to EPIL however tender for following major works, which are no way linked with pile design and hence had no constraint, have not been issued so far: superstructure work for type-2 and 3 building, lift, water system, electrical system, fir fighting system etc.

We brought to your kind attention that if construction of township is not completed by March 2018 (3 years from commissioning of Plant) then cost of township shall be not be admitted for capitalization by Central Electricity Regulatory Commission leading to significant financial loss for OTPC. We also shared with you concern of our Board of Directors expressed in their last meeting held on 2nd September 2017 regarding delay by EPIL and their direction to OTPC to take all possible measures (including engaging additional / alternative agencies) to ensure phase wise completion of township by June 2018.

Agreeing with the concern of OTPC and its Board of Directors, you very kindly agreed to review the project in detail, take necessary remedial action and provide us phase wise completion program with completion of all work of township not extending beyond June 2018.

We look forward to receive the phase wise completion program for completion of township work by June 2018. We also look forward to your continued support by way of continuous monitoring, periodically reviewing the project jointly with EPIL and OTPC and issuing appropriate direction for removing bottlenecks so that construction of township does not slip beyond June 2018.

Thanking you,

Yours faithfully,
for ONGC TRIPURA POWER COMPANY LIMITED

SATYAJIT GANGULY
MANAGING DIRECTOR

Encl: Brief status of the project dated 7th September 2017

CC: DIRECTOR (PROJECTS), EPIL

CC: CMD, ONGC & CHAIRMAN, OTPC

CC: DIRECTOR (T&FS), I/C OTPC

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7th September 2017

CONSTRUCTION OF TOWNSHIP

ABOUT OTPC

ONGC Tripura Power Company Limited (OTPC) is joint venture of ONGC (50%), Government of Tripura (0.5%), IL&FS (26%) and IDFC (23.5%). It operates a 2 x 363.3 MW gas based combined cycle power plant at Palatana in Tripura. Power from the plant has been allocated to all seven north eastern states by Ministry of Power, Government of India

TOWNSHIP

OTPC is constructing township for its employees at power plant. Township is located at about 3 KM from nearest Town Udaipur and about 5 KM from Power Plant. It consists of 4 towers comprising of (4/9/10/10 floors) 126 flats

STATUS UPDATE

a. Date of award of Contract - 28th March 2016
b. Scheduled completion - 28th March 2018 (2 years from award of contract)
c. Final clearance for test pile - 29th July 2016 (by OTPC)
d. First test pile - 9th August 2016
e. 5th test pile - 28th September 2016
f. Clearance for regular pile - 10th November 2016 (by OTPC)
g. Schedule for completion of pile - 90 days
h. Piling work status 300 days after drawing handover and 243 days after start of piling:

Building	Date of drawing handed over to EPIL	Date of start of piling	Total No. of piles	Piles completed till 6-Sep-17
Type-2	10-Nov-16	9-Jan-17	278	276
Type-3	18-Nov-16	6-Jan-17	443	99
Type-4	2-Dec-16	1-Jun-17	360	360
Type-5	15-Dec-16	3-Jul-17	280	247
Club	10-Mar-17	5-Jun-17	176	58
Total			1537	1040

i. ***It has taken 115 days on average to start piling after receipt of drawing from OTPC***

j. Status of pile testing:
   - ✓ Routine test - 15 out of 47 (32%)

- ✓ Dynamic load test - 1 out of 47 (2%)

k. **Commitment made in the meeting held with GGM-I/C-NER on 19th April 2017:**

- ✓ Piling completion - 20th June 2017 (only 68% completed till date)
- ✓ Pilecap completion - 1st August 2017 (Nil progress till date)
- ✓ Augment T&P and manpower within 15 days

l. **Commitment made in the meeting held with Director (Projects) on 30th May 2017:**

- ✓ Completion of Piling work by 30th June 2017
- ✓ Augment manpower and T&P within 10 days

m. **Commitment made in the meeting held with Director (Projects) on 28th June 2017:**

- ✓ Completion of Piling work by 20th July 2017

n. **Status of tender:**

- ✓ Tender for superstructure of type-2 & 3 - Not issued
- ✓ Tender for lift - Not issued
- ✓ Tender for water system - Not issued
- ✓ Tender for electric system - Not issued
- ✓ Tender for fire fighting system - Not issued

o. **Constraint of OTPC:**

- ✓ If work is not completed by March 2018 (3 years within commissioning of Plant) then cost shall be not be admitted for capitalization by Central Electricity Regulatory Commission

Annexure P-8

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Sl. No.	Milestone Description	Milestone Date for buildings	Remarks
i	Completion of Piling	30-Nov-17	Piling for miscellaneous structures will continue upto Jan-18
ii	Completion of Pilecap and Plinth Beam	20-Dec-17	Pile cap for miscellaneous structures will continue upto Mar-18
iii	Award of Contract for Type-II & III and mobilization of vendor	Award : 22-10-2017 Mobilization: 1st week of Nov-17	EPIL agreed to continue the work as per the agreed schedule by utilising the existing agency till the mobilization of new contractor at site.
iv	Mobilization of Tower Crane - 2 Nos.	Dec-17 and Feb-18	# Tower Crane not required for Type-II . Concrete pump shall be used. Hoist shall be used for shifting material . Hence, EPIL agreed for providing 2 nos. tower crane.
v	Mobilization of Shuttering material	31-Oct-17	EPIL requested and OTPC agreed to allow use of laminated waterproof Ply -5000 sqm in place of steel plates with maximum 4 times repetition of a particular ply.
vi	Mobilization of Staging material	31-Oct-17	9 sets
vii	Commissioning of Batching Plant and making TM available	2nd Batching Plant : -4-Oct-17 Arrangement for 3rd Batching Plant 31-Oct-17	# only one operational # 2nd Batching plant to be operational by 4-Oct-17 # EPIL agreed to make arrangement for 3rd batching plant as stand-by.
viii	Availability of material for internal plumbing & internal electrification	01-11-2017	To be procured from Agartala
ix	Placement of order for internal plumbing & internal electrification	Order placed for Type-IV , V and Club House	To be procured from Agartala
x	Award of Contract for Lift, HVAC, STP, Water system, DG Set, Fire Fighting System, Cables, Lighting, Metering, Transformer, Switchgear etc	Lift: Jan-18	OTPC suggested and EPIL agreed to place the order for DG and accessories, Lift, HVAC, STP,Transformer, Switchgear etc. directly as per the approved vendor list provided in the contract and exclude it from current tender. EPIL informed that items for Water system, Fire Fighting System, Cables, Lighting, Metering etc. is included in the current tender.
xi	Completion of Superstructure of all buildings	28-Aug-18	
xii	Handing over of all buildings	15-Jan-19	

OTPC/KNY

22-IX-2017

EPIL

22/9/17

PILE					
BUILDING	No. of Pile	Start	Finish	Duration (Days)	Rate
TYPE-II	2	25-Sep-17	27-Sep-17	2	1
TYPE-III	328	20-Sep-17	30-Nov-17	71	6
TYPE-IV	Completed				
TYPE-V	18	20-Sep-17	24-Sep-17	4	5
CLUB HOUSE	118	30-Sep-17	24-Oct-17	24	5
Miscellaneous Structure - Gate, ESS, Tank and Pumphouse	100	01-Dec-17	20-Jan-18	50	2

PILECAP & PLINTH BEAM						
BUILDING	Completion of pile testing	Start	Finish	Duration (Days)		Remarks
TYPE-II		25-Oct-17	16-Nov-17	22	620 cum	# Tower Crane not required for Type-II . Concrete pump shall be used. Hoist shall be used for shifting material. # EPIL proposed that in order to achieve the target the Column size should be made uniform to the maximum extent as far as possible and OTPC agreed. All the columns and beams width which are 230 mm at present shall be 250 mm. # EPIL requested for static pile testing to be carried out as per IS code . OTPC agreed for carrying out static pile testing of 1% for all buildings except for Type -III for 1.5% .Completion date of 10-Dec-17 for pile testing in Type-III. Casting should be completed in maximum 3- days time and remaining time should be consumed in Bar-bending, shuttering, testing
TYPE-III	6 static + 13 dynamic 10-Dec-2017	25-Nov-17	20-Dec-17	25	1000 cum	
TYPE-IV		22-Sep-17	15-Oct-17	23	965 cum	
TYPE-V	3 static + 8 dynamic 26-Oct-17	21-Oct-17	12-Nov-17	22	745 cum	
CLUB HOUSE	2 static + 5 dynamic 10-Nov-17	10-Nov-17	20-Dec-17	40	125 cum	

Superstructure works (RCC from Plinth to Roof)						
BUILDING	No. of Floors including stilt	Start	Finish	Duration (Days)	No. of Days/Floor	Remarks
TYPE-II	6	17-Nov-17	16-Apr-18	150	25	# Column Casting for each floor should be completed in 2 lifts in maximum 7 days and remaining time should be consumed in Bar-bending, shuttering, slab casting, curing and deshuttering of slab # 2 sets shuttering for slab and roof should be available # EPIL proposed that in order to achieve the target the Column size should be made uniform to the maximum extent as far as possible and OTPC agreed. All the columns and beams width which are 230 mm at present shall be 250 mm.
TYPE-III	10	21-Dec-17	28-Aug-18	250	25	
TYPE-IV	11	16-Oct-17	18-Jul-18	275	25	
TYPE-V	11	13-Nov-17	15-Aug-18	275	25	
CLUB HOUSE	1	21-Dec-17	30-Jan-18	40	40	

Brick Work and Door, Window Frame Fixing						
BUILDING	No. of Floors including stilt	Start	Finish	Duration (Days)	No. of Days/Floor	Remarks
TYPE-II	5	06-Jan-18	30-Apr-18	70	14	# Doors and window frames should be made available before completion of internal plaster of each floor # Pre-cast Lintels over doors and window openings should be made available
TYPE-III	9	09-Feb-18	11-Sep-18	126	14	
TYPE-IV	10	05-Dec-17	01-Aug-18	140	14	
TYPE-V	10	02-Jan-18	29-Aug-18	140	14	
CLUB HOUSE	1	09-Feb-18	09-Apr-18	21	21	

Internal electrification and Plumbing - Pipes + Internal Plaster						
BUILDING	No. of Floors including stilt	Start	Finish	Duration (Days)	No. of Days/Floor	Remarks
TYPE-II	5	20-Jan-18	15-May-18	115	23	# Groove cutting for internal electrification and plumbing work shall start within 14 days of completion of brick work for every floor # Internal plaster should start immediately after placing of conduits and pipes # Conduits and pipes to be made available before 8-Dec-17
TYPE-III	9	23-Feb-18	26-Sep-18	215	24	
TYPE-IV	10	19-Dec-17	16-Aug-18	240	24	
TYPE-V	10	16-Jan-18	13-Sep-18	240	24	
CLUB HOUSE	1	16-Feb-18	07-May-18	80	80	

Flooring work						
BUILDING	No. of Floors including stilt	Start	Finish	Duration (Days)	No. of Days/Floor	Remarks
TYPE-II	5	04-Feb-18	25-May-18	110	22	# Levelling course for laying Flooring to start after min. 7 days of curing for plaster
TYPE-III	9	10-Mar-18	06-Oct-18	210	23	
TYPE-IV	10	03-Jan-18	26-Aug-18	235	24	
TYPE-V	10	31-Jan-18	23-Sep-18	235	24	
CLUB HOUSE	1	08-May-18	06-Jun-18	29	29	

Finishing & Painting including external plaster, doors and window shutters , sanitay fixing, Light Fixtures , HVAC , Lift						
BUILDING	No. of Floors including stilt	Start	Finish	Duration (Days)	No. of Days/Floor	Remarks
TYPE-II	5	26-Feb-18	05-Aug-18	160	32	# Painting work to start imemdiately after completing the flooring and the flooring should be protected using POP/ other means # Materials required for finishing should be made available before 31.12.17 : - Doors and window shutters , glazing - Electrical Cables,switches, boards
TYPE-III	9	02-Apr-18	15-Jan-19	288	32	
TYPE-IV	10	26-Jan-18	12-Dec-18	320	32	
TYPE-V	10	23-Feb-18	09-Jan-19	320	32	
CLUB HOUSE	1	22-May-18	21-Jul-18	45	45	

BUILDING	Pile		Pilecap & Plinth Beam		Superstructure		Brickwork		Internal electrification and Plumbing - Pipes + Internal Plaster		Flooring work		Finishing & Painting including external plaster, doors and window shutters , sanitay fixing, Light Fixtures , HVAC , Lift		Ready
	Start	Finish	Start	Finish	Start	Finish	Start	Finish	Start	Finish	Start	Finish	Start	Finish	
TYPE-II	25-Sep-17	27-Sep-17	25-Oct-17	16-Nov-17	17-Nov-17	16-Apr-18	06-Jan-18	30-Apr-18	20-Jan-18	15-May-18	04-Feb-18	25-May-18	26-Feb-18	05-Aug-18	05-Aug-18
TYPE-III	20-Sep-17	30-Nov-17	25-Nov-17	20-Dec-17	21-Dec-17	28-Aug-18	09-Feb-18	11-Sep-18	23-Feb-18	26-Sep-18	10-Mar-18	06-Oct-18	02-Apr-18	15-Jan-19	15-Jan-19
TYPE-IV			22-Sep-17	15-Oct-17	16-Oct-17	18-Jul-18	05-Dec-17	01-Aug-18	19-Dec-17	16-Aug-18	03-Jan-18	26-Aug-18	26-Jan-18	12-Dec-18	12-Dec-18
TYPE-V			21-Oct-17	12-Nov-17	13-Nov-17	15-Aug-18	02-Jan-18	29-Aug-18	16-Jan-18	13-Sep-18	31-Jan-18	23-Sep-18	23-Feb-18	09-Jan-19	09-Jan-19
Club House	30-Sep-17	24-Oct-17	10-Nov-17	20-Dec-17	21-Dec-17	30-Jan-18	09-Feb-18	09-Apr-18	16-Feb-18	07-May-18	08-May-18	06-Jun-18	22-May-18	21-Jul-18	21-Jul-18

Requirement of Tools & Plants								
Batching Plant (20 CUM/Hr)	2 + 1 (stand-by)	2 + 1 (stand-by)	2 + 1 (stand-by)					
Movable Batching Plant (4 CUM/Hr)			1+1	1+1	1+1	1+1	1+1	
Tower Crane			2	2	2	2	2	
Crawler Crane	2		2	2	2	2	2	
Transit Mixers	2	2	1+1 sb	1+1 sb	1+1 sb	1+1 sb	1+1 sb	
Truck Mounted Rigs for Piling	5	2 (Pile rigs shall be required for other misc. structures - Gate , ESS Pump house)						
Hydraulic Rig								
Steel / Laminated Ply Shuttering			5000 sqm					
Steel props and other support for shuttering			10 set (2 sets for each floor plate area for each building)					
DG Set (250 KVA)	2	2	2	2	2	2	2	
Vibrators (Needle +Plate)	20	20	20	20	20	20	20	
Diesel and Electric pumps	4	4	4	4	4	4	4	
Steel cutting and bending machines	5	5	5	2	2	2	2	
Excavator (JCB)	1	1	1	1	1	1	1	
Tractors with Trolley	1	1	1	1	1	1	1	
Concrete Pump	1 + 1 (sb)	1 + 1 (sb)	1 + 1 (sb)	1 + 1 (sb)	1 + 1 (sb)	1 + 1 (sb)	1 + 1 (sb)	
Welding Machines	5 set	5 set	5 set	5 set	5 set	5 set	5 set	
smooth wheel roller							1	
submerisble pumps	2	2	2	2	2	2	2	
Dumpers/tippers	1	1	1	1	1	1	1	
Auto level			1 + 1 (sb)	1 + 1 (sb)	1 + 1 (sb)	1 + 1 (sb)	1 + 1 (sb)	
Hydra 10 T	1	1	1	1	1	1	1	
Builder Holsts	4	4	4	4	4	4	4	

Manpower								
Carpenter	4	8	20	10	6	6	4	
Bar-binder & Welder	10	20	20	4	2	2	2	
Helper	28	56	80	28	16	16	12	
Mason	2	4	30	20	20	10	10	
Skilled	2	4	14	15	24	24	24	
Un Skilled	20	20	60	40	40	20	20	
Bolt fixer & welder	4	1	2	2	2	2	2	
Rig Men	5	2	1	1				
Electrician	2	2	4	4	6	6	6	
Fitter	2	6	2	2	2	2	2	
Operators - Hydra, Transit Mixer, Batching Plant, Concrete Pumps	6	6	6	2	2	2	2	
Tower Crane Operator			3	3	3	3	3	
Painter								
Total Manpower Required	**85**	**129**	**242**	**131**	**123**	**93**	**87**	

	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18
Carpenter	4	32	32	42	42	42	42	42	42	42	20	20	20	20	20	20
Bar-binder & Welder	10	50	50	54	54	54	54	54	54	54	54	20	20	20	20	20
Helper	28	160	160	180	180	180	180	180	180	180	180	80	80	80	80	80
Mason	2	12	30	50	50	50	50	50	50	50	50	50	50	50	50	50
Un Skilled	30	24	60	100	100	100	100	100	100	100	100	100	100	100	100	100
Bolt fixer & welder	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Rig Men	8	8	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Electrician	2	2	4	6	12	12	12	12	12	12	12	12	12	12	12	12
Fitter /Plumber	4	4	4	4	8	8	8	8	8	8	8	8	8	8	8	8
Operators - Hydra, Transit Mixer, Batching Plant, Concrete Pumps	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Tower Crane Operator			3	3	3	3	3	3	3	3	3	3	3	3	3	3
Painter					8	8	8	8	8	8	8	8	12	12	12	12
Total Manpower Required	**98**	**300**	**355**	**451**	**469**	**469**	**469**	**469**	**469**	**469**	**447**	**313**	**317**	**317**	**317**	**317**

Annexure P-9

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From: Samarjeet Thakur
Sent: 15 June 2018 14:15
To: dp@engineeringprojects.com; DP (dp@epi.gov.in)
Cc: Satyajit Ganguly; Shree Narayan; Sudin Chattopadhyay; Tapas Bhowmik; Satyajit Ganguly; S P ROY (sp.roy@engineeringprojects.com); Biswajit Biswas (b.biswas@epi.gov.in); karan.bakshi@otpcindia.in; Ravi Yadav (yadav_ravi2000@yahoo.co.in); Avininder Gupta
Subject: RE: Review meeting of OTPC township project

Dear Sir,

First of all we would like to thank you for visiting our office yesterday along with your team and re-affirming your commitment to expedite the construction works at site. Following is the summary of discussions held yesterday in the presence of MD-OTPC and CFO-OTPC:

1. OTPC requested EPIL to fast-track their procurement actions to avoid any logistics issue due to monsoon. EPIL agreed for the same.

2. OTPC informed EPIL that there is acute shortage of manpower at site. For instance in June month only, the average manpower should be 360 nos as committed on 1st June 2018 but actual mobilization at site has a shortage of 152 nos manpower. DP-EPIL advised DGM(EPIL) to provide the contractor-wise shortage of manpower and informed that in case, the sub-contractor is not able to arrange the manpower, EPIL will themselves arrange the manpower and pay them directly to expedite the progress. EPIL will submit the detailed plan in the meeting to be held on 22-Jun-18.

3. OTPC raised concerns regarding non-availability of technical staff in sufficient numbers with its sub-contractors. DP-EPIL agreed to discuss the issue at the highest level of AB Construction and TCIL in the next week to arrange for more technical manpower – at least 3 nos. from ABC and 2 nos from TCIL.

4. OTPC requested EPIL to bring in more manager level executives at site to look after each building separately. EPIL assured OTPC that they have the sufficient manpower at site, however, they will be bringing more manage level executives at site in coming months especially additional 2 nos. civil engineers and 1 no. electrical engineer.

5. OTPC requested EPIL to explore the possibility of 2 shift work of either 2x10 hours or 2x12 hours at site. EPIL informed that they will explore the possibility to bring additional manpower and present the plan for deployment in the next meeting to be held on 22-Jun-18.

6. OTPC informed that they will clear the RA-15 bill by Monday, 18th June 2018 and in future, OTPC shall release the payment within 7 days of receiving certified RA bill copy.

7. EPIL informed OTPC that the WO for HVAC, STP and Elevator shall be awarded by 25th June 2018.

8. OTPC requested EPIL to perform parallel works in each tower to catch up the schedule of completion by March-19. EPIL informed OTPC that they will ensure parallel work in each tower and further added that manpower will not become constraint in this and EPIL will arrange separate set of manpower to expedite this. EPIL shall also expedite construction of Type –III building, which is on a critical path.

T. C. SP

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9. EPIL informed that they will prepare the detailed schedule/ chart/graphs highlighting the brick work, plastering, finishing etc for each floor of every building and shall put it for OTPC review in the meeting due on 22nd June 2018.

10. OTPC again requested EPIL to furnish the detailed deviation sheet for the project cost. EPIL confirmed that the sheet shall be provided by 20th June 2018.

11. OTPC raised concerns for the delay in pile cap works of UGT building which should have been completed by March-18. EPIL informed that they will expedite the pile cap works in UGT and plan for the same shall be submitted by 22nd June 2018.

12. OTPC informed EPIL that despite several reminders and requests, Tribeni Construction hasn't brought shear and bending machine and are doing the work manually which is affecting the speed of work. EPIL informed that they will discuss with vendor and shall arrange for the machine.

13. Next meeting will held on 22nd June 2018 at OTPC Delhi office.

Thanks & regards
Samarjeet Thakur

T.C.

Annexure P-10

MINUTES OF REVIEW MEETING HELD BETWEEN OTPC AND ENGINEERING POJECTS INDIA LIMITED (EPIL) AT OTPC DELHI OFFICE ON 22nd June 2018 FOR CONSTRUCTION OF TOWNSHIP AT KHILPARA, UDAIPUR, TRIPURA.

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Participants:

OTPC

1. Mr. Samarjeet Thakur, DGM(Contracts)
2. Mr. Karan Bakshi, Manager

EPIL

1. Col. Akhtar, GM, Corporate Office
2. Mr. S.R.Lahiri,RCM/Site in-charge

The following points were discussed

i. EPIL submitted the detailed manpower mobilization plan considering the ongoing activities and parallel working fronts. EPIL confirmed manpower strength will reach minimum 379 nos by 30th June 2018. In case of any shortfall in manpower to be mobilized by ABC and TCIL, EPIL confirmed to take necessary action to mobilize required manpower to achieve the target.

AB Construction – (available no. 146 to be increased to 181 nos. by 30th June 2018)

TYPE – IV	: 75
TYPE – V	: 75
Club House	: 31

TCIL – (available no. 63 to be increased to 198 nos. by 30th June 2018)

TYPE – II	: 82
TYPE – III	: 57
ESS	: 26
UGT	: 35

ii. EPIL informed OTPC that they have reviewed the technical manpower of sub agencies and confirmed that at present one (1) no. each minimum 5 years' experience civil engineer shall be deputed by both the sub-agencies by 15th July 2018.

iii. OTPC asked EPIL about the status of deputation of more manager level staff at township site, as requested in meeting dated 14th June 2018. EPIL informed OTPC that the matter is with RO/CO and shall inform the status to OTPC by 28th June 2018.

iv. EPIL informed OTPC that after 30th June 2018, when the workforce will be in full strength, they will strategically review the deployment of manpower and prepare the plan to work in 2 shifts of 10-12 hours. They will submit the plan to OTPC accordingly.

SRLahiri

T-C

v. OTPC informed EPIL that they released the part payment against RA-15 invoice. Full payment will be released only after receiving the revised corrected invoice from EPIL.

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vi. EPIL has submitted the building-wise completion schedule indicating the following completion dates:

S.No.	Building Type	Structure Completion	Completion including all finishing works
1	Type-II	25-Oct-2018	17-Feb-2019
2	Type-III	5-Apr-2019	29-Jul-2019
3	Type-IV	14-Dec-2018	30-Mar-2019
4	Type-V	23-Jan-2019	31-Mar-2019
5	Club House	29-Sep-2018	21-Jan-2019
6	UGT	5-Dec-2018	8-Feb-2019
7	ESS	30-Aug-2018	23-Dec-2018

OTPC outrightly rejected the completion dates mentioned for the buildings. OTPC informed EPIL that dates beyond Mar-2019 are unacceptable. EPIL to do the necessary planning at their end to complete the Type-III building by Mar-2019. EPIL to submit the revised plan by 15th July 2018.

vii. EPIL submitted the project cost deviation statement to OTPC on 18th June 2018. OTPC shall review and issue amendment after obtaining necessary approvals.

viii. EPIL confirmed that the M/s TCL shall mobilize the shear cutting and bending machine by 25th July 2018.

OTPC

22/6/18

EPIL

TYPE-II QUARTER

LOCATION	RCC ST	B/WORK	PLASTER	ELEC		PLUMB		D/W	FLOORING	PAINTIN
				Conduiting	Fitting/Fixing	Pipe fixing	Fitting/Fixing			
Mumty, Machine room, Chajjas etc.	25-10-18	14-12-18	29-12-18	22-12-18	15-02-19	24-12-18	15-02-19	10-02-19	28-01-19	17-02-1
5th Floor	29-09-18	18-11-18	03-12-18	26-11-18	20-01-19	28-11-18	20-01-19	15-01-19	02-01-19	22-01-1
4th Floor	03-09-18	23-10-18	07-11-18	31-10-18	25-12-18	02-11-18	25-12-18	20-12-18	07-12-18	27-12-1
3rd Floor	08-08-18	27-09-18	12-10-18	05-10-18	29-11-18	07-10-18	29-11-18	24-11-18	11-11-18	01-12-1
2nd Floor	13-07-18	01-09-18	16-09-18	09-09-18	03-11-18	11-09-18	03-11-18	29-10-18	16-10-18	05-11-1
1st floor	21-05-18	18-08-18	27-08-18	20-08-18	02-11-18	23-08-18	07-11-18	18-10-18	13-10-18	25-10-1
Stilt	13-04-18	10-07-18	06-08-18	30-07-18	12-10-18	02-08-18	17-10-18	27-09-18	22-09-18	04-10-1

TYPE-III QUARTER										
LOCATION	RCC ST	B/WORK	PLASTER	ELEC		PLUMB		D/W	FLOORING	PAINTIN
				Conduiting	Fitting/Fixing	Pipe fixing	Fitting/Fixing			
Mumty, Machine room, Chajjas etc.	05-04-19	25-05-19	09-06-19	02-06-19	27-07-19	04-06-19	27-07-19	22-07-19	09-07-19	29-07-1
9th Floor	10-03-19	29-04-19	14-05-19	07-05-19	01-07-19	09-05-19	01-07-19	26-06-19	13-06-19	03-07-1
8th Floor	12-02-19	03-04-19	18-04-19	11-04-19	05-06-19	13-04-19	05-06-19	31-05-19	18-05-19	07-06-1
7th Floor	17-01-19	08-03-19	23-03-19	16-03-19	10-05-19	18-03-19	10-05-19	05-05-19	22-04-19	12-05-1
6th Floor	22-12-18	10-02-19	25-02-19	18-02-19	14-04-19	20-02-19	14-04-19	09-04-19	27-03-19	16-04-1
5th Floor	26-11-18	15-01-19	30-01-19	23-01-19	19-03-19	25-01-19	19-03-19	14-03-19	01-03-19	21-03-1
4th Floor	31-10-18	20-12-18	04-01-19	28-12-18	21-02-19	30-12-18	21-02-19	16-02-19	03-02-19	23-02-1
3rd Floor	05-10-18	24-11-18	09-12-18	02-12-18	26-01-19	04-12-18	26-01-19	21-01-19	08-01-19	28-01-1
2nd Floor	09-09-18	29-10-18	13-11-18	06-11-18	31-12-18	08-11-18	31-12-18	26-12-18	13-12-18	02-01-1
1st floor	14-08-18	03-10-18	18-10-18	11-10-18	05-12-18	13-10-18	05-12-18	30-11-18	17-11-18	07-12-1
Stilt	19-07-18	07-09-18	22-09-18	15-09-18	09-11-18	17-09-18	09-11-18	04-11-18	22-10-18	11-11-1

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TYPE-IV QUARTER										
LOCATION	RCC ST	B/WORK	PLASTER	ELEC		PLUMB		D/W	FLOORING	PAINTING
				Conduiting	Fitting/Fixing	Pipe fixing	Fitting/Fixing			
Mumty, Machine room, Chajjas etc.	14-12-18	28-01-19	12-02-19	05-02-19	28-03-19	07-02-19	28-03-19	23-03-19	14-03-19	30-03-19
10th Floor	24-11-18	18-01-19	02-02-19	26-01-19	15-03-19	28-01-19	15-03-19	10-03-19	27-02-19	17-03-19
9th Floor	29-10-18	03-01-19	18-01-19	11-01-19	07-03-19	13-01-19	07-03-19	02-03-19	17-02-19	09-03-19
8th Floor	03-10-18	08-12-18	23-12-18	16-12-18	09-02-19	18-12-18	09-02-19	04-02-19	22-01-19	11-02-19
7th Floor	07-09-18	12-11-18	27-11-18	20-11-18	14-01-19	22-11-18	14-01-19	09-01-19	27-12-18	16-01-19
6th Floor	12-08-18	17-10-18	01-11-18	25-10-18	19-12-18	27-10-18	19-12-18	14-12-18	01-12-18	21-12-18
5th Floor	17-07-18	21-09-18	06-10-18	29-09-18	23-11-18	01-10-18	23-11-18	18-11-18	05-11-18	25-11-18
4th Floor	21-06-18	26-08-18	10-09-18	03-09-18	28-10-18	05-09-18	28-10-18	23-10-18	10-10-18	30-10-18
3rd Floor	29-04-18	31-07-18	15-08-18	08-08-18	21-10-18	10-08-18	26-10-18	06-10-18	01-10-18	13-10-18
2nd Floor	18-03-18	25-06-18	25-07-18	18-07-18	30-09-18	20-07-18	05-10-18	15-09-18	10-09-18	22-09-18
1st floor	14-02-18	10-06-18	15-07-18	08-07-18	20-09-18	10-07-18	25-09-18	05-09-18	31-08-18	12-09-18
Stilt	12-01-18	10-05-18	10-07-18	03-07-18	15-09-18	05-07-18	20-09-18	31-08-18	26-08-18	07-09-18

TYPE-V QUARTER										
LOCATION	RCC ST	B/WORK	PLASTER	ELEC		PLUMB		D/W	FLOORING	PAINTING
				Conduiting	Fitting/Fixing	Pipe fixing	Fitting/Fixing			
Mumty, Machine room, Chajjas etc.	23-01-19	12-02-19	22-02-19	15-02-19	29-03-19	17-02-19	29-03-19	24-03-19	19-03-19	31-03-19
10th Floor	08-01-19	07-02-19	22-02-19	15-02-19	28-03-19	17-02-19	28-03-19	23-03-19	14-03-19	30-03-19
9th Floor	13-12-18	22-01-19	06-02-19	30-01-19	21-03-19	01-02-19	21-03-19	16-03-19	03-03-19	23-03-19
8th Floor	17-11-18	27-12-18	11-01-19	04-01-19	28-02-19	06-01-19	28-02-19	23-02-19	10-02-19	02-03-19
7th Floor	22-10-18	01-12-18	16-12-18	09-12-18	02-02-19	11-12-18	02-02-19	28-01-19	15-01-19	04-02-19
6th Floor	26-09-18	05-11-18	20-11-18	13-11-18	07-01-19	15-11-18	07-01-19	02-01-19	20-12-18	09-01-19
5th Floor	31-08-18	10-10-18	25-10-18	18-10-18	12-12-18	20-10-18	12-12-18	07-12-18	24-11-18	14-12-18
4th Floor	05-08-18	14-09-18	29-09-18	22-09-18	16-11-18	24-09-18	16-11-18	11-11-18	29-10-18	18-11-18
3rd Floor	10-07-18	19-08-18	03-09-18	27-08-18	21-10-18	29-08-18	21-10-18	16-10-18	03-10-18	23-10-18
2nd Floor	23-05-18	10-08-18	25-08-18	18-08-18	12-10-18	20-08-18	12-10-18	07-10-18	24-09-18	14-10-18
1st floor	12-04-18	20-07-18	04-08-18	28-07-18	21-09-18	30-07-18	21-09-18	16-09-18	03-09-18	23-09-18
Stilt	13-02-18	10-07-18	25-07-18	18-07-18	11-09-18	20-07-18	11-09-18	06-09-18	24-08-18	13-09-18

CLUB HOUSE										
LOCATION	RCC ST	B/WORK	PLASTER	ELEC		PLUMB		D/W	FLOORING	PAINTIN
				Conduiting	Fitting/Fixing	Pipe fixing	Fitting/Fixing			
Mumty, Chajjas, Canopy etc.	29-09-18	29-10-18	23-11-18	16-11-18	29-01-19	18-11-18	03-02-19	14-01-19	09-01-19	21-01-1
1st Floor	30-08-18	19-10-18	13-11-18	06-11-18	19-01-19	08-11-18	24-01-19	04-01-19	30-12-18	11-01-1
Ground Floor	31-07-18	19-09-18	14-10-18	07-10-18	20-12-18	09-10-18	25-12-18	05-12-18	30-11-18	12-12-1

ELECTRICAL SUBSTATION

LOCATION	RCC ST	B/WORK	PLASTER	ELEC		PLUMB		D/W	FLOORING	PAINTIN
				Conduiting	Fitting/Fixing	Pipe fixing	Fitting/Fixing			
Mumty, Chajjas, Canopy etc.	30-08-18	19-10-18	03-11-18	27-10-18	21-12-18	29-10-18	21-12-18	16-12-18	03-12-18	23-12-1
1ST Floor	31-07-18	19-09-18	04-10-18	27-09-18	21-11-18	29-09-18	21-11-18	16-11-18	03-11-18	23-11-1

UNDER GROUND TANK

LOCATION	RCC ST	B/WORK	PLASTER	ELEC		PLUMB		D/W	FLOORING	PAINTIN
				Conduiting	Fitting/Fixing	Pipe fixing	Fitting/Fixing			
ROOF SLAB	05-12-18	04-01-19	14-01-19	07-01-19	06-02-19	09-01-19	06-02-19	01-02-19	24-01-19	08-02-1
ALL WORKS UPTO PLINT	15-11-18	--	25-12-18	--	--	--	--	--	--	--
FOUNDATION	15-09-18	--	--	--	--	--	--	--	--	--

MANPOWER STATUS OF M/S. ASHUTOSH BANDYOPADHAYAYA

Sl No.	Location	Manpower														Open scope avaialble
		Rod Binder		Carpenter		Brickwork		Electrical		Plumbing		Misc Works (Helper)		Total		
		Available	Required	Available	Required	Available	Required	Available	Required	Available	Required	Available	Required	Available	Required	
1	TYPE-IV	20	25	12	20	12	15	8	8	0	5	0	2	**52**	**75**	>5F Slab >B/w in 2F & 3F >Lintel/Balcony RCC Works >Elec work in 1F, 2F, 3F >Pl work in 1F & 2F
2	TYPE-V	17	25	16	20	15	15	0	8	0	5	0	2	48	75	>4F Slab >B/w in 1F & 2F >Lintel/Balcony RCC Works >Elec work in 1F, 2F >Pl work in 1F & 2F
3	CLUB HOUSE	10	15	6	15	0	0	0	0	0	0	0	1	**16**	**31**	>1F Column >1F Slab Backfilling
	Total	47	65	34	55	27	30	8	16	0	10	0	5	**116**	**181**	
SHORTFALL		**18**		**21**		**3**		**8**		**10**		**5**		**65**		
Additional Manpower to be deployed by 30.06.2018		**18**		**21**		**3**		**8**		**10**		**5**		**65**		Committed on 18.06.2018

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Program for mobilization of Manpower within 30.06.2018

Sl No	Location	Manpower (Skilled & unskilled)							
		Carpenter	Barbender	Mason	Electrician	Plumbing	Misc	Total	Cummulative Total
1	TYPE-IV	20	25	15	8	5	2	75	181
2	TYPE-V	20	25	15	8	5	2	75	
3	CLUB HOUSE	15	15	-	-	-	1	31	

Note: Working Time for Carpenter/Barbender/Mason = 12 Hrs/Day

18/4/2018

(R S Gangwar)
Project Manager
M/s. Ashutosh Bandyopadhayaya

MANPOWER STATUS OF M/S. TRIBENI CONSTRUCTIONS LTD.

Sl No.	Location	Manpower														Open scope avaialble
		Rod Binder		Carpenter		Mason		Electrical		Plumbing		Misc Works (Helper)		Total		
		Available	Required	Available	Required	Available	Required	Available	Required	Available	Required	Available	Required	Available	Required	
1	TYPE-II	10	25	10	25	0	20	0	5	0	5	0	2	20	82	>3F Slab >B/w in 1F & 2F >Elec work in 1F >Pl work in 1F
2	TYPE-III	10	30	10	25	0	0	0	0	0	0	0	2	20	57	>1F Column >1F slab >Below Pl. B/w >Backfilling
3	ESS	0	10	0	15	0	0	0	0	0	0	0	1	0	26	>1F Column >1F slab >Backfilling
4	UGT	0	15	0	10	0	0	0	0	0	0	0	10	0	35	>Earthwork dressing >PCC >RCC Foundation/Wall
	Total	20	80	20	75	0	20	0	5	0	5	0	15	40	200	
SHORTFALL		60		55		20		5		5		15		160		
Additional Manpower to be deployed by 30.06.2018		60		55		20		5		5		13		158		Committed on 18.06.2018

SRLahiri

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18-06-2018

Name of Work :- Construction of Township at Kh Ipara, Udaipur, Tripura for OTPC:- SH: Construction of Type II, Type-III Quarters, External Development works including Civil,Internal Sanitary/ Plumbing, Internal Electrical works, External Sanitary/Plumbing, Water Supply, External Electrification including Substation, Fire Fighting and Security works, Roads, Drains, Landscapping, Main Gate etc

Name of Agency : M/S Tribeni Constructions Limited.

Award Letter No & Date : DLI/CON/753/573 Date: 26.12.2017

SL NO	AVAILABLE AT SITE FROM DATE	MANPOWER (Skilled & Unskilled)				
		Mason	Carpenter	Blacksmith	Helper	REMARKS
1	24th June-2018	Nil	10	10	20	
2	26th June-2018	Nil	5	5	20	
3	28th June-2018	Nil	10	5	20	
4	30th June-2018	18	5	10	20	
5	Total=	18	30	30	80	
6	Available at site till today=	40	Nos			
7	All Total=	198	Nos			

18/06/2018

R. J. KALITA
PM. (CIVIL)
OTPC. Site, Udaipur, Tripura.
M/s. Tribeni Constructions Ltd.

T. C'

Annexure P-11

OTPC

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ONGC Tripura Power Company Limited

(JV Company of ONGC, IL&FS, IDFC and Govt. of Tripura)

6th Floor, A Wing, IFCI Tower-61, Nehru Place, New Delhi-110019 Phone: +91-11-26402100 Fax: +91-11-26227532/26227533

27th June 2018

Shri Vinoo Gopal,
Director Projects
Engineering Projects India Limited
Core-3, Scope Complex,
7, Lodhi Road, New Delhi -110003

Sub: **Construction of Township at Khilpara, Udaipur, Tripura for 2 x 363.3 MW Gas based combined cycle Power Plant for OTPC**

Dear Sir,

This has reference to our letter dated 4th June 2018 (Annexure-1), the meeting held between MD-OTPC and your goodself on 14th June 2018 (Annexure-2) and minutes of meeting held on 22nd June 2018 (Annexure-3). We would like to highlight the status of the commitment done during the meeting held on 14th June 2018 and 22nd June 2018 and seek your kind intervention to ensure that the work is completed in all respect before Mar-19:

a. During the meeting held on 22nd June 2018, it was confirmed by EPIL to increase the manpower strength upto 379 nos by 30th June 2018. However, despite your assurance, it has been observed that the manpower mobilized at site was only 228 nos. as on 27th June 2018 against a requirement of 379 nos (Manpower Requirement Vs Actual deployment is enclosed as Annexure-4). EPIL had confirmed to take necessary action to mobilize required manpower to achieve the target, in case their sub-contractors fail to meet the manpower mobilization target. In view of the above, we request you to kindly take requisite action for mobilization of manpower as it is apparent that your sub-agencies shall not be able to mobilize the required manpower by 30th June 2018 .

b. As informed by MD-OTPC during the meeting held with your goodself that the Township completion date beyond 31st March 2019 shall not be acceptable to OTPC. However, to our surprise, EPIL submitted the building-wise completion schedule in the meeting held on 22nd June 2018 indicating completion date of finishing works of 7th, 8th & 9th Floor of Type-III falling beyond March-19. EPIL has confirmed to provide catch –up plan to complete all buildings within Mar-2019 including the Type-III building by 15th July 2018.

S.No.	Building Type	Structure Completion	Completion including all finishing works
1	Type-II	25-Oct-2018	17-Feb-2019
2	Type-III	5-Apr-2019	29-Jul-2019
3	Type-IV	14-Dec-2018	30-Mar-2019
4	Type-V	23-Jan-2019	31-Mar-2019
5	Club House	29-Sep-2018	21-Jan-2019
6	UGT	5-Dec-2018	8-Feb-2019
7	ESS	30-Aug-2018	23-Dec-2018

T-E

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c. During the meeting held on 14th June 2018, EPIL had informed OTPC that the Work Order for HVAC, STP and Elevator shall be awarded by 25th June 2018. However, we have not received any confirmation for award of work.

d. We are highly disappointed to note that the commitments given by Dir(Projects), EPIL to MD,OTPC have not been fulfilled and very less progress has been achieved since past 14 days. Moreover, the corrective actions taken are not sufficient to achieve the milestone targets.

Considering the criticality of the project, we request your urgent intervention in advising the concerned to: (a) ensure that adequate manpower is mobilized including technical manpower of sub-agencies and manager level staff of EPIL and adhere to the commitments made by EPIL during the meeting held on 14th June 2018 and 22nd June 2018, and (b) award the contract for HVAC, STP, DG and Elevator on immediate basis. We look forward to have your kind intervention on continual basis so that completion of construction of Township is achieved within Mar-19 by executing the work on 24 x 7 basis.

Thanking you,

Yours faithfully,
for ONGC TRIPURA POWER COMPANY LIMITED

27th June 2018.

SAMARJEET THAKUR
DGM-C &M

Encl: MOM dated 14th June2018 and 22nd June 2018

CC: MD, OTPC
CC: CMD, EPIL
CC: VP(C&M),OTPC
CC: VP (PLANT),OTPC
CC: CFO,OTPC
CC: GM(Commercial),OTPC

T. C.

Annexure 12 (colly)

MINUTES OF REVIEW MEETING HELD AMONG M/s ONGC TRIPURA POWER COMPANY LIMITED (OTPC), AND ENGINEERING POJECTS INDIA LIMITED (EPIL) AT SITE OFFICE,KHILPARA ON 1st June 2018 FOR CONSTRUCTION OF TOWNSHIP AT KHILPARA, UDAIPUR, TRIPURA.

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Participants:

OTPC

1. Mr. Samarjeet Thakur, DGM(Contracts)
2. Mr. Tapas Bhowmik, DGM(Mech)
3. Mr. S.K.Saha, Consultant
4. Mr. Karan Bakshi, Manager

KNY

1. Mr. Sunil Dutt, Site CM

EPIL

1. Mr. S.R.Lahiri,RCM/Site in-charge
2. Mr. Abhijit Nandi, Manager

AB Construction/Tribeni

1. Mr. Gangwar, Site in-charge, AB Construction
2. Mr. R.J Kalita, Site in-charge, TCIL

The following points were discussed

i. As per the MoM dated 10th April 2018, it was agreed by EPIL to mobilize manpower and T&Ps to meet the schedule without fail. However, Construction activity being done at site is not in consonance with commitment given 10th April 2018 and is leading to consequential delay in the project and is already 5-6 months behind the schedule committed on 22nd September 2017, which is not acceptable. OTPC again requested EPIL to submit catch-up plan to achieve the target of 15th January 2019.

ii. EPIL accepted that the current mobilization of manpower i.e., 230 (ABC nos. – 138 and TCIL - 92 Nos.)is not adequate against the requirement of 360 nos. manpower (ABC nos. – 170 and TCIL - 190 Nos.) and has led to the delay in the project. EPIL agreed to submit the plan for increasing the manpower by 4-Jun-18. EPIL confirmed to mobilize manpower as per the schedule and also assured that if their contractor fails to meet the manpower requirement, EPIL shall take necessary action with the contractors. Following is the minimum manpower to be deployed by EPIL in June-18 and July-18:

10-Jun-18	:	245 against the requirement of 360
21-Jun-18	:	275 against the requirement of 360
30-Jun-18	:	275 against the requirement of 360

T/C-8

10-Jul-18 : 300 against the requirement of 360
20-Jul-18 : 320 against the requirement of 360

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OTPC informed EPIL that for less deployment of each manpower, amount may be deducted from the RA bills proportionately.

iii. EPIL confirmed the requirement of 260 m safety nets for each building. 160m available with ABC. 260m shall reach site by 15.06.18. TCIL informed that 300m safety nets shall be made available by 10.06.18. OTPC informed EPIL that for any non-compliance of Safety /statutory requirements, penalty shall be imposed.

iv. **Roads:** Even after repeated requests from OTPC, the service road extension was not constructed by EPIL leading to problem in vehicular movement at site. OTPC insisted and EPIL agreed to lay at least 35 cum brickbats to ensure smooth movement of vehicles/T&Ps for construction during monsoon Road across all the buildings by 02.06.18.

v. Tower Crane for Type-III (supplied by Manitowac) mobilized at site by TCIL 30.05.18. Foundation for Tower Crane to be completed by 07.06.18. Erection & Commissioning to be completed by 5.07.18.

vi. Shear cutting and bending machine not deployed by TCIL even after repeated requests. OTPC advised EPIL to mobilize the Shear cutting and bending machine at the risk and cost of TCIL.

vii. **Delay in award of contract for major equipment:** OTPC expressed concerned regarding delay in award of packages like Lift, HVAC, STP, DG, Switchgears and Transformer which shall lead to delay in supply and installation of equipment. EPIL informed the following:

HVAC : 2 bids received. Both bidders are technically qualified. Verification from Client awaited. Verification from customer expected by 1st week of June 2018. Expected award of contract by 15th June 2018.

STP : 2 bids received. Post- bid clarifications to be received from bidders by 4th June 2018. Technical evaluation to be completed by 10th June 2018. Expected award of contract by 25th June 2018.

LIFT :7th corrigendum issued on 22nd May 2018 for extension due to single bid. Bids to be received by 7th June 2018.

Tendering for Transformer to be done after finalization of source of supply (11KV or 33 KV). OTPC informed to give the clearance by 8th June 2018. Tendering for DG to be done after review of loads y 7th June 2018.

viii. Discussion was held between OTPC and EPIL on 9th May 2018 regarding amendment of contract price due to implementation of GST w.e.f Jul-17. OTPC has submitted the calculation to EPIL on 21st May 2018. EPIL to review and revert back by 5th June 2018 for early resolution of the issue and release of payment held on account of GST.

ix. EPIL requested OTPC to release payment of extra works of Rs. 57 Lakh and RA-15 bill Tax Invoice submitted to OTPC on 29th May 2018. OTPC informed to release the payment expeditiously and requested EPIL to submit the deviation statement by 20th June 2018.

x. Following is the status of construction w.r.t the commitment done on 10th April 2018:

	Commitment on 10-Apr-18	**Status/Revised Target**
Type –II : Casting of 2 F slab	12-May-18	21-May-18 (C)
Casting of 3 F slab	8-Jun-18	20-Jun-18
Casting of 4 F slab	4-Jul-18	25-Jul-18
Type –III : Plinth Beam concrete	5-May-18	5-Jun-18
Plinth Sand filling	20-May-18	22-Jun-18
Casting of 1 F slab	30-May-18	15-Jul-18
Type –IV : Casting of 4 F slab	16-Apr-18	29-Apr-18 (C)
Casting of 5 F slab	13-May-18	15-Jun-18
Casting of 6 F slab	11-Jun-18	15-Jul-18
Type –V : Casting of 3 F slab	9-May-18	23-May-18 (C)
Casting of 4 F slab	8-Jun-18	22-Jun-18
Casting of 5 F slab	4-Jul-18	22-Jul-18
Club H : Plinth Beam concrete	9-May-18	29-May-18 (C)
Plinth Filling	15-May-18	30-Jun-18
Column upto 1F level	14-May-18	10-Jul-18
UGT : PCC	25-Apr-18	20-Jun-18
Pile Cap	12-May-18	5-Jul-18
1st Lift - Wall	24-Jun-18	30-Jun-18

(EPIL requested for sand filling inside plinth for reducing the time by 15 days. OTPC/KNY to discuss and revert by 5th June 2018)

(OTPC expressed disappointment over no work being done for UGT and instructed EPIL and TCIL to take up the work on priority)

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ESS	: Pile Cap	29-Apr-18	9-May-18 (C)
	Plinth Beam	17-May-18	28-May-18 (C)
	Column		10-Jun-18
	Roof (1F)		6-Jul-18

xi. The next review meeting shall be held at site on 28th June 2018.

01-Jun-18

OTPC

01.06.18

KNY

EPIL

(T.C.L)

(ASL)

MINUTES OF REVIEW MEETING HELDBETWEEN OTPCAND ENGINEERING POJECTS INDIA LIMITED (EPIL) ATOTPC TOWNSHIP ON 29th and 30th NOVEMBER2018FOR CONSTRUCTION OF TOWNSHIP AT KHILPARA, UDAIPUR, TRIPURA.

Participants:

OTPC/KNY

1. Mr. Samarjeet Thakur, DGM(Contracts)
2. Mr. Tapas Bhowmik, DGM(Projects)
3. Mr. Ravi Yadav, MD (KNY Projects)
4. Mr. Karan Bakshi, Manager
5. Mr. C. Ravi, Civil Advisor
6. Mr. S.K.Saha, Consultant
7. Mr. Sunil Dutt, Project Manager, KNY

EPIL

1. Mr. B. Biswas, GGM
2. Mr. S. R. Lahiri, Project Manager
3. Mr. A. Nandi, Manager

The following points were discussed:

i. OTPC reiterated and requested EPIL to complete all the balance works of township, as per the revised scope (vide OTPC letter dated 16.11.2018), latest by 20th March 2019 and mobilize adequate manpower for achieving the target. EPIL assured to put their best efforts to complete the work within March-19.

ii. OTPC clarified that ornamental beams/slab at the terrace level shall be cast in RCC in all the buildings in line with columns. KNY agreed to provide the required drawings to EPIL by 1st December 2018.

iii. OTPC informed that Elevator GA drawings are essential for Elevator Machine room framing plan drawing and structural drawings. EPIL noted the same.

iv. OTPC informed that Rising main – electrical stands deleted for all the buildings.

v. Water tank (to be placed at Mumty top) Material of Construction and capacity stands revised for Type-III building as:

   a. For Domestic use : PVC Sintex tank- 3x2000 L
   b. For Flushing use : PVC Sintex tank- 2x2000 L

   Shop drawing for plumbing works shall be provided by EPIL and OTPC/KNY to review the same at site.

vi. OTPC informed that for extended columns above terrace (900 mm), bottom 300 mm shall be of M-25 concrete and balance to be of lean concrete (1:3:6). Water proofing to be carried out upto 300 mm as per specification.

vii. SLD-DB drawing issued to EPIL on 29th November 2018. OTPC further informed EPIL that final electrical drawings shall be provided to EPIL latest by 5th December 2018.

viii. Location for tubewell is identified today in joint discussion between EPIL and OTPC/KNY. EPIL confirmed that no further details are required from OTPC to execute the tubewell works.

ix. EPIL informed that as per BoQ item normal Earthing was provided, however during detailed engineering and as per electrical resistivity of the soil, the electrical consultant has advised to do entire earthing as chemical earthing. The issue was deliberated in the meeting and OTPC agreed with the recommendation of MD-KNY to proceed with chemical earthing instead of Normal earthing in all locations as per revised drawings. Cost for chemical earthing shall be paid extra as per the agreed terms of the contract.

x. After protracted discussions, it was agreed to delete the Rain Water Harvesting System works from the present scope of work.

xi. Doors in toilets of Type-II building and club house shall be with wooden frame and wooden flush Shutter. Toilet in other buildings shall be with PVC door frame and shutter as per BOQ item.

xii. Dado height in toilets (All buildings) shall be 2250 mm.

xiii. Wall hung washbasin of Hindware make, model no- NEO. as per Catalogue no : 10098 is approved for all the buildings.

xiv. Internal and External painting shades for all the buildings has been finalized and attached as **Annexure-1.**

xv. OTPC informed EPIL to bring the sample of PVC Jaali for OTPC approval. Post approval, the item shall be considered as an extra item. EPIL agreed to provide the sample by 5th December 2018.

xvi. Fire doors shall be as per BOQ and Technical specifications. However, fire door - fittings and accessories shall be charged as extra items.

xvii. EPIL informed that Hume pipe and Manhole for Storm water drainage system shall be considered as an extra item. Detailed discussion was held and drawings were reviewed and it was agreed to provide the storm water drainage as per the plans approved by Fichtner consisting of Hume pipe and connected manholes as an extra items.

xviii. All roads except main gate portion shall be of 5m width from earlier width of 6m. From main gate to fountain shall be of 6m width. The revised cost of Roads and drains is expected be within the BoQ amount. Following shall be the details of Road section:

Bottom most	:300 mm sand filling over the subgrade
Middle-1 layer	:2 layers of WBM – (100 mm and 75 mm) with appropriate stone grading
Middel-2 layer	:75 mm PCC (1:4:8)
Top layer	:150 mm RCC (M-20) with reinforcement 8mm dia @ 200mm c/c bothways with broom finish. Expansion joint to be provided every 6m with salitex board with bitumen filler at expansion joint (as extra items).
Kerb Stone	: Kerb stone (150 mm) shall be placed on one side of the road (as extra item).
Pathway	: 1.4 m wide pathway (including Kerb stone)

30/11/18

30/11/18

960

All around the buildings and parking area will consist of following section WBM (in 2 layers -100 +75mm) + 75 mm PCC 1:4:8 + Paver – 60 mm as per boQ item to match the line and levels as per the drainage plan

xix. OTPC requested EPIL to start construction of Roads and drains immediately. EPIL confirmed that marking of the roads shall start from 1-Dec-18.

xx. OTPC expressed their strong concerns regarding the delay in ordering of STP. DGM (Contracts), NERO-EPIL informed that the ordering of STP is in final stage and shall be ordered by 3rd December 2018.

xxi. OTPC reiterated EPIL to adhere to the timelines for BoI procurement schedule attached as **Annexure-2,** which is very critical to meet the 20th March 2018 deadline. EPIL agreed to follow the schedule timelines without any delay.

xxii. EPIL requested OTPC to approve the Billing Break-up for lump-sum items. OTPC informed EPIL that the BBU is under review and will be approved by 10th December 2018.

xxiii. Revised Specifications of DG and Transformers were given to EPIL on 28th November 2018. EPIL to take necessary procurement action by 7-Dec-18.

xxiv. EPIL informed OTPC that all the drawing related issues have been closed as of now. EPIL to furnish GA drawing of Machine room and based upon this drawing KNY/OTPC will furnish structural details of machine room slab.

xxv. EPIL to furnish revised BoQ (as per reduced scope of work) by 15th December 2018.

xxvi. OTPC informed that payment till RA-18 including extra items has been released on 29th November 2018, deducting 10% against GST. RA-19 has been submitted to KNY/OTPC on 20th November 2018 for measurement checking which will be paid as per the provisions of the contract.

OTPC

EPIL

30/11/18

30/11/18

30/11/18

30/11/18

30/11/2018

Annexure-1 (Painting Schedule)

S.No	Building Type	Utility Type	Area	Color	Color Code
1	All	Ceiling	All rooms	Persian Lace	2P1846
2	Type-II to Type-V	Master Bedroom	walls (3 Side)	Drops of Violet	6P0163
3		Master Bedroom	Bed backside wall	Deep Violet	6D2362
4		Bedroom-1	walls (3 Side)	Tutu (Pg-22)	1P0004
5		Bedroom-1	Bed backside wall	Pink Aroma (Pg-22)	1T1970
6		Bedroom-2	walls (3 Side)	Gull Lake (Pg-128)	5P1130
7		Bedroom-2	Bed backside wall	Wild Horizon (Pg-128)	5D1134
8		Living Room	Dark Side	Scarelett Tide (Pg-285)	1A2794
9		Dining	Dark Side	Scarelett Tide (Pg-285)	1A2794
10		Common Passage	Dark Side	Scarelett Tide (Pg-285)	1A2794
11		Living Room	Balance Sides	Gentle Breeze (Pg-10)	2P1902
12		Dining	Balance Sides	Gentle Breeze (Pg-10)	2P1902
13		Common Passage	Balance Sides	Gentle Breeze (Pg-10)	2P1902
14		Kitchen	Balance space	Gentle Breeze (Pg-10)	2P1902
15		Store Room	Complete	Gentle Breeze (Pg-10)	2P1902
16		Servant Room	Complete	Gentle Breeze (Pg-10)	2P1902
17		Toilet	Complete	Gentle Breeze (Pg-10)	2P1902
18		Exterior outside (As per View)	Dark shade	Carmine Red (Exterior Collection)	1A0448
19			Light Shade	Casaba (Exterior Collection)	7P1618
20		Balcony Wall (Inside)		Hazel Cream (Exterior Collection)	7P0178
21		Balcony Wall (Outside- Facia)		Angoora White (Exterior Collection)	3P0074
22	UGT	UGT - Exterior		Carmine Red (Exterior Collection)	1A0448
23	UGT	UGT - Interior		Gentle Breeze (Pg-10)	2P1902
24	ESS	ESS- Exterior		Carmine Red (Exterior Collection)	1A0448
25	ESS	ESS- Interior		Gentle Breeze (Pg-10)	2P1902
26	Main Gate	Main Gate	Piller	All Side ACP	
27	Guard room	Guard room	Facia	ACP of Equivalent Carmine Red (Exterior Collection)	1A0448
28	Guard room	Guard room (Outer walls)		Limestone Lighthouse	7T1548
29	Club House	Club House	Exterior Pillar and Facia	Angoora White (Exterior Collection)	3P0074
30	Club House	Club House	Exteror walls	Carmine Red (Exterior Collection)	1A0448
31	Club House	Club House	Elevated part	Casaba (Exterior Collection)	7P1618
32	Club House	Club House (Interior) as per drawing markings	Entrance, Lobby and Common area walls	Tuscan Orange (Interior Collection)	2A0672
33	Club House			Always Adela	6T1404
34	Club House			Angoora White (Interior Collection)	3P0074
35	Club House		Gym	Sky's the limit	5P0289
36	Club House		Admin	Angoora White (Interior Collection)	3P0074
37	Club House		Cafeteria	Lemon Ice	3P0721
38	Club House		Cafeteria (one wall)	Secret Garden	1D0323
39	Club House		Badminton Court	Angoora White (Interior Collection)	3P0074
40	Club House		Kitchen	Angoora White (Interior Collection)	3P0074
41	Club House		Change Room	Angoora White (Interior Collection)	3P0074
42	Club House	Second Floor	TT Room	Angoora White (Interior Collection)	3P0074
43	Club House	Second Floor	Billiard Room	Angoora White (Interior Collection)	3P0074
44	Club House	Second Floor	Children Play Area- 2 walls	Lime Crazy (Interior Collection)	4A0402
45	Club House	Second Floor	Children Play Area- 2 walls	Dogwood Blossom(Interior Collection)	1T0491
46	Club House	Second Floor	Card and Chess Room	Angoora White (Interior Collection)	3P0074
47	Club House	Second Floor	Library	Angoora White (Interior Collection)	3P0074
48	All Buildings	PVC Jali Shade	Dark shade	Carmine Red (Exterior Collection) Type-II : 2 Floors (Top) Type-III : 1 Floor (Top) Type-IV : 4 Floor (Top) Type-V : 3 Floor (Top)	1A0448
49	All Buildings	PVC Jali Shade	Light Shade	Casaba (Exterior Collection) Type-II : 4 Floors (Bottom) Type-III : 3 Floor (Bottom) Type-IV : 5 Floor (Bottom) Type-V : 5 Floor (Bottom)	7P1618

ANNEXURE-2 : BOUGHT OUT ITEMS PROCUREMENT SCHEDULE (Rev-1)

Sl. No.	ITEM	Name of Vendor	Make List	Date of PO	DATE OF DISPATCH	DISPATCH FROM	DELIVERY AT PALATANA SITE	STATUS
				CIVIL WORK				
1	Vitrified Tiles Ceramic Tiles	Orientbell	Orientbell	Initial:24-11-2018 Rev 1: 03-12-2018	24-Dec-18	Gujarat	07-Jan-18	PO to be placed by 03-Dec-18. - 2 samples to be submitted on 03-Dec-2018. PO for balance tiles to be placed within 2 days of approval.
2	Wall Tiles Ceramic Tiles	Orientbell	Orientbell	Initial:24-11-2018 Rev 1: 03-12-2018	24-Dec-18	Bulandshahar, UP (Wall Tiles)	07-Jan-18	Pattern for Bathroom approved on 28.11.2018. PO to be placed by 03-Dec-18.
3	Granite	Rishi/Gupta Marbles		After approval of sample- 03-12-2018		Guwahati (Availibility of approve sample) otherwise it will come from Banglore/Gujrat	16-Dec-18	Rosy Pink + Cats eye Granite approved. Sample yet to be submitted. (Samples approved on 30.11.2018)
4	Kota Stone	Rishi/Gupta Marbles				Guwahati	16-Dec-18	sample approved. PO to be placed along with Granite.
5	Flush Door	As per approved Make		PO to be placed within 5 days after sample approval		Kolkata	40 Days	sample to be submitted by 05.12.2018
6	M.S Grill (Balcony)			05-Dec-18		Making at site	10 Days	Subcontractor to be engaged for Grill work in baicony , handrail in service staircase.
7	Internal Painting	Berger		07-Jan-19		Kolkata	20 Days	Approved
8	External Painting	Berger		07-Jan-19		Kolkata	20 Days	Approved
9	Aluminium work and SS for Staircase	Maa Kamakhya				Banglore via Guwahati	30 Days	sub-contractor(Rajkumar Pandey) visited site on 25-Nov-18 to finalize the drawing. Drawings to be submitted by 10.12.2018.PO for purchase of raw material (readymade) to be done after approval of drawing
10	Water proofing (Toilet)	Mascon India		20-Nov-18		Kolkata	10-Dec-18	Material 10th Decemeber will be reach at site
11	Filling of Sunken Slab							cynder material enquiry from guwahati within 04-Dec-18
				ELECTRICAL WORK				
15	Switches & Socket	Kakrania Industrial Store	Legrand	15-Dec-18		Kolkata via Guwahati	45 Days	
16	DB & MCB	Kakrania Industrial Store	Legrand	15-Dec-18		Kolkata via Guwahati	45 Days	
17	Wire (FRLS)	Kakrania Industrial Store	Havells	07-Dec-18		Kolkata via Guwahati	45 Days	
18	Fan & Light Fixture	Kakrania Industrial Store	Bajaj/Philips/Syska			Pune via Guwahati	60 Days	4 lights and 3 Fan sample to be provided
19	Rising Main	Legrand	Legrand					Rising Main deleted for all the buildings
20	All Panels	EPIL to finalize the Vendor by 29-11-18		15-Dec-18		Kolkata via Guwahati	60 Days	
21	All Cables	Kakrania Industrial Store	Havells	15-Dec-18		Kolkata via Guwahati	40 Days	OTPC will furnish the cable details by 05-Dec-2018.

ANNEXURE-2 : BOUGHT OUT ITEMS PROCUREMENT SCHEDULE (Rev-1)

Sl. No.	ITEM	Name of Vendor	Make List	Date of PO	DATE OF DISPATCH	DISPATCH FROM	DELIVERY AT PALATANA SITE	STATUS
22	D.G set	KOEL	KOEL	07-Dec-18		Kolkata via Guwahati	45 Days	
23	Transformer	Voltamp	Voltamp	07-Dec-18		Pune via Guwahati	90 Days	Technical specification approved on 28-Nov-2018
24	Street Light & Poles	Kakrania Industrial Store	Bajaj/			Pune via Guwahati	60 Days	Drawing to be submitted by 30-Nov-18
				FIRE FIGHTING				
25	All Pumps	B.D Enterprises		20-Dec-18		Kolkata via Guwahati	90 Days	UGT to be ready by 31-Jan-19.
25	M.S Pipe	B.D Enterprises		10-Dec-18		Guwahati	25 Days	
25	All Valves	B.D Enterprises		07-Jan-19		Guwahati	60 Days	
				PLUMBING WORK				
26	Internal Plumbing (CPVC Pipes & Fittings)	Ragi Marchentile		23-Nov-18		Kolkata via Guwahati	28-Nov-18	Tribeni supplied material recahed site. ABC to place PO of Ajay Make by 05-Dec-18
27	Internal Plumbing (uPVC Pipes & Fittings)	Ragi Marchentile				Kolkata via Guwahati	Available at site	Tribeni supplied material recahed site. ABC to place PO of Ajay Make by 05-Dec-18
28	Sanitary and CP Fittings	Ragi Marchentile		15-Jan-19		Kolkata via Guwahati	45 Days	Catalog of Jaguar to be given by 24-Nov-18 for CP fittings . OTPC to approve by 26-Nov-18
29	Pumps	Hydro Energy Solution	Kirloskar/Mather&Platt	15-Jan-19		Kolkata via Guwahati	60 Days	
30	Water Filters	Hydro Energy Solution	Kirloskar/Mather&Platt	15-Jan-19		Kolkata via Guwahati	60 Days	

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30/11/18

30/11/18

964

MINUTES OF REVIEW MEETING HELDBETWEEN OTPCAND ENGINEERING POJECTS INDIA LIMITED (EPIL) ATOTPC TOWNSHIPON 2nd& 3rd MAY2019FOR CONSTRUCTION OF TOWNSHIP AT KHILPARA, UDAIPUR, TRIPURA.

Participants:

OTPC/KNY

1. Mr. Bibek Roy, Plant I/c
2. Mr. Samarjeet Thakur, DGM(Contracts)
3. Mr. Tapas Bhowmik, DGM(Projects)
4. Mr. Ravi Yadav, MD, KNY
5. Mr. C. Ravi, Civil Advisor
6. Mr. S.K.Saha, Consultant
7. Mr. Sunil Dutt, Project Manager, KNY

EPIL

1. Mr. B. Biswas, GGM I/c (NERO)
2. Mr. S. P. Roy, DGM
3. Mr. S. R. Lahiry, Project Manager

The following points were discussed:

i. OTPC reviewed the status of progress of work and reiterated completion of Type-II and Type-III along with all ancillary services of townshipby 31st May 2019th and completion of Type-IV, Type-V and Club House by 30th June 2019.

ii. GGM, EPIL informed that the said targets could not be achieved due to decrease in manpower due to Poila Baishakhclubbed with General Elections. However, agreed to put best efforts and confirmed to make Type-II and Type-III operational along with ancillary servicesby Jun-19 and Type-IV & Type-V within Jul-19. The revised schedule of finishing of Type-II and Type-III is attached as **Annexure-1** with **handing over of Type-II by 20-Jun-19 and Type-III by 30-Jun-19**.

iii. OTPC expressed strong concerns regarding the delay in ordering of the Bought-out items (BOI) necessary for the completion of the project. EPIL discussed with its sub-contractors submitted a BOI procurement schedule attached as **Annexure-2**. OTPC informed EPIL that the adherence to the timelines mentioned in the schedule are very critical to meet the June-19 deadline.

iv. EPIL informed that manpower mobilized at site was260 on 30th April 2019 which increased to 340 nos. on 2nd May 2019. GGM,EPIL informed that he has taken up strongly with the sub-contractors advised them to deploy additional 160 manpower for finishing works (per building : 15 skilled worker for flooring + 10 carpenter for cupboard/doors+ 15 for putty and painting), else EPIL shall deploy them on their own.

v. ABC confirmed that following skilled manpower shall be increased for expediting finishing works:

	Required	Available	Date of deployment of balance
Type- IV – Flooring:	15	6	10.05.19
Type- IV – Woodwork:	15	0	20.05.19
Type- IV – Painting:	15	0	15.05.19
Type- V – Flooring:	15	0	10.06.19
Type- V – Woodwork:	15	0	10.06.19
Type- V – Painting:	15	0	20.06.19

3/5/19

KNY

Annexure P-15
(Colly) 238

भारत सरकार,
भारत मौसम विज्ञान विभाग,
मौसम विज्ञान केंद्र,
अगरतला हवाई अड्डा,

No. OB - 00105 /DS/2016/IV / 108 **Dated: 22.01.2018**

To,
ONGC Tripura Power Company Ltd.
Kakraban Road,
Palatana, Udaipur,
Tripura 799116.

Sub.:- Rainfall Data

Ref.:- Your letter No OTPC/UDP/Platana/2017-18/573 dated 12-01-2018

Sir,

Kindly find enclosed the Normal Average Rainfall On daily basis in respect of Agartala,, Tripura

Thanking you

Yours faithfully,

22/01/18
(D.Dey)
Meteorologist-A
for –Director(Scientist-E)
Met. Centre, Agartala.

T. C.
SP

339

Average Normal Rainfall

Station : Agartala

Date	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	0.2	0.3	1.9	3.5	9.9	14.2	10.7	8.8	8.7	8.9	2.6	0.3
2	0.1	0.5	1.8	4.0	9.0	14.2	11.0	8.9	8.5	8.4	2.5	0.3
3	0.1	0.6	1.7	3.7	9.6	13.5	11.6	8.5	8.7	8.8	1.9	0.2
4	0.1	0.6	1.7	4.3	9.9	13.1	12.2	8.9	8.7	8.4	1.7	0.2
5	0.2	0.6	1.1	4.1	10.7	14.6	11.8	8.7	8.1	8.2	1.4	0
6	0.2	0.6	1.2	3.6	10.7	14.7	11.5	8.8	8.2	7.8	2.1	0.2
7	0.3	0.6	1.4	4.2	11.5	15.1	12.5	8.3	9.0	7.6	2.4	0.5
8	0.5	0.6	1.4	4.5	12.3	15.3	13.2	8.2	8.4	7.0	2.5	0.5
9	0.5	0.5	1.5	4.7	11.9	16.1	13.8	7.9	8.8	7.1	2.5	0.7
10	0.5	0.4	1.8	5.9	10.9	17.1	14.0	7.9	8.7	6.9	2.4	0.8
11	0.5	0.3	1.8	5.9	10.3	17.2	12.8	7.7	8.4	7.2	2.2	0.9
12	0.5	0.2	1.5	6.3	9.9	15.8	13.1	8.6	8.5	5.8	2	0.9
13	0.5	0.2	1.5	7.6	8.7	16.1	13.7	9.5	9.1	4.9	1.5	0.7
14	0.5	0.5	1.3	8.0	7.8	15.8	13.4	11.6	8.4	4.6	1.1	0.3
15	0.3	0.4	1.2	8.3	7.4	17.0	13.2	11.9	8.9	3.9	1.2	0.3
16	0.1	0.5	1.4	8.9	7.7	15.8	12.8	11.8	8.3	3.6	0.9	0.2
17	0.1	0.5	1.7	8.3	8.4	16.1	12.4	12.4	8.0	3.6	0.8	0.1
18	0.1	0.6	2.2	8.1	8.8	15.9	12.9	12.3	7.6	3.0	0.8	0.1
19	0.2	0.7	2.3	8.1	10.0	15.3	12.4	11.7	7.3	3.4	0.8	0.1
20	0.3	0.7	2.5	7.4	9.8	14.2	12.4	11.9	6.5	3.8	0.6	0.1
21	0.2	0.7	3.1	6.5	10.1	13.6	11.3	10.5	6.1	3.9	0.9	0.1
22	0.2	1.0	3.4	6.3	10.4	12.6	11.1	10.5	5.6	4.4	0.7	0
23	0.2	1.2	3.0	6.0	10.7	12.8	11.0	10.5	5.6	4.5	0.7	0
24	0.2	1.2	3.0	5.5	10.0	11.6	10.5	9.8	5.9	4.2	0.8	0.1
25	0.3	1.2	2.9	6.9	9.2	10.9	10.9	10	5.8	3.7	0.8	0.1
26	0.3	1.7	2.9	7.6	9.8	10.8	10.8	9.9	5.9	3.3	0.7	0.1
27	0.2	1.7	2.9	7.8	10.5	10.5	10.3	8.8	6.4	3.7	0.5	0.2
28	0.2	1.6	2.6	8.4	11.3	11.0	11.1	9.3	6.8	3.6	0.5	0.2
29	0.3		2.8	9.5	11.4	10.7	10.2	9.1	7.3	3.5	0.4	0.2
30	0.0		3.5	9.4	12.3	10.0	9.3	8.5	7.5	3.2	0.4	0.2
31	0.7		3.5		13.5		9.5	8.9		2.7		0.2
Total	8.6	20.2	66.5	193.3	314.4	421.6	367.4	300.1	229.7	163.6	40.3	8.8	2134.5

22/11/18

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भारत सरकार,
भारत मौसम विज्ञान विभाग,
मौसम विज्ञान केंद्र,
अगरतला हवाई अड्डा,

No. OB - 00105 /DS/2016/IV / 108 **Dated: 22.01.2018**

To,
ONGC Tripura Power Company Ltd.
Kakraban Road,
Palatana, Udaipur,
Tripura 799116.

Sub.:- Rainfall Data

Ref.:- Your letter No OTPC/UDP/Platana/2017-18/573 dated 12-01-2018

Sir,

Kindly find enclosed the Normal Average Rainfall On daily basis in respect of Agartala,, Tripura

Thanking you

Yours faithfully,

22/01/18
(D.Dey)
Meteorologist-A
for –Director(Scientist-E)
Met. Centre, Agartala.

130

8.41

Average Normal Rainfall

Station : Agartala

Date	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	0.2	0.3	1.9	3.5	9.9	14.2	10.7	8.8	8.7	8.9	2.6	0.3
2	0.1	0.5	1.8	4.0	9.0	14.2	11.0	8.9	8.5	8.4	2.5	0.3
3	0.1	0.6	1.7	3.7	9.6	13.5	11.6	8.5	8.7	8.8	1.9	0.2
4	0.1	0.6	1.7	4.3	9.9	13.1	12.2	8.9	8.7	8.4	1.7	0.2
5	0.2	0.6	1.1	4.1	10.7	14.6	11.8	8.7	8.1	8.2	1.4	0
6	0.2	0.6	1.2	3.6	10.7	14.7	11.5	8.8	8.2	7.8	2.1	0.2
7	0.3	0.6	1.4	4.2	11.5	15.1	12.5	8.3	9.0	7.6	2.4	0.5
8	0.5	0.6	1.4	4.5	12.3	15.3	13.2	8.2	8.4	7.0	2.5	0.5
9	0.5	0.5	1.5	4.7	11.9	16.1	13.8	7.9	8.8	7.1	2.5	0.7
10	0.5	0.4	1.8	5.9	10.9	17.1	14.0	7.9	8.7	6.9	2.4	0.8
11	0.5	0.3	1.8	5.9	10.3	17.2	12.8	7.7	8.4	7.2	2.2	0.9
12	0.5	0.2	1.5	6.3	9.9	15.8	13.1	8.6	8.5	5.8	2	0.9
13	0.5	0.2	1.5	7.6	8.7	16.1	13.7	9.5	9.1	4.9	1.5	0.7
14	0.5	0.5	1.3	8.0	7.8	15.8	13.4	11.6	8.4	4.6	1.1	0.3
15	0.3	0.4	1.2	8.3	7.4	17.0	13.2	11.9	8.9	3.9	1.2	0.3
16	0.1	0.5	1.4	8.9	7.7	15.8	12.8	11.8	8.3	3.6	0.9	0.2
17	0.1	0.5	1.7	8.3	8.4	16.1	12.4	12.4	8.0	3.6	0.8	0.1
18	0.1	0.6	2.2	8.1	8.8	15.9	12.9	12.3	7.6	3.0	0.8	0.1
19	0.2	0.7	2.3	8.1	10.0	15.3	12.4	11.7	7.3	3.4	0.8	0.1
20	0.3	0.7	2.5	7.4	9.8	14.2	12.4	11.9	6.5	3.8	0.6	0.1
21	0.2	0.7	3.1	6.5	10.1	13.6	11.3	10.5	6.1	3.9	0.9	0.1
22	0.2	1.0	3.4	6.3	10.4	12.6	11.1	10.5	5.6	4.4	0.7	0
23	0.2	1.2	3.0	6.0	10.7	12.8	11.0	10.5	5.6	4.5	0.7	0
24	0.2	1.2	3.0	5.5	10.0	11.6	10.5	9.8	5.9	4.2	0.8	0.1
25	0.3	1.2	2.9	6.9	9.2	10.9	10.9	10	5.8	3.7	0.8	0.1
26	0.3	1.7	2.9	7.6	9.8	10.8	10.8	9.9	5.9	3.3	0.7	0.1
27	0.2	1.7	2.9	7.8	10.5	10.5	10.3	8.8	6.4	3.7	0.5	0.2
28	0.2	1.6	2.6	8.4	11.3	11.0	11.1	9.3	6.8	3.6	0.5	0.2
29	0.3		2.8	9.5	11.4	10.7	10.2	9.1	7.3	3.5	0.4	0.2
30	0.0		3.5	9.4	12.3	10.0	9.3	8.5	7.5	3.2	0.4	0.2
31	0.7		3.5		13.5		9.5	8.9		2.7		0.2
Total	8.6	20.2	66.5	193.3	314.4	421.6	367.4	300.1	229.7	163.6	40.3	8.8	2134.5

22/11/18

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भारत सरकार,
भारत मौसम विज्ञान विभाग,
मौसम विज्ञान केंद्र,
अगरतला हवाई अड्डा,

No. OB-00105 /DS/2016/IV / 104

To,

Dated: 17.12.2017

ONGC Tripura Power Company Ltd.
Kakraban Road,
Palatana, Udaipur,
Tripura 799116.

Sub.:- Rainfall Data

Ref.:- Your letter No OTPC/UDP/Palatana/2017-18/493 dated 28-11-2017

Sir,

Kindly find enclosed the Daily Rainfall Data(in millimeters) in respect of Udaipur, Tripura for the period of 19 months from April 2016 to October 2017.

Thanking you

Yours faithfully,

(D.Dey) 17/12/17
Meteorologist-A
for –Director(Scientist-E)
Met. Centre, Agartala.

132

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DAILY RAINFALL DATA IN MM. OF UDAIPUR(Gomoti) FOR THE YEAR 2016

Month / Date	Apr.	May	Jun.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
01	027.3	000.0	003.1	000.0	035.0	073.5	012.0	000.0	000.0
02	000.0	005.5	000.0	003.0	003.0	000.5	001.5	000.0	000.0
03	000.0	009.1	000.0	014.0	001.5	010.5	000.5	000.0	000.0
04	025.2	011.5	000.0	060.0	000.0	008.5	000.0	008.0	000.0
05	000.0	000.0	000.0	011.0	000.0	005.0	000.5	002.0	000.0
06	004.0	000.0	000.0	011.5	000.0	000.0	000.5	102.0	000.0
07	000.0	017.0	000.0	000.0	000.0	000.0	052.5	113.5	000.0
08	002.5	000.0	031.8	009.5	006.0	000.0	019.5	000.0	000.0
09	000.0	000.0	002.4	000.0	000.0	000.0	000.5	000.0	000.0
10	000.0	000.0	000.0	004.5	006.5	000.0	000.5	000.0	000.0
11	000.0	000.0	083.5	007.0	007.0	000.0	003.5	000.0	000.0
12	000.0	003.2	010.5	004.0	000.0	000.0	008.0	000.0	000.0
13	000.0	012.4	011.5	001.5	004.0	025.5	012.5	000.0	000.0
14	000.0	000.0	000.0	000.0	036.5	002.0	004.5	000.0	000.0
15	000.0	000.0	000.0	000.0	014.5	000.0	003.5	000.0	000.0
16	000.0	000.0	001.1	046.0	003.5	000.0	000.0	000.0	000.0
17	000.0	000.0	000.0	009.5	026.0	000.0	000.0	000.0	000.0
18	000.0	009.5	001.4	123.5	000.0	002.0	000.0	000.0	000.0
19	000.0	008.4	000.6	020.0	000.0	000.0	000.0	000.0	000.0
20	000.0	007.8	001.1	008.5	000.0	012.0	000.0	000.0	000.0
21	000.0	099.3	004.8	000.0	056.5	000.0	000.0	000.0	000.0
22	000.0	051.2	000.0	000.0	005.5	011.5	000.0	000.0	000.0
23	000.0	000.0	000.0	017.5	000.0	016.0	000.0	000.0	000.0
24	000.0	000.0	006.4	024.5	000.0	000.5	000.0	000.0	000.0
25	000.0	018.3	000.0	001.5	000.0	000.0	000.0	000.0	000.0
26	000.0	018.2	000.0	009.5	030.6	000.0	000.0	000.0	000.0
27	000.0	000.0	032.2	000.0	008.5	001.5	000.0	000.0	000.0
28	000.0	031.2	007.0	000.0	039.5	011.5	012.5	000.0	000.0
29	000.0	077.4	024.4	000.0	000.5	002.5	000.0	000.0	000.0
30	000.0	006.2	045.0	009.0	000.0	000.0	000.0	000.0	000.0
31		000.0		048.5	032.0		000.0		000.0

133

DAILY RAINFALL DATA IN MM. OF UDAIPUR(Gomoti) FOR THE YEAR 2017

Month / Date	Jan	Feb	Mar	Apr.	May	Jun.	July.	Aug.	Sept.	Oct.
01	000.0	000.0	000.0	000.0	000.0	056.0	000.0	000.0	118.5	013.3
02	000.0	000.0	000.0	000.0	029.0	036.5	003.0	031.1	000.0	000.0
03	000.0	000.0	000.0	000.0	000.0	011.5	014.0	037.9	000.0	000.0
04	000.0	000.0	000.0	034.0	000.0	068.5	060.0	000.0	065.0	000.0
05	000.0	000.0	000.0	000.0	000.0	003.5	011.0	006.3	000.0	006.0
06	000.0	000.0	013.5	014.2	000.0	000.0	011.5	000.0	000.0	000.0
07	000.0	000.0	000.0	000.0	019.0	000.0	000.0	007.4	009.1	000.0
08	000.0	000.0	000.0	000.0	000.0	000.0	009.5	000.0	015.1	000.0
09	000.0	000.0	032.5	000.0	000.0	015.0	000.0	000.0	000.0	000.0
10	000.0	000.0	000.0	000.0	000.0	000.0	004.5	006.9	000.0	029.3
11	000.0	000.0	018.0	000.0	000.0	003.0	007.0	030.2	021.3	000.0
12	000.0	000.0	022.0	000.0	000.0	018.0	004.0	107.1	010.2	000.0
13	000.0	000.0	000.0	000.0	000.0	018.0	001.5	029.5	000.0	000.0
14	000.0	000.0	000.0	000.0	000.0	000.0	000.0	026.5	000.0	000.0
15	000.0	000.0	000.0	000.0	045.5	000.0	000.0	047.5	000.0	000.0
16	000.0	000.0	000.0	000.0	030.0	011.0	046.0	099.3	000.0	000.0
17	000.0	000.0	000.0	003.5	000.0	000.0	009.5	000.0	000.0	000.0
18	000.0	000.0	000.0	000.0	000.0	041.5	123.5	000.0	001.5	065.0
19	000.0	000.0	010.5	000.0	000.0	007.3	020.0	008.2	016.4	012.5
20	000.0	000.0	000.0	046.5	010.5	024.9	008.5	000.0	004.4	020.3
21	000.0	000.0	005.5	020.0	004.0	006.7	000.0	012.4	000.0	062.2
22	000.0	000.0	000.0	011.5	000.0	001.5	000.0	045.5	002.0	090.9
23	000.0	000.0	000.0	044.0	000.0	000.0	017.5	000.0	000.0	000.0
24	000.0	000.0	000.0	093.0	000.0	000.0	024.5	033.4	000.0	000.0
25	000.0	000.0	000.0	016.0	000.0	000.0	001.5	000.0	002.1	000.0
26	000.0	000.0	015.0	036.0	000.0	000.0	009.5	000.0	000.0	000.0
27	000.0	000.0	000.0	000.0	000.0	000.0	000.0	000.0	000.0	000.0
28	000.0	000.0	000.0	000.0	000.0	000.0	000.0	000.0	010.4	000.0
29	000.0		000.0	000.0	000.0	000.0	000.0	000.0	028.3	000.0
30	000.0		003.5	000.0	002.5	000.0	009.0	003.0	000.0	005.3
31	000.0		000.0		039.5		048.5	006.5		009.1

CLIMATE OF TRIPURA

Prepared by,

Meteorological Centre, Agartala
India Meteorological Department

Tripura is located in the north-eastern part of India. It is the third-smallest state in the country. The state is located between 22°56′ & 24°32′ north latitudes and 91°09′ & 92°20′ east longitudes. Its area is 10,491 km^2 and is bordered by Bangladesh to the north, south, and west, and the Indian states of Assam and Mizoram to the east. The length of its international border with Bangladesh is 856 km (84 per cent of its total border). It consists of eight districts, namely West Tripura, Khowai, Sipahijala, Dhalai, North Tripura, Unakoti, Gomati and South Tripura. Forests cover more than half of the state, in which bamboo and cane tracts are common. About 60% of its land is hilly, while the remaining 40% is plain land. Five hill ranges - Boromura, Atharamura, Longtharai, Shakhan and Jampui Hills, run almost parallel from north to south. The state lies in the seismic zone 5, as per seismic zoning map of India, which is considered as the most vulnerable zone for high intensity earthquakes. The capital Agartala is located on a plain to the west with a height of 15 meters above mean sea level.

1. Climate of Tripura:

IMD has two full time meteorological observatories in Tripura. One Meteorological Centre (MC) located at the state capital Agartala (23° 53′ N, 91° 15′ E) in West Tripura district and one Meteorological Observatory (MO) located at Kailashahar (24° 19′ N, 92° 00′ E) in Unakoti District. Besides, it also has part-time observatories across the state from which daily rainfall data are obtained. The state observes moderately warm temperatures during summer and moderately cold temperatures during winter. Due to the presence of Bay of Bengal to its south, the humidity in the state is fairly high during summer.

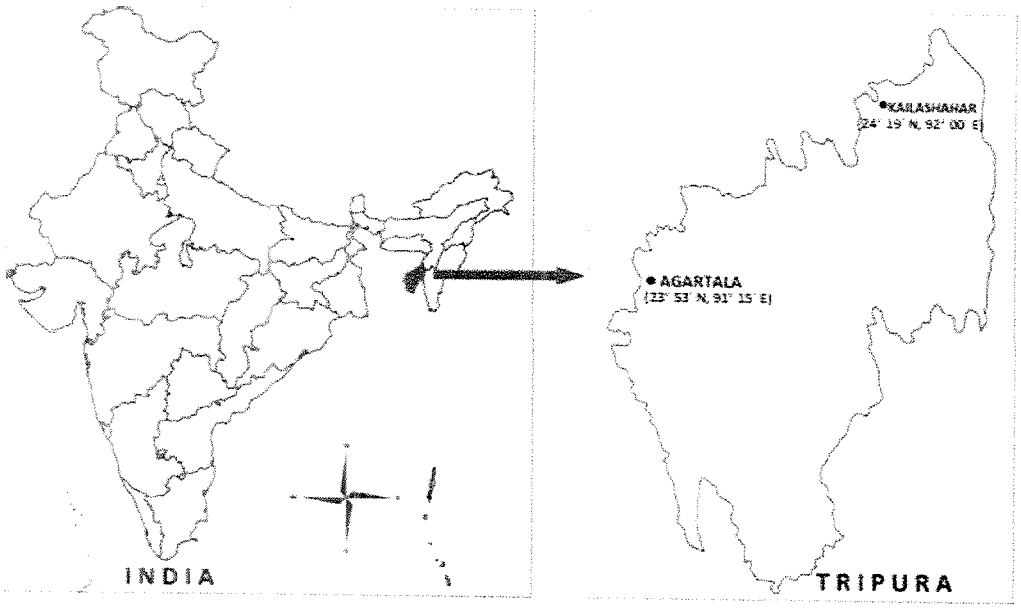

Fig.1: Map of Tripura with location of Agartala and Kailashahar observatories

As per IMD's classification of meteorological seasons in India, the period of the year has been classified into four seasons, namely,

i. Winter Season (January to February)
ii. Pre-monsoon Season (March to May)
iii. Monsoon Season (June to September)
iv. Post-monsoon Season (October to December)

i. **Winter:** The winters in Tripura are generally moderately cold, but on one or two occasions, temperatures as low as 2-3 degree Celsius have also been observed in the two observatories of IMD. Winter conditions commence in the state from December itself. During this period, moderate to dense fog and sometimes very dense fog is observed during morning hours. January is the coldest month of the year. Average minimum temperatures are around 10 degrees Celsius in this month. The days are generally dry, cloud free and light northerly surface winds are observed.
ii. **Pre-monsoon:** Temperatures start rising from March which also brings thunderstorms accompanied with rain to the state. These thunderstorm events in the pre-monsoon season are known as 'Norwesters' or 'Kalbaisakhi' in local language. They generally move from northwest to southeast direction. Their duration may be from a few minutes

to a few hours. Sometimes thundershowers are accompanied with squall, with wind speed of more than 150 km per hour or hail. The activity begins in March and progressively increases with the advance of the season reaching to its peak in May. It is the secondary rainy season of the state, with nearly 30% of the annual rainfall. On an average, thunderstorms occur more than 30 days in Tripura during this season. The average maximum temperatures are around 32-33 degrees Celsius during this season, with April being the warmest month of the year. During this season, skies are partly cloudy over the state, while towards the end of the season cloudiness increases.

iii. **Monsoon:** Normally south-west monsoon enters in the season in the first week of June. With this the wind direction changes from northerly/northwesterly to southerly which brings humid air from the Bay of Bengal to the state. Cloudiness increases over the state in this season. On an average 75% of the sky is covered by clouds during June to September. Severe thunderstorm activity decreases but rainfall increases during this season. Although some thunderstorms are observed in this season, but they are of lower intensity as compared to pre-monsoon season. It is the main rainy season for the state with an average of more than 1300mm. It is about 60% of the annual rainfall. June is the rainiest month of the year with more than 400mm of average rainfall. The average maximum temperatures are around 31-32 degrees and minimum temperatures are around 24-25 degrees Celsius. The humidity is quite high in this season. The south-west monsoon is normally withdrawn from the state during mid-October.

iv. **Post-monsoon:** Rainfall decreases in the state from October. The temperatures also start decreasing. The average maximum and minimum temperatures fall from 31 and 22 degrees in October to 26 and 11 degrees Celsius respectively in December. From November itself the weather becomes dry, but sometimes one or two cyclonic circulations in the Bay of Bengal bring some rainfall for 2-3 days during this season. Mornings start becoming foggy from December and winter conditions are setup. The surface winds change direction once again to northerly/northwesterly from November.

2. Month wise normal temperature and rainfall

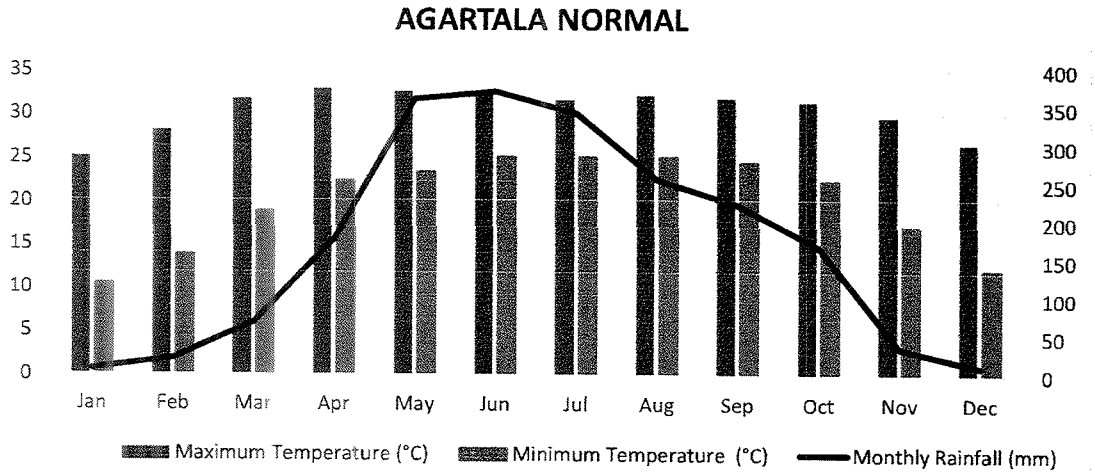

Fig.2: Climatological Normal Temperature and Rainfall at Agartala (Based on 1981-2010)

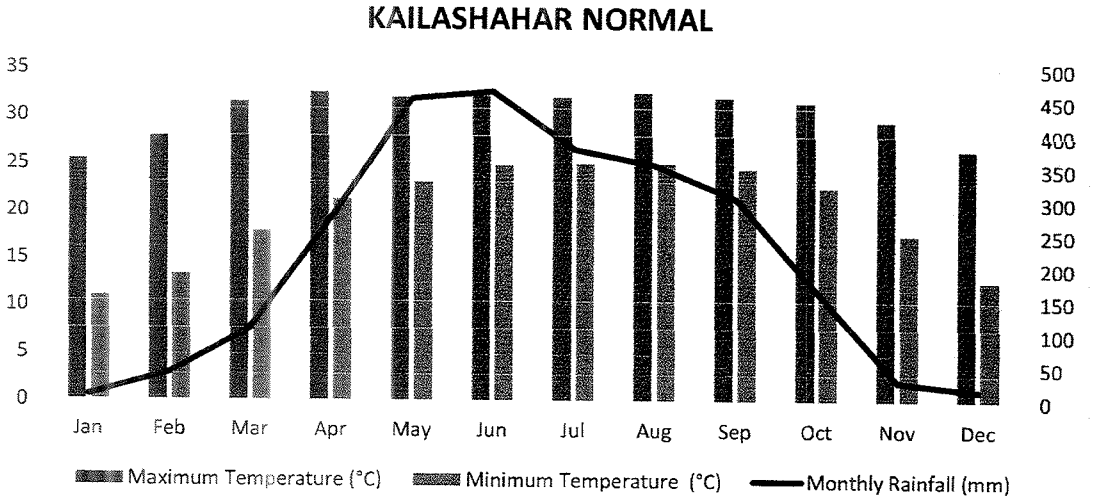

Fig.3: Climatological Normal Temperature and Rainfall at Kailashahar (Based on 1981-2010)

The month wise climatological normal values (based on 1981-2010 climatology) of maximum and minimum temperatures and rainfall for Agartala and Kailashahar are shown in the above figures. It is seen from the above figures that, the maximum temperatures keep on increasing from January to April, but due to significant increase in rainfall from May, it decreases slightly during that period. Again due to decrease in monsoon rainfall from August,

temperatures increase slightly. From November onwards, both temperatures and rainfall decreases significantly.

3. Month wise extreme temperature and rainfall

The highest ever temperature recorded at Agartala is 42.2 °C on 01st May 1960, whereas the lowest ever temperature is 02.0 °C on 30th December 1972. The highest one-day rainfall recorded was 257.2 mm on 22nd May 1993.

At Kailashahar, the highest and the lowest recorded temperatures were 42.2 °C (09th April 1960) and 02.4 °C (15th January 1976) respectively. The highest rainfall recorded in one day was 284.0 mm on 03rd June 1965.

4. Tables:

4.1 Climatological normal values based on the period 1981-2010

STATE: TRIPURA			
	MONTHLY RAINFALL (in mm)	SEASON	SEASONAL RAINFALL (in mm)
JANUARY	7.8	WINTER (JAN-FEB)	35.4
FEBRUARY	27.6		
MARCH	78.7	PRE-MONSOON (MAR-MAY)	677.7
APRIL	211.1		
MAY	387.9		
JUNE	460.1	MONSOON (JUNE-SEP)	1457.8
JULY	402.8		
AUGUST	340.9		
SEPTEMBER	254.0		
OCTOBER	170.8	POST-MONSOON (OCT-DEC)	221.8
NOVEMBER	39.4		
DECEMBER	11.6		
ANNUAL	2392.7		

Table 1: Month wise climatological normal values for Tripura

CITY: AGARTALA								
MONTH	MEAN TEMPERATURE(°C)		MEAN TOTAL RAINFALL (mm)	MEAN NUMBER OF RAINY DAYS	MEAN NUMBER OF DAYS WITH			
	DAILY MAXIMUM	DAILY MINIMUM			HAIL	THUNDER	FOG	SQUALL
JANUARY	25.2	10.5	7.6	0.8	0.1	0.4	12.9	0.1
FEBRUARY	28.2	13.9	22.1	2.1	0.0	2.1	3.8	0.1
MARCH	31.7	18.9	69.4	3.3	0.1	5.0	1.5	1.2
APRIL	32.9	22.4	180.4	7.9	0.1	11.8	0.4	2.3
MAY	32.6	23.4	362.9	13.3	0.0	15.5	0.1	3.4
JUNE	32.3	25.2	373.0	14.9	0.0	10.7	0.1	0.6
JULY	31.6	25.2	344.0	15.8	0.0	8.5	0.0	0.1
AUGUST	32.2	25.2	258.2	14.9	0.0	9.9	0.1	0.0
SEPTEMBER	31.8	24.6	225.1	12.2	0.0	11.2	0.6	0.0
OCTOBER	31.4	22.4	167.7	7.1	0.2	5.3	1.8	0.1
NOVEMBER	29.6	17.1	36.2	1.2	0.0	0.4	4.4	0.0
DECEMBER	26.6	12.1	11.0	0.7	0.0	0.1	10.1	0.0
ANNUAL	30.5	20.1	2057.5	94.3	0.6	81.1	35.9	8.1

Table 2: Month wise climatological normal values for Agartala

CITY: KAILASHAHAR								
MONTH	MEAN TEMPERATURE(°C)		MEAN TOTAL RAINFALL (mm)	MEAN NUMBER OF RAINY DAYS	MEAN NUMBER OF DAYS WITH			
	DAILY MAXIMUM	DAILY MINIMUM			HAIL	THUNDER	FOG	SQUALL
JANUARY	25.5	11.0	8.3	1.0	0.0	0.7	10.5	0.0
FEBRUARY	27.9	13.3	41.9	2.3	0.1	2.4	4.0	0.0
MARCH	31.5	17.9	109.3	5.0	0.2	6.2	1.1	0.2
APRIL	32.5	21.3	277.5	10.8	0.3	12.8	0.2	0.6
MAY	32.0	23.2	455.9	15.0	0.0	14.9	0.2	0.3
JUNE	32.2	24.9	465.9	17.1	0.0	11.8	0.0	0.0
JULY	32.0	25.1	380.2	18.7	0.0	8.1	0.0	0.0
AUGUST	32.5	25.2	357.1	18.4	0.0	10.8	0.2	0.0
SEPTEMBER	32.0	24.6	306.9	15.0	0.1	12.0	1.2	0.0
OCTOBER	31.5	22.6	166.7	7.2	0.0	4.6	6.0	0.0
NOVEMBER	29.5	17.6	29.7	1.4	0.0	0.4	10.5	0.0
DECEMBER	26.6	12.7	16.8	0.8	0.0	0.2	11.8	0.0
ANNUAL	**30.5**	**20.0**	**2616.2**	**112.8**	**0.6**	**85.2**	**45.6**	**1.2**

Table 3: Month wise climatological normal values for Kailashahar

4.2 Month wise extreme temperature and rainfall

CITY: AGARTALA				
MONTH	TEMPERATURE (°C)		RAINFALL (mm)	
	HIGHEST MAXIMUM (DATE)	LOWEST MINIMUM (DATE)	24 HOURS HIGHEST (DATE)	MONTHLY TOTAL (YEAR)
JANUARY	**32.2** (26, 2017)	**03.3** (10, 2013)	**50.0** (11, 1957)	**66.0** (1957)
FEBRUARY	**35.1** (28, 1969)	**04.7** (07, 1983)	**66.4** (27, 2001)	**86.1** (1973)
MARCH	**38.9** (31, 1962)	**09.4** (04,1972)	**98.6** (01, 1960)	**220.3** (1990)
APRIL	**41.5** (30, 1960)	**14.2** (03, 2002)	**198.0** (11, 2007)	**537.3** (1977)
MAY	**42.2** (01, 1960)	**16.1** (02, 1955)	**242.6** (18, 2018)	**730.3** (2018)
JUNE	**40.2** (01, 1979)	**19.5** (16, 1961)	**236.2** (08, 1976)	**799.9** (1976)
JULY	**37.7** (14, 1972)	**21.3** (07, 1972)	**257.2** (22, 1993)	**786.9** (2007)
AUGUST	**37.2** (22, 2019)	**20.8** (26, 1966)	**238.8** (15, 1955)	**658.8** (1965)
SEPTEMBER	**37.6** (18, 2015)	**21.1** (19, 1965)	**220.9** (13, 2004)	**496.2** (1960)
OCTOBER	**36.5** (04, 2010)	**14.6** (31, 1967)	**183.6** (11, 1989)	**418.0** (1963)
NOVEMBER	**34.8** (02, 2016)	**09.2** (26, 1982)	**120.8** (06, 2016)	**205.9** (1955)
DECEMBER	**33.1** (21, 1990)	**02.0** (30, 1972)	**69.3** (25, 1991)	**117.5** (1991)
ALL TIME RECORD	**42.2** (01 May 1960)	**02.0** (30 December 1972)	**257.2** (22 May 1993)	**799.9** (June 1976)

Table 4: Month wise extreme temperature and rainfall data for Agartala

(Updated on 01st January 2020)

CITY: KAILASHAHAR				
MONTH	TEMPERATURE (°C)		RAINFALL (mm)	
	HIGHEST MAXIMUM (DATE)	LOWEST MINIMUM (DATE)	24 HOURS HIGHEST (DATE)	MONTHLY TOTAL (YEAR)
JANUARY	**31.6** (26, 2016)	**02.4** (15, 1976)	**67.2** (30, 1969)	**102.8** (1969)
FEBRUARY	**34.5** (28, 2006)	**03.9** (05, 1968)	**66.3** (08, 1965)	**152.8** (2016)
MARCH	**38.6** (30, 1986)	**07.2** (02, 1972)	**108.4** (30, 2010)	**353.5** (1983)
APRIL	**42.2** (09, 1960)	**12.1** (01, 1968)	**257.1** (19, 2004)	**1012.8** (1977)
MAY	**42.0** (01, 1960)	**17.4** (04, 2013)	**226.0** (26, 1985)	**867.8** (1988)
JUNE	**38.3** (06, 1979)	**19.3** (20, 1982)	**284.0** (03, 1965)	**854.7** (2017)
JULY	**37.8** (29, 1963)	**19.7** (17, 1961)	**153.5** (20, 2004)	**877.2** (2004)
AUGUST	**37.5** (19, 1987)	**20.8** (27, 1968)	**206.6** (08, 1964)	**589.4** (2017)
SEPTEMBER	**37.2** (15,1996;18,2015)	**20.0** (07, 1976)	**126.8** (12, 1979)	**538.7** (1985)
OCTOBER	**36.0** (02,2009;04,2010)	**15.4** (31, 1976)	**182.0** (09, 1986)	**408.0** (1986)
NOVEMBER	**36.8** (23, 1981)	**08.8** (28, 1969)	**104.2** (10, 1986)	**191.3** (2016)
DECEMBER	**31.7** (02, 2011)	**05.6** (18, 2013)	**76.2** (19, 2003)	**122.2** (2003)
ALL TIME RECORD	**42.2** (09 April 1960)	**02.4** (15 January 1976)	**284.0** (03 June 1965)	**1012.8** (April 1977)

Table 5: Month wise extreme temperature and rainfall data for Kailashahar

(Updated on 01st January 2020)

****

Dinesh Laha

From: Alokesh Hazarika
Sent: 28 April 2021 12:24
To: Amit Dabas; Smruti Ranjan Das
Cc: Arup ch. Sarmah
Subject: RE: Requiment of P437 Relay.
Attachments: Fwd: Offer for Supply & retrofitting of MiCOM P443 as Main 2 distance protection relays in place of P437 relays

Dear Sir,

Please find the attached mail shared by M/S GE.

Same P437 relay was replaced by M/S NEEPCO.

Regards
Alokesh Hazarika

-----Original Message-----
From: Amit Dabas
Sent: 27 April 2021 12:10
To: Smruti Ranjan Das; Alokesh Hazarika
Cc: Arup ch. Sarmah
Subject: FW: Requiment of P437 Relay.

Dear Sir

The below email shows that you enquired for specific relays and GE said it is not their manufacturing range.
It does not show the reason why particular relay was replaced/decapitalized within 6 years of plant commissioning.

Request you to share a write-up so that even CERC can understand on following:
1. the reasons for which this decision of relay replacement was taken?
2. how OTPC ascertained that the relays are obsolete?
3. is it proprietary item as otpc enquired only with GE?
4. why such early replacement within 6 years of plant commissioning? Is relay life actually that much?
5. provide proof of obsolescence of relays

Regards
Amit Dabas

-----Original Message-----
From: Smruti Ranjan Das
Sent: 25 April 2021 13:21
To: Amit Dabas <amit.dabas@otpcindia.in>
Subject: FW: Requiment of P437 Relay.

Dear sir

FYIP

Regards
Smruti Ranjan Das

_____

From: Smruti Ranjan Das
Sent: Thursday, April 22, 2021 5:54 PM
To: Soubhik Choudhury
Subject: FW: Requiment of P437 Relay.

From: Mukherjee, Angsu (GE Renewable Energy) [mailto:angsu.mukherjee@ge.com]
Sent: Monday, August 3, 2020 2:37 PM
To: Alokesh Hazarika
Cc: Smruti Ranjan Das
Subject: RE: Requiment of P437 Relay.

CAUTION: This email originated from outside of the OTPC Domain Network. Do not click links or open attachments, unless you recognize the sender and know the content is safe.

Dear Sir,
MiCOM P437 is not in our manufacturing range now & we can quote MiCOM P443.

Offer will be submitted soon

Thanks & Regards,
Angsu Mukherjee

T +91 033 40097005
M +91 9163315765
F +91 033 4009 7020/21
angsu.mukherjee@ge.com<mailto:angsu.mukherjee@ge.com>

GE T&D India Limited
(Formerly Alstom T & D India Limited)
DLF IT Park, Tower-C, 8th Floor,
Newtown (Rajarhat), Kolkata – 700 156

From: Alokesh Hazarika <alokesh.hazarika@otpcindia.in>
Sent: Friday, July 31, 2020 11:31 AM
To: Mukherjee, Angsu (GE Renewable Energy) <angsu.mukherjee@ge.com>
Cc: Smruti Ranjan Das <sr.das@otpcindia.in>
Subject: EXT: Requiment of P437 Relay.

WARNING: This email originated from outside of GE. Please validate the sender's email address before clicking on links or attachments as they may not be safe.

Dear Sir,

As discussed we have P442 Relay for our Main -1 Relay and P437 for our Main -2 Relay.

Kindly confirm if P437 is still available in market.

If not kindly send the details of replacement relay for P437 Relay along with offer

Following are our requirement:

a) Retrofitting of 4 nos of relay at our site.
b) Spare support for minimum 10 years.

Details of our P437 relay attached.

[cid:image001.png@01D4332E.77B79860]

ONGC TRIPURA POWER COMPANY LTD
COMPOSITE ORDER

Order No.	OTPC/PO/1800000121	Date	29 December, 2020

Purchaser:	**Supplier:**
OTPC CCGT POWER PLANT,PALATANA KAKRABAN ROAD,, PALATANA, DISTT - GOMATI-799116, INDIA GSTIN - 16AACCT2591G1ZC	SIEMENS LTD Goa Works, Plot No. L-6 GOA, Goa, INDIA-403722 GSTIN - 30AAACS0764L1ZJ

Enquiry No	RFQ/1300000382/2020-21/219	Quotation Number	Email offer
Enquiry Date	07.09.2020	Quotation Date	29.12.2020

Dear Sir(s),
We are pleased to place the order in accordance with the instructions contained here in and subject to the terms and conditions indicated below and as per attached enclosures.

Supply Portion:

SNO	Material Code	HSN Code	Description	Unit	Quantity	Unit Rate	Amount
00001	7003131	85371000	Distance Relay	NOS	5	219,500	1,097,500

Service Portion:

SNo.	Description	Quantity	UOM
2	Retrofitting of 4 Relays	1	AU

Line	Long Text	SAC	Quantity	UOM	Unit Value	Gross Value	Currency
2. 1	Retrofitting		4	NOS	25,000	100,000	INR

FOURTEEN LAKH THIRTEEN THOUSAND FIFTY RUPEES INR

Basic Amount	1197500.00
Integrated GST-ND	215550.00
Total Amount	1413050.00

Tax Details:

Tax Description	Po Line Item
Integrated GST-ND 18 % ,	1, 2

Delivery Terms	firm & on FOR OTPC basis	Delivery Date	4 April, 2021

ONGC TRIPURA POWER COMPANY LTD
COMPOSITE ORDER

Order No.	OTPC/PO/1800000121	Date	29 December, 2020

RECEIVED AND ACCEPTED	
for **SIEMENS LTD** AUTHORISED SIGNATORY (NAME, DESIGNATION AND STAMP)	for **ONGC Tripura Power Company Limited** 06.01.2021 Mr. Tapas Bhowmik DGM (Projects) / In-Charge (C&M) ONGC Tripura Power Company Ltd. Kakraban Road, P.O.-Palatana, P.S.-Kakraban, Gomati District, Tripura.-799105
ONGC Tripura Power Company Ltd. Udaipur-Kakraban Road, Palatana P.O., District Gomati, Tripura - 799105.	Telephone: 0381-2374288 Fax: 0381-2374288

Enclosures:

1. **Annexure-A : Terms and Conditions** ☐
2. **Annexure-B : Technical Specification** ☐
3. **Annexure-C : Drawing** ☐
4. **Other Attachments** ☐

Annexure-A

STANDARD TERMS & CONDITIONS

1	**Scope**: The Purchase order and subsequent amendments, if any and supplier's acceptance in writing without any alterations thereto or supply shall constitute the contract.
2	**Prices**: The price governing the order shall remain firm fixed & binding till the execution of the order, unless otherwise agreed to in writing.Price basis shall be FOR,ONGC-Tripura Power Company Ltd., Site Office, Kakraban Road, P.O. Palatana, P.S. Kakraban, Dist. Gomati, Tripura.
3	**Taxes & Duties:** Prices shall be inclusive of all levies such as CGST,SGST/IGST etc unless otherwise agreed to in writing. In the event of Purchaser having agreed to pay these levies extra, the same shall be paid/reimburesed (as the case may be) at actual against documentary evidence. Any upward variation in levies after expiry of delivery period shall be to the Supplier's account. # Any cost increase/ benefit of cost reduction, on account of GST, shall be to the account of the Buyer. # In case any credit, refund or other benefit is denied or delayed to the Buyer due to any non-compliance by the Seller (such as failure to upload the details of supply on GSTN portal, failure to pay GST to the Government) or due to non-furnishing or furnishing of incorrect or incomplete documents/ details/ information by the Seller, the Seller would reimburse the Buyer the loss to Buyer including, but not limited to, the tax loss, interest and penalty. # If tax is liable to be charged/ paid at the time of advances under the current indirect regime or on introduction of GST, the Seller would issue appropriate document (i.e. Receipt Voucher mentioning GST component applicable on advance) to the Buyer and also deposit the applicable taxes as per statutory timelines. Further, the Seller would furnish details of such Receipt Voucher on the GST portal within statutory timelines.
4	**Order Acceptance**: The service provider's order acceptance in writing must be received by the bidder within 7 days from the date of order and non-receipt of such acceptance would be considered as acceptance of the order and the terms & conditions specified therein.
5	**Bills / Invoices**: All bills / invoices for supplies made bearing GST registration number,HSN number and PAN number of the Supplier shall be sent in DUPLICATE within a week from the date of supply, specifying Purchase order number and date, accompanied by signed copy of delivery challan to ONGC-Tripura Power Company Ltd., Site Office, Kakraban Road, P.O. Palatana, P.S. Kakraban, Dist. Gomati, Tripura or to as specified, in the order. In case of second sale, relevant sales tax forms must accompany the invoice.
6	**Payment Terms :** **Supply:** 100% payment including all taxes & duties shall be paid **within 15 days of material receipt** at site in good conditions. **Service:** 100% payment including all taxes & duties shall be paid **within 07 days of work completion.** **Travelling Charges, airport pick-up & drop, Local conveyance, food & accommodation: Vendor scope**
	PGB : 10% of contract value valid for warranty period.
7	**Delivery Period:** **Supply:** Material shall be delivered **within 12 weeks** from the date of placement of this PO. **Service:** Team to be mobilised after receipt of schedule from Engineer-in-Charge of OTPC and on finalisation of mutually agreed dates in consultation with OTPC Electrical department. a) LD: 1% (one) of the Contract price for each weeks delay or part thereof subject to a maximum of 10% of the contract price and/ or b) Treat the order as cancelled and recover any loss or damage from the supplier, and / or c) Purchase goods ordered or any part thereof from other source on Supplier's account, in which case the Supplier shall be liable to pay the Purchaser not only the difference between the price at which such goods have been actually purchased and the price calculated at the rate set out in this order but also any other loss or damage the Purchaser may suffer, including penalty for late delivery.
8	**Covid Protocol:** Any person visiting OTPC site **needs to produce COVID19 – Negative report to OHC-OTPC** (Occupational Health Centre), testing of which is to be conducted within 72 hrs prior to the date of arrival at OTPC Palatana site. Person not having COVID19 report must undergo RT-PCR test at any ICMR authorised lab at their own expenses".
9	**Freight & Insurance**: Freight & Insurance is in vendor's scope & is included in basic price. In case of loss or damage it would be the responsibility of the supplier to arrange free replacement/repairs immediately on intimation without waiting for settlement of insurance claim. The settlement of claim with insurance company will be the responsibility of the supplier.
10	**Force Majeure**: The Service will not hold the Supplier responsible, in case of delay in delivery arising from any causes beyond the supplier's control such as Acts of God, war, riot, fire, changes in statutory regulations.
11	**Rejection**: All the goods supplied against this order will be subject to inspection and approval by the Service. The Service reserves the right to inspect the goods at any stage during the manufacture or supply and to reject such portion thereof as may be found defective or not in conformity with the specification, without invalidating the remainder of the order, if so desired by the Purchaser. Rectifications of such rejections, if any, done by the Purchaser will be at Supplier's cost.
	All rejected goods shall be removed by the Supplier within 15 days from the date of intimation of such rejection, otherwise the goods may be returned by the Purchaser to the Supplier at the Supplier's risk and expenses. The Purchaser shall in no case be responsible or be held liable for any damage, loss or deterioration of the rejected material. The Purchaser shall also be entitled to charge the Supplier reasonable storage charges.
12	**Secrecy**: If for the contractual work, the Purchaser furnishes the Supplier any drawings, dies, etc. or these are made by the Supplier himself, the same shall be kept strictly confidential by the Supplier and shall be used by him only for the contractual work. On completion of the contractual work, the Purchaser's drawings, dies etc shall be returned forthwith by the supplier to the purchaser, before the last payment is released by the Purchaser.
	The Supplier shall, under no circumstances, allow the drawings, dies, etc. made for the contractual work to be used by a third party. The Supplier shall also not make supplies of the articles made with the help of these drawings, dies, and etc. to any party other than the Purchaser.
13	**Patents**: The Supplier shall indemnify and keep the Purchaser indemnified against all losses of profits, damages or both arising from any infringement or alleged infringement of any patent in respect of any goods supplied by him under this contract. In addition all litigation costs, if any, suffered by the Purchaser as a result of any patent suit shall be reimbursed to him by the supplier forthwith.
14	**Warranty Period:** 18 months from date of dispatch or 12 months from date of commissioning whichever is earlier.
15	**Limitation of Liability : (#)** Both Owner and Supplier understand and agree that there shall be absolutely no personal liability on the part of any of the members, shareholders, officers, employees, directors, agents, authorized representatives or Affiliates of the Owner or Supplier for the payment of any amounts due hereunder, or performance of any obligations hereunder.**(#)** Neither the Supplier nor the Owner shall be liable to the other as a result of any action or inaction under this Contract or otherwise for any special, indirect, incidental or consequential losses such as but not limited to loss of profit, loss of revenue, loss of opportunity, loss of goodwill, loss of contracts or cost of capital. It is hereby agreed that this limitation of liability shall not apply in respect of claims for which either Party is indemnified. The aggregate liability of the Supplier with respect to all claims arising out of or in connection with performance or non-performance of this Contract whether in contract, warranty, tort or otherwise shall not exceed the Contract Price, provided that this limitation shall not apply in case of negligence, Willful Misconduct or liabilities arising out of indemnity provisions in this Contract.**(#)** The provisions of this Contract constitute Supplier's and Owner's exclusive liability, respectively, to each other, and Supplier's and Owner's exclusive remedy, respectively, to each other, with respect to the obligations under this Contract
16	**Tools**: Any special tools made by the Supplier for the Service where the cost of such tools is paid separately will be the Service's property and shall be delivered to the Service as and when asked to do so. The Supplier shall maintain the tools in proper working condition during the life of the tools and such tools shall be capable of being used for remainder of their working life. The Supplier shall also give a certificate for possession of the tools as and when required by the Service.
	The Supplier shall furnish a guarantee in such case while submitting the bills / invoices for the tool that "The tools manufactured by us will be your property and will be used for manufacture of your items only. The same will be delivered to you on demand."
	The tools shall be returned along with the last supply of the component ordered. If the supply is continuing beyond one year, the tools must be sent to the Purchaser at the end of one year for inspection, if so desired by the Purchaser at the Purchaser's cost.
17	**Right to Set Off**: The Purchaser shall be entitled to recover from the Supplier any sum as may be due to it on account of damages or otherwise in respect of supplies under this contract or previous contract(s) by deducting such sum from the amount due to Supplier in respect of supplies made under this contract. The Purchaser also reserves the right to cancel this contract or any part thereof, in case of stoppages arising due to fire, strike, lockout, riots. force majeure or any other cause beyond Purchaser's control
18	**Arbitration**: Any dispute, question or difference whatsoever may arise between the Supplier and the Purchaser in relation to or in connection with the order, the same shall be referred within the meaning of the Indian Arbitration and Reconciliation Act of 1996 or any statutory modification thereof.
19	**Jurisdiction**: This WO shall be governed by the Indian Laws and rules as amended from time to time. The courts of Tripura shall have exclusive jurisdiction.
20	**Safety at Work**: Contractor will be responsible for provision of all necessary personal and collective protective equipment for the work group to prevent injury (e.g. safety helmet with chinstrap, safety shoes, safety harness, ear plug, ear muff, safety net, raincoat, rain shoes, etc. to name a few). Contractor must assess this complete requirement while accepting the contract and provision made should be adequate. All such equipment being used at site shall conform with ISI/ANSE/CE specification. Work shall be suspended/cancelled if work group is found working without protective equipment.
21	**Road Safety**: Vehicles, if any , brought for work within company premises shall have spark arrestor at exhaust pipe, seat belts, indicators, and shall maintain a maximum speed limit of 20 kmph. Violation of any of these may attract penalty.
22	**Housekeeping**: Cleanliness shall be maintained at work site during work. After completion of work awarded, site shall be left clean by removing all materials, wastes, trashes and shifting them to the location decided by the Engineer-in-Charge of supervision of the work.
23	**Care for Environment :** OTPC is committed to protection of environment including prevention of pollution and occupational illness by using sustainable technologies and work practices towards this OTPC expects its suppliers/associates/contractors to co-operate and collaborate towards acheiving this commonly shared goal of sustainability and ensure establishment of a green supply chain.Together we shall create a process through which environmental improvements and achievements can be shared upstream and downstream with broader objectives as under: (#)Contract shall be executed in an eco-friendly manner with minimal practicable damage to environment and natural resources. (#)Suppliers should try to reduce an adverse impact on environment by reducing emmission of green house gases in manufacturing & transportation of goods and services. (#)Supplier should try to minimize adverse environmental impact on air, land, and water by using sustainable packaging.

06.01.2021

OTPC

ONGC Tripura Power Company Limited

(JV Company of ONGC, IL&FS, IIF and Govt. of Tripura)

Udaipur-Kakraban Road, Palatana P.O., District Gomati, Tripura - 799105 Phone: 0381-2363714, Fax: 0381-2363716

WORK ORDER

WO No.: 1800000127 **12th February 2021**

M/s Utility Power Test
509, Imperial Tower,
C-Block, Naraina Vihar,
New Delhi - 110028

Kind Attn: **Mr. Parveen Sharma**

Dear Sir,

Subject: **Work Order for Supply and Implementation of Complete online Transformer Monitoring System for Inter Connecting Transformer-1 (ICT-1) at OTPC 2 x 363.3 MW Gas Based Combined Cycle Power Plant at Palatana.**

ONGC Tripura Power Company Limited, a public limited company incorporated under the Indian Companies Act, 1956 and having its registered office at ONGC Tripura Power Company Limited, Udaipur-Kakraban Road, Palatana P.O., District Gomti, Tripura-799116 (hereinafter referred as "**OTPC**" or "**Owner**" which expression shall include its successors and permitted assigns); is pleased to issue the work order for **Supply and Implementation of Complete Online Transformer Management System for Inter Connecting Transformer-1 (ICT-1) at Palatana Power Plant** to **Utility Power Test** having its registered office at 401, Labh Complex, opp. Pramukhswami Hospital, Atladra, Vadodara – 390012. (hereinafter referred to as the "**Contractor/ Supplier**" which expression shall include its successors and permitted assigns).

The Owner and the Supplier are hereinafter referred to individually as a "**Party**" and collectively as the "**Parties**".

WHEREAS:

1. The Owner is implementing Complete Online Transformer Monitoring System for ICT-1 along with all associated systems at 2 x 363.3 MW combined cycle power plant at Palatana, which is about 60 (sixty) km from capital city Agartala in the State of Tripura (the "**Project**").

2. The Owner, based on a transparent bidding process, has selected the Contractor as the successful bidder for implementing Complete Transformer Monitoring System for ICT-1 and associated systems.

ONGC Tripura Power Co. Ltd. New Delhi

UTILITY POWER TEST

3. The Contractor represents that it has the necessary specialized knowledge, expertise and infrastructure for implementing the system and to perform its obligations under this Contract.

4. The Owner desires to engage the Contractor to set up and implement the Complete Transformer Monitoring System for ICT-1 and associated systems in accordance with the terms and conditions specified in this Contract.

5. The Contractor is willing and has agreed to provide and implement the required Complete Transformer Monitoring System for ICT-1 along with all associated systems for the Contract Price in accordance with the terms and conditions specified in this Contract.

6. The Owner and the Contractor desire to enter into this Contract pursuant to which the Contractor shall supply, install and commission the system and the Owner shall engage the contractor to supply, install and commission the system, pursuant to the terms and conditions herein set forth.

NOW, THEREFORE, IN CONSIDERATION OF THE MUTUAL COVENANTS HEREIN SET FORTH, THE PARTIES AGREE AS FOLLOWS:

1.0 **DEFINITION AND INTERPRETATION**

When used in the Contract, the following terms shall have the meanings specified in this Article 1.0:

1.1 "**Abandonment**" means the substantial cessation of the performance of the obligations under this Contract for a continuous period of 1 (one) day i.e. 24 (twenty-four) continuous hours and which cessation is not excused under this Contract.

1.2 "**Acceptable Bank**" means a bank listed in Annexure 5 (List of Acceptable Banks).

1.3 "**Affiliate**" means, with respect to a Person, any entity which directly or indirectly:

(i) owns or Controls such Person;

(ii) is owned or Controlled by such Person; or

(iii) is under common ownership or Control with such Person.

1.4 "**Applicable Law**" means the substantive or procedural laws of India, whether now or hereafter in effect, including all legislations, acts, rules, regulations, notifications, laws, statutes, awards, orders, decrees, judgments, injunctions, ordinances, codes, requirements, Permits, licenses, Directives, approvals, instructions, standards of any Government Agency, having the force of law.

1.5 "**Arbitral Award**" shall have the meaning ascribed to it in Clause 34.4.4.

1.6 "**Arbitration Act**" shall have the meaning ascribed to it in Clause 34.4.1.

1.7 "**Bankruptcy Event**" means commencement, whether voluntarily or involuntarily, of any proceedings relating to the rescheduling of obligations, bankruptcy, re-organization, insolvency or judicial liquidation or any other similar proceedings.

ONGC-Tripura Power Co. Ltd. New Delhi

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1.8 **"Change in Law Request Date"** shall have the meaning ascribed to it in Clause 35.2.

1.9 "**Claim**" shall have the meaning ascribed to it in Clause 30.1.

1.10 "**Coercive Practice**" means impairing or harming, or threatening to impair or harm, directly or indirectly, any Person or property to influence any Person's participation or action in relation to negotiation or performance of this Contract.

1.11 "**Commissioning Spares**" shall have the meaning ascribed to it in Clause 5.2.1.

1.12 **"Completion of Supply of Materials"** shall have the meaning ascribed to it in Clause 17.1.

1.13 "**Confidential Information**" shall have the meaning ascribed to it in Clause 38.1.

1.14 "**Consumables**" shall have the meaning ascribed to it in Clause 5.4.1.

1.15 "**Contract Price**" shall have the meaning ascribed to it in Clause 7.1.1.

1.16 "**Control**" means, with respect to any Person, (i) the possession, directly or indirectly, of the power to direct or cause the direction of the management and policies of such Person whether through the ownership of voting securities, by agreement or otherwise or the power to elect more than one-half of the directors of such Person; or (ii) the possession, directly or indirectly, of a voting interest of more than 50% (fifty percent); or (iii) the power to veto decisions of such Person, whether through ownership of voting securities, by contract, or otherwise.

1.17 "**Corrupt Practice**" means (i) the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence the actions of any Person connected with the negotiation, signing or performance of this Contract (for avoidance of doubt, offering of employment to or employing or engaging in any manner whatsoever, directly or indirectly, any official of the Owner who is or has been associated or dealt in any manner, directly or indirectly with the negotiation, signing or performance of this Contract or has dealt with matters concerning the Contract or arising there from, before or after the execution thereof, at any time prior to the expiry of 1 (one) year from the Effective Date such official resigns or retires from or otherwise ceases to be in the service of the Owner, shall be deemed to constitute influencing the actions of a Person connected with the negotiation, signing or performance of this Contract); or (ii) engaging in any manner whatsoever, whether during the negotiation of the Contract or after the execution of the Contract, as the case may be, any Person in respect of any matter relating to the Project or the Contract, who at any time has been or is a legal, financial or technical adviser of the Owner in relation to any matter concerning the Project.

1.18 "**Cost of Completion**" shall have the meaning ascribed to it in Clause 32.6.1.

1.19 "**Directive**" means any directive issued by a Government Agency.

1.20 "**Direct Tax**" shall have the meaning ascribed to it in Clause 9.1.

ONGC-Tripura Power Co. Ltd. New Delhi

UTILITY POWER TEST DELHI

1.21 "**Effective Date**" means the date of Notice to Proceed issued by Owner.

1.22 **"Facility"** or **"Facilities"** means Complete Transformer Monitoring system for Interconnecting Transformer-1 (ICT-1) and all associated systems being set-up at 2 x 363.3 MW gas based combined cycle power plant at Palatana, Tripura.

1.23 **"Final Acceptance of Facility"** shall have the meaning ascribed to it in Clause 42.4.

1.24 "**Force Majeure**" shall have meaning ascribed to it in Clause 25.1.

1.25 "**Fraudulent Practice**" means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation.

1.26 "**Good Engineering & Manufacturing Practices**" means the exercise of that degree of skill, diligence, prudence, foresight, and engineering & manufacturing practice taking into account Indian conditions, generally followed internationally by highly qualified, prudent professionals in similar industry including in the procurement, manufacturing, inspection, testing, packing etc in relation thereto; which in any such case should have been expected to accomplish the desired result at the lowest cost, consistent with licensing and regulatory considerations, environmental considerations, reliability, safety and expedition. Good Engineering & Manufacturing Practices is not intended to be limited to the optimum practice, method or act, to the exclusion of all others, but rather to be a spectrum of possible practices, methods or acts employed by owners and contractors.

1.27 "**Government Agency**" means any local, State Government in India or the Government of India or any national authority, inspectorate, ministry, department, instrumentality or agency thereof or any corporation (to the extent acting in a legislative, judicial or administrative capacity and not as a contracting party with the Owner) or commission under the direct or indirect control of such local or State Government or the Government of India or any political subdivision thereof or any court, tribunal, judicial body, quasi judicial authority or statutory Person (whether autonomous or not) of the Republic of India which has jurisdiction over the Parties to, or the subject matter of, this Contract or any of the Project Agreements, and this definition includes, for the avoidance of doubt, any authority that may affect the Owner's or the Supplier's ability to perform any or all of its or their obligations under this Contract or any authority that gives consents or permits (including Permits) within India.

1.28 "**Governmental Authorizations**" means all approvals, authorizations, permits, licenses, consents, clearances, etc., received or required to be received from Government Agency for the Plant.

1.29 "**Hazardous Material**" means (i) "hazardous materials", "hazardous substances", "toxic substances" or "contaminants" as those terms are defined under any Environmental Law, or any other Applicable Laws, (ii) petroleum and petroleum products, including crude oil and any fractions thereof, (iii) any other hazardous, radioactive, toxic or noxious substance, material, pollutant or solid, liquid or gaseous waste, and (iv) any substance that, whether by its nature or its use, is subject to regulation under any Applicable Law or with respect to which any applicable

ONGC-Tripura Power Co. Ltd. New Delhi

UTILITY POWER TEST DELHI

Annexure-1

CONTRACT PRICE

Sl. No.	Description	PRICE IN FIGURES (INR)
I	**SUPPLY PRICE**	
IA	Price for supply of Equipment and Materials (excluding Mandatory Spares) required for implementing complete transformer monitoring system for Inter Connecting Transformers-1 (ICT-1) and associated systems at Palatana Power Plant.	**47,48,983/-**
IB	All applicable taxes, duties and levies on IA above.	**8,54,817/-**
IC	Price for supply of Mandatory Spares	**NA**
ID	All applicable taxes, duties and levies on IC above.	**NA**
	Total Price: Supply including Taxes, Duties and Levies (IA + IB + IC + ID)	**56,03,800/-**
II	**INSTALLATION SERVICES, TRAINING & FREIGHT PRICE**	
IIA	Price for insurance, unloading, handling, storage, preservation at site, erection, testing and commissioning and training services for implementation of complete transformer monitoring system for ICT-1 transformer and associated systems as defined in Bidding Document.	**5,40,000/-**
IIB	All applicable taxes, duties and levies on IIA above.	**97,200/-**
IIC	Freight for the total supplies (excluding Mandatory Spares)	**50,000/-**
IID	All applicable taxes, duties and levies on IIC above.	**9,000/-**
IIE	Freight for the Mandatory Spares	**NA**
IIF	All applicable taxes, duties and levies on IIE above.	**NA**
	Total Price: Installation and Training Services including Taxes, Duties and Levies (IIA + IIB + IIC + IID + IIE + IIF)	**6,96,200/-**
III	**TOTAL PRICE FOR SUPPLY, INSTALLATION & TRAINING SERVICES (in Figures) INR (I + II)**	**63,00,000/-**
IV	**TOTAL PRICE FOR SUPPLY, INSTALLATION & TRAINING SERVICES (in Words) INR (I + II)**	**Sixty Three Lacs Only**

ONGC Tripura Power Co. Ltd. New Delhi

UTILITY POWER TEST DELHI

Biplab Ghosh

From: Neeraj Narwal <neeraj.narwal@otpcindia.in>
Sent: 05 February 2020 18:13
To: Bishwanath Bhattacharrya
Cc: Samarjeet Thakur; Karan Bakshi; Biplab Ghosh
Subject: Letter of Award - Complete online Transformer Monitoring System for Unit-2 Generator Transformers

Flag Status: Flagged

Dear Sir,

Kindly consider this email as "Letter of Award" for Complete online Transformer Monitoring System for Unit-2 Generator Transformers.

This LOA is subject to following:

1. Terms & Conditions and Technical Specifications of earlier Order no: OTPC/PAL/17-18/CTMS dated 25th May 2018.

2. Contract Price:

Sl. No.	Description	PRICE (IN INR)
I	**Supply Price:**	
IA	Price for supply of Equipment and Materials (excluding Mandatory Spares) required for implementing complete transformer monitoring system for Unit-2 generator transformers and associated systems at Palatana Power Plant	**64,63,939/-**
IB	GST @ 18%	**11,63,509/-**
I	**Total Price : Supply including Taxes, Duties and Levies (IA + IB)**	**76,27,448/-**
II	**Installation Services, Commissioning & Freight Price:**	
IIA	Price for insurance, unloading, handling, storage, preservation at site, erection, testing and commissioning services for implementation of complete transformer monitoring system for Unit-2 generator transformers and associated systems	**4,00,000/-**
IIB	Price for Training	**50,000/-**
IIC	All applicable taxes, duties and levies on IIA and IIB above.	**81,000/-**
IID	Freight and Transit Insurance for the total supplies (excluding Mandatory Spares)	**Included**
II	**Total Price: Installation Services including Taxes, Duties and Levies (IIA + IIB + IIC+IID)**	**5,31,000/-**
I+II	**TOTAL PRICE ("CONTRACT PRICE") FOR SUPPLY, INSTALLATION, COMMISSIONING & FREIGHT**	**81,58,448/-**

Sl. No.	Description	PRICE (IN INR)
Rupees Eighty One Lakh Fifty Eight Thousand Four Hundred and Forty Eight Only		

3. Broad Payment Terms: 10% of Contract Price as Advance, 60% of Supply Price against receipt of material, 20% of Supply Price along with 80% of Installation Price against installation and Final 10% of Contract Price against Final Acceptance.

4. Completion Time: 3 Months from Date of this LOA.

In order to enable us issue the Work Order, kindly provide your acceptance to above LOA along with the following at the earliest:

- Manufacturer Authorization as per Form attached with the earlier PO.
- Current shareholding of the Contractor.

Thanks & Regards

Neeraj Narwal

ONGC Tripura Power Company Ltd.
6th Floor, A – Wing, IFCI Tower-61,
Nehru Place, New Delhi-110019
Board: +91-11-26402100
Direct: +91-11-26402113
Fax : +91-11-26227532/26227533
E-Mail : neeraj.narwal@otpcindia.in

ONGC Tripura Power Company Limited

Udaipur-Kakraban Road, Palatana P.O., District Gomati, Tripura - 799105, Phone: 0381-2363714, Fax: 0381-2363716

WORK ORDER

WO No.: 1800000167 **21st February 2023**

M/s Utility Power Test
509, Imperial Tower,
C-Block, Naraina Vihar,
New Delhi - 110028

Kind Attn: **Mr. Parveen Sharma**

Dear Sir,

Subject: **Work Order for Supply and Implementation of Online Monitoring System for Bus Reactor at OTPC 2 x 363.3 MW Gas Based Combined Cycle Power Plant at Palatana, Tripura.**

ONGC Tripura Power Company Limited, a public limited company incorporated under the Indian Companies Act, 1956 and having its registered office at ONGC Tripura Power Company Limited, Udaipur-Kakraban Road, Palatana P.O., District Gomti, Tripura-799116 (hereinafter referred as "**OTPC**" or "**Owner**" which expression shall include its successors and permitted assigns); is pleased to issue the Work Order for **Supply and Implementation of Online Monitoring System for Bus Reactor at Palatana Power Plant** to **Utility Power Test** having its registered office at 401, Labh Complex, opp. Pramukhswami Hospital, Atladra, Vadodara – 390012. (hereinafter referred to as the "**Contractor/ Supplier**" which expression shall include its successors and permitted assigns).

The Owner and the Supplier are hereinafter referred to individually as a "**Party**" and collectively as the "**Parties**".

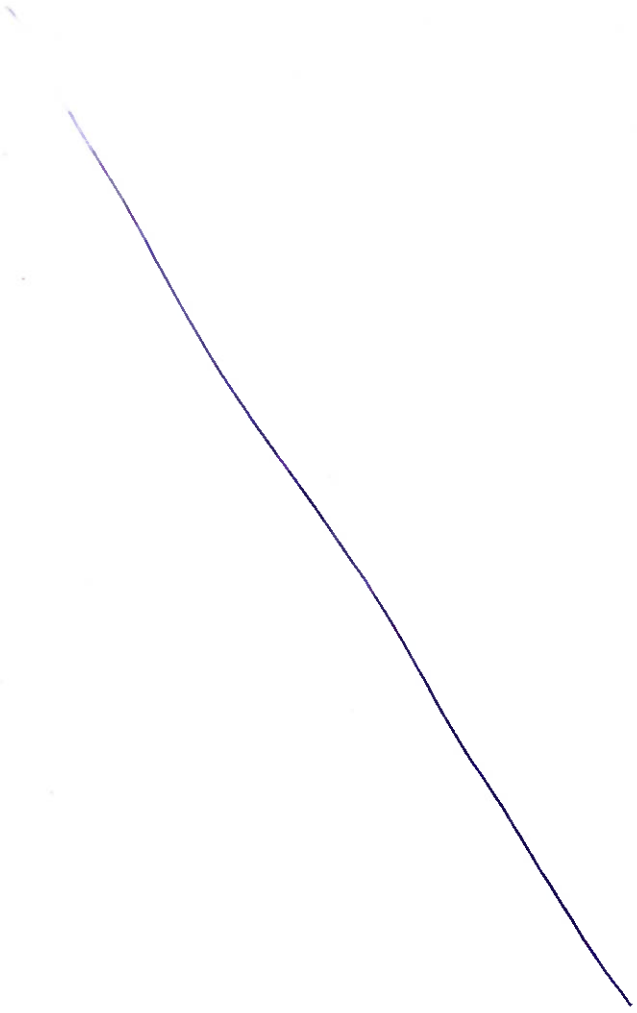
WHEREAS:

1. The Owner is implementing Online Monitoring System for Bus Reactor along with all associated systems at 2 x 363.3 MW combined cycle power plant at Palatana, which is about 60 (sixty) km from capital city Agartala in the State of Tripura (the "**Project**").

2. The Owner, based on a transparent bidding process, has selected the Contractor as the successful bidder for implementing Online Monitoring System for Bus Reactor and associated systems.

3. The Contractor represents that it has the necessary specialized knowledge, expertise and infrastructure for implementing the system and to perform its obligations under this Contract.

ONGC Tripura Power Co. Ltd. Palatana, Tripura



4. The Owner desires to engage the Contractor to set up and implement the Online Monitoring System for Bus Reactor and associated systems in accordance with the terms and conditions specified in this Contract.

5. The Contractor is willing and has agreed to provide and implement the required Online Monitoring System for Bus Reactor along with all associated systems for the Contract Price in accordance with the terms and conditions specified in this Contract.

6. The Owner and the Contractor desire to enter into this Contract pursuant to which the Contractor shall supply, install and commission the system and the Owner shall engage the contractor to supply, install and commission the system, pursuant to the terms and conditions herein set forth.

NOW, THEREFORE, IN CONSIDERATION OF THE MUTUAL COVENANTS HEREIN SET FORTH, THE PARTIES AGREE AS FOLLOWS:

1.0 **DEFINITION AND INTERPRETATION**

When used in the Contract, the following terms shall have the meanings specified in this Article 1.0:

1.1 "**Abandonment**" means the substantial cessation of the performance of the obligations under this Contract for a continuous period of 1 (one) day i.e. 24 (twenty-four) continuous hours and which cessation is not excused under this Contract.

1.2 "**Acceptable Bank**" means a bank listed in Annexure 5 (List of Acceptable Banks).

1.3 "**Affiliate**" means, with respect to a Person, any entity which directly or indirectly:

(i) owns or Controls such Person;

(ii) is owned or Controlled by such Person; or

(iii) is under common ownership or Control with such Person.

1.4 "**Applicable Law**" means the substantive or procedural laws of India, whether now or hereafter in effect, including all legislations, acts, rules, regulations, notifications, laws, statutes, awards, orders, decrees, judgments, injunctions, ordinances, codes, requirements, Permits, licenses, Directives, approvals, instructions, standards of any Government Agency, having the force of law.

1.5 "**Arbitral Award**" shall have the meaning ascribed to it in Clause 34.4.4.

1.6 "**Arbitration Act**" shall have the meaning ascribed to it in Clause 34.4.1.

1.7 "**Bankruptcy Event**" means commencement, whether voluntarily or involuntarily, of any proceedings relating to the rescheduling of obligations, bankruptcy, re-organization, insolvency or judicial liquidation or any other similar proceedings.

1.8 **"Change in Law Request Date"** shall have the meaning ascribed to it in Clause 35.2.

ONGC-Tripura Power Co. Ltd. Palatana, Tripura

1.9 "**Claim**" shall have the meaning ascribed to it in Clause 30.1.

1.10 "**Coercive Practice**" means impairing or harming, or threatening to impair or harm, directly or indirectly, any Person or property to influence any Person's participation or action in relation to negotiation or performance of this Contract.

1.11 "**Commissioning Spares**" shall have the meaning ascribed to it in Clause 5.2.1.

1.12 **"Completion of Supply of Materials"** shall have the meaning ascribed to it in Clause 17.1.

1.13 "**Confidential Information**" shall have the meaning ascribed to it in Clause 38.1.

1.14 "**Consumables**" shall have the meaning ascribed to it in Clause 5.4.1.

1.15 "**Contract Price**" shall have the meaning ascribed to it in Clause 7.1.1.

1.16 "**Control**" means, with respect to any Person, (i) the possession, directly or indirectly, of the power to direct or cause the direction of the management and policies of such Person whether through the ownership of voting securities, by agreement or otherwise or the power to elect more than one-half of the directors of such Person; or (ii) the possession, directly or indirectly, of a voting interest of more than 50% (fifty percent); or (iii) the power to veto decisions of such Person, whether through ownership of voting securities, by contract, or otherwise.

1.17 **"Corrupt Practice"** means (i) the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence the actions of any Person connected with the negotiation, signing or performance of this Contract (for avoidance of doubt, offering of employment to or employing or engaging in any manner whatsoever, directly or indirectly, any official of the Owner who is or has been associated or dealt in any manner, directly or indirectly with the negotiation, signing or performance of this Contract or has dealt with matters concerning the Contract or arising there from, before or after the execution thereof, at any time prior to the expiry of 1 (one) year from the Effective Date such official resigns or retires from or otherwise ceases to be in the service of the Owner, shall be deemed to constitute influencing the actions of a Person connected with the negotiation, signing or performance of this Contract); or (ii) engaging in any manner whatsoever, whether during the negotiation of the Contract or after the execution of the Contract, as the case may be, any Person in respect of any matter relating to the Project or the Contract, who at any time has been or is a legal, financial or technical adviser of the Owner in relation to any matter concerning the Project.

1.18 "**Cost of Completion**" shall have the meaning ascribed to it in Clause 32.6.1.

1.19 "**Directive**" means any directive issued by a Government Agency.

1.20 "**Direct Tax**" shall have the meaning ascribed to it in Clause 9.1.

1.21 "**Effective Date**" means the date of this Work Order no. 1800000167.

1.22 **"Facility"** or **"Facilities"** means the Equipment and Materials to be supplied and installed, along with all associated Services including design, fabrication,

ONGC Tripura Power Co. Ltd. Palatana, Tripura

manufacture, supply, transportation, painting, erection, testing and commissioning to be carried out by the Contractor under the Contract.

1.23 **"Final Acceptance of Facility"** shall have the meaning ascribed to it in Clause 42.2.

1.24 "**Force Majeure**" shall have meaning ascribed to it in Clause 25.1.

1.25 "**Fraudulent Practice**" means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation.

1.26 "**Good Engineering & Manufacturing Practices**" means the exercise of that degree of skill, diligence, prudence, foresight, and engineering & manufacturing practice taking into account Indian conditions, generally followed internationally by highly qualified, prudent professionals in similar industry including in the procurement, manufacturing, inspection, testing, packing etc in relation thereto; which in any such case should have been expected to accomplish the desired result at the lowest cost, consistent with licensing and regulatory considerations, environmental considerations, reliability, safety and expedition. Good Engineering & Manufacturing Practices is not intended to be limited to the optimum practice, method or act, to the exclusion of all others, but rather to be a spectrum of possible practices, methods or acts employed by owners and contractors.

1.27 "**Government Agency**" means any local, State Government in India or the Government of India or any national authority, inspectorate, ministry, department, instrumentality or agency thereof or any corporation (to the extent acting in a legislative, judicial or administrative capacity and not as a contracting party with the Owner) or commission under the direct or indirect control of such local or State Government or the Government of India or any political subdivision thereof or any court, tribunal, judicial body, quasi judicial authority or statutory Person (whether autonomous or not) of the Republic of India which has jurisdiction over the Parties to, or the subject matter of, this Contract or any of the Project Agreements, and this definition includes, for the avoidance of doubt, any authority that may affect the Owner's or the Contractor's ability to perform any or all of its or their obligations under this Contract or any authority that gives consents or permits (including Permits) within India.

1.28 "**Governmental Authorizations**" means all approvals, authorizations, permits, licenses, consents, clearances, etc., received or required to be received from Government Agency for the Plant.

1.29 "**Hazardous Material**" means (i) "hazardous materials", "hazardous substances", "toxic substances" or "contaminants" as those terms are defined under any Environmental Law, or any other Applicable Laws, (ii) petroleum and petroleum products, including crude oil and any fractions thereof, (iii) any other hazardous, radioactive, toxic or noxious substance, material, pollutant or solid, liquid or gaseous waste, and (iv) any substance that, whether by its nature or its use, is subject to regulation under any Applicable Law or with respect to which any applicable Environmental Law or any Government Agency requires environmental investigation, monitoring or remediation.

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1.30 **"Indirect Taxes"** shall have the meaning ascribed to it in Clause 9.2.

1.31 **"INR"** or **"Rs"** or **"Indian Rupees"** means the legal currency of the Republic of India.

1.32 **"Latent Defects"** means defects inherently lying within the material or arising out of design deficiency which do not manifest themselves during Warranty Period.

1.33 **"Lenders"** means any and all lenders and institutions providing credit, including interim and long-term financing (including any leveraged lease or any other refinancing thereof) in respect of the development, design, engineering, construction, and operation of the Plant, and their respective successors and assigns, including any trustee, agent or designee acting on their behalf.

1.34 NOT USED

1.35 **"Loading Point"** means the factory/warehouse or the point of delivery of the Materials by the Contractor or by any of its Subcontractors or its suppliers.

1.36 **"Losses"** means any and all liabilities, losses, damages, claims, costs, obligations, charges and expenses (including reasonable attorneys' fees) of whatsoever kind or nature and it does not include indirect and consequential losses.

1.37 **"Maintenance Tools & Tackles"** shall have the meaning ascribed to it in Clause 5.5.1.

1.38 **"Mandatory Spares"** shall have the meaning ascribed to it in Clause 5.3.1.

1.39 **"Materials"** shall have the meaning ascribed to it in Clause 4.2.

1.40 **"Obstructive Practice"** means and includes (i) deliberately destroying, falsifying, altering, or concealing of evidence material to the investigation or making false statements to investigators in order to materially impede an Owner's investigation into allegations of a corrupt, fraudulent, coercive or collusive practice; and/or threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation, or (ii) acts intended to materially impede the exercise of the Owner's inspection and verification rights provided for under this Contract.

1.41 **"Operating Year"** means the consecutive 12 (twelve) month period starting from 00:00 hrs of the date of the Final Acceptance of Facility.

1.42 **"Owner's Event of Default"** shall have the meaning ascribed to it in Clause 32.2.1.

1.43 **"Owner Indemnified Parties"** shall have the meaning ascribed to it in Clause 18.1.1.

1.44 **"Performance Bank Guarantee"** shall have the meaning ascribed to it in Clause 12.1.

1.45 **"Person"** means, unless specified otherwise, a natural person, corporation, society, partnership, joint venture, unincorporated association or other entity.

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1.46 **"Plant"** means 2 x 363.3 MW gas based combined cycle power plant set-up at Palatana, Tripura including associated Facilities.

1.47 "**Project**" shall have the meaning ascribed to it in Recital 1.

1.48 "**Quality Assurance Program**" means the quality assurance program provided by the Contractor and approved by the Owner in accordance with the provisions of Clause 16.0.

1.49 **"Services"** shall have the meaning ascribed to it in Clause 4.0

1.50 "**Site**" means the land/and or other places on, into or through which the work is to be executed under the Contract or any adjacent land, path or street through which work is to be executed under the Contract or any adjacent land, path or street which may be allotted or used for the purpose of carrying out the Contract.

1.51 "**Subcontract**" means any contract entered into by the Contractor or its subcontractor with a third party for carrying out any of the responsibilities or obligations of the Contractor under this Contract.

1.52 "**Subcontractor**" means any Person carrying out any of the responsibilities or obligations of the Contractor under this Contract under or pursuant to a Subcontract.

1.53 "**Subsidiary**" shall have the meaning ascribed to it in Section 4 of the Companies Act, 1956.

1.54 "**Contractor's Event of Default**" shall have the meaning ascribed to it in Clause 32.1.1.

1.55 "**Contractor Indemnified Parties**" shall have the meaning ascribed to it in Clause 18.2.1.

1.56 **"Taking-Over of Material"** shall have the meaning ascribed to it in Clause 17.2.

1.57 "**Technical Specifications**" means the specifications for Implementing Online Monitoring System for Bus Reactor attached as Annexure-2.

1.58 "**Term**" shall have the meaning ascribed to it in Clause 3.1.1.

1.59 "**Termination Date**" means the date upon which termination pursuant to Clause 32.5.1 takes effect.

1.60 "**Time for Completion**" shall have the meaning ascribed to it in Clause 10.2.

1.61 "**Warranty**" shall have the meaning ascribed to it in Clause 27.1.

1.62 "**Warranty Period**" shall have the meaning ascribed to it in Clause 27.2.

1.63 "**Willful Misconduct**" means, with respect to any Party or Person an intentional or reckless, disregard by such Party or Person, of Applicable Law, any common duty of care, any provision of this Contract, any other document prepared pursuant to this

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Contract or of Prudent Utility Practice, and relating to the performance by such Party of its obligations there under, but shall not include any error of judgment or mistake made in good faith.

1.64 **Rules of Interpretation**

In the interpretation of this Contract, unless the context otherwise requires:

1.64.1 the singular includes the plural and vice versa and in particular (but without limiting the generality of the foregoing) any word or expression defined in the singular has the corresponding meaning used in the plural and vice versa;

1.64.2 a reference to any gender includes the other genders;

1.64.3 a reference to a Clause, Article, Annexure or Recital is a reference to a Clause, Article, Annexure or Recital in this Contract;

1.64.4 the Annexures to this Contract form part of this Contract and will be of full force and effect as though they were expressly set out in the body of this Contract. The provisions of this Contract and the Annexures hereto shall be interpreted harmoniously and only if the provisions of this Contract cannot be interpreted harmoniously with the Annexures or vice-versa on account of inconsistencies or ambiguities then the provisions of this Contract shall prevail over the Annexures;

1.64.5 in case of any discrepancy between words and figures, the words shall prevail over the figures;

1.64.6 a reference to a statute shall be construed as including all statutory provisions consolidating, amending, modifying, supplementing or replacing the statute referred to;

1.64.7 a reference to "writing" includes printing, typing, lithography and other means of reproducing words in a visible form;

1.64.8 any date of any period set forth in this Contract shall be such date or period as may be adjusted pursuant to the terms and conditions of this Contract;

1.64.9 titles or captions of Clauses or Articles contained in this Contract are inserted as a matter of convenience only, and in no way define, limit, extend, describe or otherwise affect the interpretation, meaning or intent of this Contract or the interpretation, meaning or intent of any term or provision contained herein;

1.64.10 the rule of construction, if any, that a contract should be interpreted against the Party responsible for the drafting and preparation thereof, shall not apply; and

1.64.11 reference to any agreement, deed, document, instrument, or the like shall mean a reference to the same as may have been duly amended, modified or replaced. For the avoidance of doubt, it is clarified that a document shall be construed as amended, modified or replaced only if such amendment, modification or replacement is executed in compliance with the provisions of such document(s).

2.0 **EFFECTIVE DATE OF CONTRACT**

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2.1 This Contract shall become effective on the date of this Work Order no. 1800000167 and the obligations of the Contractor to supply Materials and implement the system shall also commence from such date ("**Effective Date**").

3.0 **TERM AND AUTHORIZATION TO PROCEED**

3.1 **Term**

3.1.1 This Contract shall become effective on the Effective Date and unless terminated earlier in accordance with the provisions of this Contract, this Contract shall remain valid, in full force and in effect till completion of Warranty Period ("**Term**").

3.2 **Authorization to Proceed**

3.2.1 Work Order shall be considered as authorization to proceed. Contractor shall commence performance of its obligations from the date of Work Order and shall continue to perform its obligations as provided in this Contract during the Term.

4.0 **SCOPE OF WORK**

4.1 The Contract is for supply of Materials, equipment, installation of the entire system and training of Owner staff by the Contractor in accordance with the terms and conditions of this Contract.

4.2 The Contractor shall supply Complete Online Monitoring System for Bus Reactor and associated mechanical, electrical and instrumentation materials including Commissioning Spares, Mandatory Spares, Maintenance Tools & Tackles, and Consumables etc required till Taking-over of Facility by Owner in accordance with the terms and conditions specified in this Contract and as set out in detail in the Technical Specifications.

4.3 The Contractor's obligations include design, engineering, procurement, manufacturing, testing, inspection, packaging, Insurance, supply, delivery, Installation, commissioning of the complete system in accordance with the terms and conditions of this Contract (**"Work"). Providing** training to the OTPC staff to use the system efficiently, effectively and in entirety is also in the scope of contractor.

4.4 The Contractor shall provide all the services required for successful implementation of Online Monitoring System for Bus Reactor and associated systems, including transportation of materials to site, unloading, storage, handling at site, insurance, installation, testing, commissioning, and putting the complete online monitoring system for Bus Reactor and associated system into successful operation, as set out in further detail in the Technical Specifications.

4.5 All the services required for successful completion of Work is in the scope of Contractor. The services shall be provided in such a manner so that hook-up of the Facility with existing equipments and systems shall require minimum time. Any modification required in the existing equipments and systems for hooking it with Facility, without adversely affecting the performance of existing equipments and systems, shall be included in services. Contractor shall be responsible for any loss or damage to the existing equipments and systems while performing services.

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4.6 The Contractor agrees that the scope of service also includes all temporary work, ancillary work, enabling work etc including dewatering of surface and subsurface water, construction of approach road required for performing services.

4.7 Materials shall be supplied complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such materials and/or needed for erection, completion and safe operation of the Materials as required by applicable code though they may not have been specifically specified in Technical Specifications unless included in the list of exclusions.

4.8 The Contractor expressly agrees that the scope of Work shall also include all such supply and services which may not have been specifically mentioned in this Contract or the Technical Specifications but which may be necessary for the successful fulfillment of Contractor's obligation under this Contract as per Good Engineering & Construction Practices and such services shall be performed by the Contractor without any additional cost to the Owner.

4.9 As part of the scope of its obligations under this Contract, the contractor shall procure and pay for, in its own name as an independent contractor and not as an agent of the Owner, all materials, equipment, manufacturing, fabrication etc. necessary in connection with the supply of Materials in accordance with this Contract. All such Materials shall be new, fit for purpose and free from any improper workmanship or defects and properly warranted or guaranteed to the extent required by Clause 27.0 (Warranty and Warranty Period) and comply with all Applicable Laws.

4.10 The Contractor shall, at all times during the Term, supply the Materials as per approved drawings & documents, Technical Specifications, applicable Indian / International Codes and Applicable Laws and Good Engineering and Manufacturing Practices.

4.11 Except as otherwise expressly provided in this Contract, the Contractor agrees and acknowledges that it shall perform all its obligations and responsibilities under this Contract at its own risk, cost and expense.

5.0 SPARES, CONSUMABLES AND MAINTENANCE TOOLS & TACKLES

5.1 All the spares for the equipment under the Contract shall strictly conform to the technical specification and documents and shall be identical to the corresponding main equipment / components supplied under the Contract and shall be fully interchangeable.

5.2 Commissioning Spares

5.2.1 The Contractor shall supply along with the Materials, commissioning spares considering allowances as per experience of the Contractor to cover wastage / breakage during transportation, storage, handling, construction, erection, testing and commissioning (**"Commissioning Spares"**). The Contractor shall be fully responsible for ensuring availability of adequate quantities of Commissioning Spares at the Site. If Commissioning Spares supplied are found to be inadequate, the Contractor shall supply additional Commissioning Spares promptly at his own cost.

5.3 **DELETED**

5.4 **Consumables**

5.4.1 All the consumables such as oils, lubricants, chemicals etc., required till commissioning of the system shall be supplied by the Contractor (**"Consumables"**).

5.4.2 Contractor shall also furnish consumption rates of Consumables along with estimated annual requirements and ordering specification to enable the Owner to procure these in time for operation & maintenance of system

5.5 **Maintenance Tools & Tackles**

5.5.1 Contractor shall supply all the special tools & tackles, appliances and lifting devices for the effective maintenance of the equipment and components covered under this Contract (**"Maintenance Tools & Tackles"**). Price for Maintenance Tools & Tackles is included in Contract Price. Maintenance Tools & Tackles shall be dispatched simultaneously with equipments and components.

5.5.2 Maintenance Tools & Tackles shall not be used for installation of equipments & components.

6.0 **STAFFING AND AUTHORITY**

6.1 **Contractor's Staff**

6.1.1 The Site shall be staffed adequately to perform the Work in accordance with Good Engineering & Construction Practices and the provisions of this Contract, including but not limited to, in a prudent, efficient, reliable and safe manner.

6.1.2 The minimum staff to be deployed at Site, both in supervisory as well as workmen categories, shall not be less than what is specified in the Staffing Plan. However, in order to fully meet the Contractor's obligation and perform the Work as defined in this Contract, if any additional manpower, beyond those specified in Staffing Plan, is required to be deployed by Contractor at Site, same shall be deployed by Contractor without any delay and without any additional cost to the Owner.

6.1.3 All personnel engaged in the performance of the Work shall be qualified to perform, licensed to the extent required by Applicable Law and sufficiently trained & experienced in the duties to which they are assigned and shall satisfy the standards of performance provided in this Contract. Contractor shall demonstrate that the personnel provided under this Contract are properly trained, competent to perform the work assigned and are aware of the HES Policy.

6.1.4 Contractor shall provide experienced manpower employed by them preferably on their direct role. Resident Construction Manager, 1 (one) electrical engineer and 1 (one) control & instrumentation engineer shall necessarily be employees on the direct role of the Contractor. CV of Resident Construction Manager, electrical engineers and control & instrumentation engineers shall be submitted to Owner for their review and concurrence at least fifteen (15) days prior to their deployment at site. Owner shall reserve the right to accept or reject proposed Resident

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Construction Manager, electrical engineers and control & instrumentation engineers. Resident Construction Manager, electrical engineer and control & instrumentation engineer shall be deployed at site only after approval of their CV by Owner. Resident Construction Manager, electrical engineer and control & instrumentation engineer shall have at least fifteen (15), seven (7) and seven (7) years of experience respectively in supervising similar work out of which Resident Construction Manager shall have three (3) years of experience as Resident Construction Manager for similar work.

6.1.5 Contractor shall provide experienced and qualified operation and maintenance personnel required till completion of Pre-commissioning Tests, Commissioning Tests, Initial Operation and Trial Operation and during Guarantee Tests.

6.1.6 The Contractor shall be responsible for maintaining strict discipline and good order amongst its personnel and those of its Subcontractors at all times.

6.1.7 Contractor shall bear the entire responsibility, liability and risk relating to coverage of Contractor Staff under Applicable Law including but not limited to Workmen's Compensation Act, 1923, Industrial Disputes Act, 1947, Maternity Benefits Act, 1961, Employees' Provident Funds and Miscellaneous Provisions Act, 1952, Contract Labour (Regulation and Abolition) Act, 1970, Employees State Insurance Act, 1948, Factories Act, 1948 and any other relevant act/regulations as will be applicable during the Term.

6.1.8 Contractor shall also be solely responsible for the payment of all benefits to the Contractor Staff under Applicable Law, such as provident fund, bonus, retrenchment compensation, leave, etc., and shall keep the Owner indemnified in this regard against any claims. The Owner shall be entitled to, if it is noticed that Contractor is in default, make such payment, solely at its discretion and recover such amounts as deemed fit from any sum due and payable to Contractor by the Owner.

6.1.9 Contractor shall be responsible for making any overtime payment for providing services under this Contract and Owner shall not bear any liability whatsoever in this regard.

6.1.10 It shall be responsibility of Contractor to take care of the boarding, lodging, travel arrangements, immigration clearance and visas for all Contractor Staff engaged in providing services.

6.1.11 Contractor shall arrange local transportation facility for all Contractor Staff.

6.1.12 The hours of work at the Site shall be decided by the Owner and the Contractor shall adhere to it. Working hours in each shift shall normally be eight (8) hours per day - Monday through Saturday.

6.1.13 No personnel involved in the provision of Work under this Contract shall be deemed employees of the Owner. Neither Party shall be deemed to be a successor to the other Party under any union, labor, or collective bargaining agreement, or any other similar agreement, to which such Party is or may in the future be a party.

6.1.14 The Contractor shall ensure that required Contractor Staff is always available at the Site. If in the opinion of Owner, number of Contractor Staff deployed at site to

perform services is not adequate to meet the time schedule for completion of services, he may direct Contractor to mobilize additional manpower within reasonable time. In the event of failure of Contractor to mobilize additional manpower as directed by Owner, Owner may mobilize additional manpower at risk and cost of Contractor. Such manpower mobilized by Owner shall be treated as Contractor Staff.

6.2 **Authority of Resident Construction Manager**

6.2.1 The Resident Construction Manager appointed by Contractor shall be authorized and empowered to act for and on behalf of the Contractor on all matters concerning this Contract and its obligations hereunder. In all such matter, the Contractor shall be bound by the written communication, direction, request and decision given or made by the Resident Construction Manager. The Resident Construction Manager will direct and manage Contractor's resources and shall have full responsibility for performing the services.

6.2.2 The Resident Construction Manager will report to the Owner's designated officer in matters relating to performance of the services.

6.3 **Owner's Staff**

6.3.1 Owner shall appoint a project manager (such Person the "**Project Manager**") who shall be assisted by the other Owner's Staff. The Owner may, from time to time, appoint any other Person as the Project Manager in place of the Person previously so appointed, and shall provide not less than 7 (seven) days notice of the name of such other Person to the Resident Construction Manager.

6.3.2 Contractor shall report to the Project Manager.

6.3.3 Project Manager or Persons authorized by him shall co-ordinate with Contractor and supervise performance of services.

6.3.4 The Project Manager may, at any time, assign duties and/or delegate to any Person, any of the powers and duties vested in it, upon notice to the Contractor. The Project Manager may also revoke such assignment or delegation and give notice of the same to the Contractor.

6.4 **General Personnel Requirement**

6.4.1 Contractor shall employ Contractor Staff including labour in sufficient numbers to ensure workmanship of the degree specified in this Contract and to the satisfaction of the Owner. The Contractor shall employ labour in sufficient numbers to maintain the required rate of progress and workmanship of the degree specified in the Contract and to the satisfaction of the Owner.

6.4.2 The Contractor is expected to employ only such Persons, for the performance of services, who have requisite experience of particular work.

6.4.3 The Contractor shall employ only qualified and medically fit Persons who are not below 18 (eighteen) years of age.

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6.4.4 No female staff or labour shall be employed for night shifts or after darkness.

6.4.5 Contractor's Staff shall wear identification badges at all times while on work at Site.

6.4.6 Contractor shall employ local people under unskilled workmen category.

6.4.7 Local people shall be given preference by Contractor in employment of staff and skilled workmen wherever local people with requisite skills are available.

6.4.8 Contractor shall comply with labour rules, regulations and statutes as specified in Clause 22.0 (Applicable Labour Laws).

6.4.9 All Contractor Staff shall be considered employees of Contractor only and Owner shall have no relation whatsoever with the Contractor Staff.

6.4.10 The Contractor Staff shall work exclusively at the Site and they shall not be transferred / deputed to any other site of the Contractor, without prior written consent of the Owner.

6.4.11 For smooth functioning, the Contractor shall ensure that requisite number of the Contractor Staff shall be fluent in the local language of India spoken at the Site.

6.5 **Discipline of Workmen**

6.5.1 The Contractor shall adhere to the disciplinary rules, regulations and procedures set by the Owner in respect of Contractor Staff at Site. The Owner shall be at liberty to object to the presence of any Contractor Staff at the Site if, in the opinion of the Owner, such Person's conduct is inappropriate or such Person is incompetent or negligent or otherwise undesirable or if there is malfeasance in the conduct of such Person's duties or responsibilities to be performed at Plant or if, in the opinion of the Owner, the presence of such Person poses a threat towards safety & security of the Plant or Services or creates an environment detrimental to the interest of the Owner. In such a case the Owner may give written notice to the Contractor identifying the Person(s) concerned and describing the complaint in detail. Upon receipt of such complaint, the Contractor shall immediately remove the relevant Person(s) from the performance of the services and replace him with appropriate personnel.

7.0 **CONTRACT PRICE AND PRICE BASIS**

7.1 **Contract Price**

7.1.1 The Owner shall, in consideration for the supply, installation, commissioning, Training etc. obligations of the Contractor under this Contract, pay to the Contractor, the contract price of **Rs. 52,12,650/- (Rupees Fifty-Two Lakhs Twelve Thousand Six Hundred and Fifty Only) including GST@18%** comprising of the amounts specified in Annexure 1 (Contract Price), subject to the terms of this Clause 7.0 and Clause 8.0 (Payment Terms) below ("**Contract Price**").

7.1.2 The Contract Price is full compensation to Contractor for implementation of complete online monitoring system for Bus Reactor and satisfactory performance of all its obligations under this Contract in compliance with all terms and conditions of this

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Contract. The Contract Price as payable hereunder shall cover all costs, expenses, overheads, etc., to be incurred by the Contractor and profit margin for the performance of all its obligations under this Contract including but not limited to costs and expenses of supplying Materials. No additional claim or payment would be admissible in this regard. Contract Price shall be regulated and paid in the manner described in this Clause 7.0 and Clause 8.0 (Payment Terms and Performance Bank Guarantee) below.

7.2 **Price Basis**

7.2.1 Contract Price, unit prices, pricing for change, and all other prices and rates set forth in the Contract shall remain fixed and firm and shall not be subject to any change whatsoever during the Term.

7.2.2 Contract Price includes all costs, expenses, overheads, etc., to be incurred by the Contractor and profit margin for the supply of materials and performance of all the Works and Services and obligations under this Contract including but not limited to the following and no additional claim or payment would be admissible therefore:

7.2.2.1 Cost of providing construction materials, tools & plants, scaffoldings;

7.2.2.2 Cost of dismantling, transportation, insurance, unloading, handling, storage, installation, testing, commissioning, and housekeeping;

7.2.2.3 Salaries and wages, including benefits, general and administrative overheads, and all miscellaneous expenses for the Contractor Staff;

7.2.2.4 Out-of-pocket costs paid or reimbursed for travel and subsistence during said periods of travel of the Contractor Staff;

7.2.2.5 Cost of evaluation, selection, employment, relocation, and training of Contractor's Staff;

7.2.2.6 All office and administrative expenses (including stationery, telephone, fax, printer, scanner, photocopier, etc.);

7.2.2.7 Cost of uniform, personal safety equipment, etc. for Contractor's Staff;

7.2.2.8 Premium of insurance policies and deductible amounts for all insurance policies provided by the Contractor, as per Clause 11.0 (Insurance);

7.2.2.9 All costs and expenses associated with records management, including but not limited to preparation of materials, equipments, reproduction and storage expenses;

7.2.2.10 Cost of transporting the systems, equipments, construction materials, tools & plants, etc to the Site;

7.2.2.11 Cost of legal, payroll and accounting services with respect to the Contractor Staff, and accounting and legal matters related to the administration of this Contract;

7.2.2.12 Any and all other costs and expenses for performing services, not specifically set forth herein but incurred by the Contractor for fulfillment of its overall obligation covered under this Contract;

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7.2.3 Contract Price shall be inclusive of all applicable Indirect Taxes, as specified in Part B of Annexure 1 (Contract Price). Tax payable on income or profession of the Contractor, its employees and its Subcontractor shall be the sole responsibility of the Contractor, its employees and its Subcontractor and the Owner shall have no obligation regarding the same.

7.2.4 All payments to be made to the Contractor under this Contract shall be made net of any withholding or deduction, if applicable under any Applicable Law in force at the relevant time, including Income Tax Act, 1961. In case of such deduction made by the Owner from the amount payable to the Contractor, the Owner shall provide the Contractor with appropriate tax deduction certificates.

7.2.5 For the avoidance of doubt, it is clarified that the Contract Price includes any and all direct, indirect and ancillary charges, cess, costs and expenses of whatsoever nature, taxes on the Contractor, applicable indirect taxes on supplies under this Contract, all profit, license, royalty and fees, accessories, Consumables, Commissioning Spares, Mandatory Spares, Maintenance Tools & Tackles, and intellectual property licenses to be provided under this Contract, packaging and loading of the Materials, delivery at the Loading Point, unloading at site, insurance, installation, commissioning and training of OTPC staff.

7.2.6 Failure by Contractor to fully assess the scope of the implementation of the Complete Online monitoring system for Bus Reactor, as specified in this Contract shall not be considered as a basis for variations to the Contract Price or any part thereof such as pricing of individual items (unit prices) and time and material rates for changes.

7.2.7 The Contract Price shall include mobilization, demobilization and site establishment charge which shall not be subject to adjustment based upon any additions or deletions to the Contract Price.

7.2.8 The Contract Price (including the break-up) specified under Annexure 1 (Contract Price), shall apply regardless of when the Services are performed, during day or night or a holiday.

7.2.9 Contract Price shall include all costs associated with and relating to, performing Services in accordance with all Applicable Laws as well as Owner's HES Policy and security regulations.

7.2.10 Failure by Contractor to assess fully the scope of Services, as required and described in this Contract shall not be accepted as a basis for variations to the Contract Price or any part thereof such as pricing of individual items and time and material rates for changes.

7.2.11 Contract Price shall be inclusive of all applicable Indirect Taxes as specified in Annexure 1 (Contract Price). Taxes and duties applicable on any imported services relevant to Contractor's scope of Services are also included in Contract Price. Tax payable on income or profession of the Contractor shall be the sole responsibility of the Contractor and the Owner shall have no obligation regarding the same.

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7.2.12 All payments to be made to the Contractor under this Contract shall be made net of any withholding or deduction as may be required under any Applicable Law in force at the relevant time including Income Tax Act, 1961. In case of such deduction made by the Owner from the amount payable to the Contractor, the Owner shall provide the Contractor with appropriate tax deduction certificates.

8.0 **PAYMENT TERMS**

8.1 The payment to the Contractor for the supply of the Materials, installation and commissioning of the entire system and the performance of its obligations under this Contract shall be made by the Owner as per the guidelines and conditions specified herein. All payments made during the Contract shall be on-account payment only. The final payment shall be made on Final Acceptance of the Facility and on fulfillment by the Contractor of all its liabilities under the Contract including those in respect of warranties etc. Payments to be made hereunder are subject to any adjustment/deductions as per the provisions of this Contract.

8.2 The Contract Price will be paid in Indian Rupees only.

8.3 **Payment Term:**

8.3.1 Ten percent (10%) of the Contract Price shall be released as initial advance within thirty (30) days of receipt of Invoice by Owner on fulfillment of the following conditions:

8.3.1.1 Unconditional and unequivocal acceptance of Work Order;

8.3.1.2 Submission of Performance Bank Guarantee as provided in Clause 12.0;

8.3.1.3 Submission of detailed PERT Network as specified in Clause 10.3;

8.3.1.4 Submission of an unconditional Bank Guarantee covering the advance amount which shall be initially kept valid till ninety (90) days after the Time for Completion. Format of Bank Guarantee (ABG) is attached as Annexure-4.

8.3.2 Sixty percent (60%) of the Contract Price shall be released as per billing break-up (BBU) approved by Owner on pro-rata basis against progressive receipt of Materials in good condition at Site within thirty (30) days of receipt of following documents by Owner in 1 (one) original + 2 (two) copies:

8.3.2.1 Invoice;

8.3.2.2 Copy of Consignment Note / Lorry Receipt having material receipt endorsed by Owner;

8.3.2.3 Copy of Way Bill / Road Permit used for transportation of Materials; and

8.3.2.4 Material Receipt Certificate issued by Owner;

8.3.3 Twenty percent (20%) of the Contract Price shall be released on pro-rata basis as per billing break-up (BBU) approved by Owner against progressive completion of Services duly certified by Project Manager within thirty (30) days of receipt of following documents by Owner in 1 (one) original + 2 (two) copies:

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8.3.3.1 Work completion & measurement certificate duly certified by Project Manager;

8.3.3.2 Protocols required to be filled-in after completion of work as per approved Field Quality Plan duly signed by quality control engineer of Owner;

8.3.3.3 Running Account Bill (to be submitted on monthly basis) duly certified by Project Manager; and

8.3.3.4 Documentary evidence of payment of taxes, duties & levies.

8.3.4 Ten percent (10%) of the Contract Price shall be released by the Owner after Final Acceptance of Facility evidenced by final acceptance certificate issued by Owner and submission of as-built drawings, documents, test reports & certificates and Operation & Maintenance Manuals within 30 days of submission of Invoice and supporting documents.

8.4 **Mode of Payment**

8.4.1 Payment shall be made either by cheque or in such other manner as the Parties may mutually agree in writing. All bank charges shall be to the account of Contractor.

8.4.2 Applicable income tax/withholding tax/TDS shall be deducted while making payment and necessary certificate as per Applicable Law shall be issued in due course of time.

8.4.3 If the Owner disputes any item of an invoice, the Owner shall make payment for the undisputed portion of such invoice when such payment becomes due under this Contract. The Owner shall make the balance payment within 30 (thirty) days after resolution of the dispute in accordance with Clause 34.0 (Settlement of Disputes).

9.0 **TAXES, DUTIES & LEVIES**

9.1 The Contractor shall bear and pay all personal, property and corporate taxes (including withholding tax, if applicable), duties, levies and its related charges assessed on the Contractor (including surcharge on income tax), its Subcontractors (or their contractors) or their employees by a Government Agency in connection with the supply of Materials and performance of its obligations under this Contract ("**Direct Tax**"). For the avoidance of any doubt, it is clarified that all Direct Taxes by whatever name called, arising on the income of the Contractor, its Subcontractors (or their contractors) or their employees, shall be borne by the Contractor. The Contractor shall provide the requisite information/documents to the Owner (including its permanent account number), so as to enable the Owner in complying with its obligations as per Applicable Law.

9.2 The Contract Price is inclusive of all indirect taxes, duties and levies as applicable on the Effective Date, the description and rates of which and the corresponding amounts included in the Contract Price are specified in Annexure 1 (Contract Price) ("**Indirect Taxes**"). Only such Indirect Taxes shall be paid/reimbursed by Owner to Contractor as part of the Contract Price against documentary evidence of payment by Contractor thereof.

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9.3 The Contractor acknowledges and agrees that the description, rates and corresponding amounts of Indirect Tax included in the Contract Price, as specified in Part B of Annexure 1 (Contract Price), has been provided by the Contractor on the Effective Date. The Owner's liability to reimburse/pay the Contractor in respect of any Indirect Tax is restricted to the extent such Indirect Tax is indicated in Part B of Annexure 1 (Contract Price). In the event this information is subsequently found to be incomplete, incorrect or misleading, the Owner shall have no liability to reimburse/pay the Contractor the excess amounts with respect to any Indirect Tax, if such amounts are finally levied / imposed / recovered by any Government Agency on / from the Contractor.

9.4 Any statutory variation (upward or downward) in Indirect Taxes, as specified in Annexure 1 (Contract Price) within Time for Completion shall be to the account of the Owner. The Contractor shall submit documentary evidence of above variation along with his invoice.

9.5 Imposition of new Indirect Taxes by the Central or State government within the Time for Completion shall be to the Owner's account. However, any increase in the rates of Indirect Taxes or imposition of new Indirect Taxes, beyond the Time for Completion shall be to the Contractor's account and any benefit of statutory downward revision in Indirect Taxes beyond the Time for Completion shall be passed on by the contractor to the Owner.

9.6 In the event that the Owner is required to pay the income tax/withholding tax applicable on supply of Materials and the performance of obligations under this Contract whether outside India or within India, the Owner shall deduct such taxes from the gross value of the Contractor's invoice and remit the net amount taking into account such deductions. However, the Owner shall furnish a TDS certificate to this effect in favour of the Contractor so as to enable it to take the tax credit.

9.7 All taxes, duties and levies applicable outside India on the performance of obligation under this Contract whether outside India or within India shall be included in the Contract Price. The Owner shall have no liability whatsoever in this regard.

10.0 **TIME FOR COMPLETION**

10.1 The Contractor agrees to complete the implementation of Complete Online monitoring system for Bus Reactor in a timely manner in accordance with the terms of this Contract. The Contractor admits and acknowledges that time is the essence of this Contract for the supply of the Materials and installation of the system.

10.2 The time for Completion of Implementation of Online Monitoring System for Bus Reactor along with associated systems shall be 3 (Three) months from the Effective Date (**"Time for Completion"**).

10.3 Contractor shall submit to Owner for his approval, within fifteen (15) days from the Effective Date, a detailed PERT Network, consisting of adequate number of activities covering various key phases of the implementation of the complete online monitoring system for Bus Reactor such as design, engineering, procurement, manufacturing, inspection, testing, packing, loading of materials at the Loading Point, Insurance, Unloading at site, Installation, Commissioning, training of OTPC staff and final handling over. The PERT Network shall be based on Time for Completion specified in Clause 10.2 above. Approved PERT Network shall form

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integral part of the Contract. As provided elsewhere in this Section, finalization of the PERT Network will be a precondition for release of any initial advance to the Contractor.

10.4 The Contractor shall promptly notify the Owner of any event or conditions which might delay the completion of intended system within Time for Completion and the steps being taken to remedy or mitigate such situation, including on its own initiative and at its own expense, increasing or supplementing the supervision, procurement and manufacturing to such an extent so as to restore the lost sequence or progress and provide assurance of compliance with the Time for Completion under this Contract. In the event the steps taken by the Contractor to remedy or mitigate such situation causes the Owner to incur additional costs, the Contractor shall reimburse such costs to the Owner. If the Contractor fails to take necessary steps to remedy or mitigate a delay, then the Owner may take such steps as it may deem necessary, in its sole discretion (including but not limited to engaging other contractor's to perform the obligations under this Contract and deduct the cost of the same from the Contract Price).

11.0 LIQUIDATED DAMAGES AND INSURANCE

11.1 Liquidated Damages for Delay in Completion

11.1.1 In case of failure of Contractor to complete the implementation of the online monitoring system for Bus Reactor within Time for Completion specified in Clause 10.2, the Contractor shall pay to the Owner liquidated damages as follows:

For every 1 (one) week (or part thereof) delay in completion of system for reasons not attributable to the Owner, the Contractor shall pay to the Owner a sum equivalent to half percent (0.5%) of the Contract Price.

11.1.2 The total amount of liquidated damages payable by the Contractor on account of delay in completion of system under Clause 11.1 shall be limited to 10% (ten percent) of the Contract Price.

11.2 Liquidated Damages for Shortfall in Guaranteed Performance during Warranty Period

11.2.1 In case of failure of Contractor to achieve the guaranteed performance for the Online monitoring system for Bus Reactor during Warranty Period specified in Clause 43.2, the Contractor shall pay to the Owner liquidated damages as follows:

For every 0.1% (zero decimal one percent) (or part thereof) decrease in guaranteed availability of the Online monitoring system for Bus Reactor, 0.5% (zero decimal five percent) of Contract Price shall be paid as liquidated damage by the Contractor to the Owner on a *pro rata* basis.

11.2.2 The total amount of liquidated damages payable by the Contractor on account of shortfall in guaranteed performance under Clause 11.2 shall be limited to 10% (ten percent) of the Contract Price.

11.3 Payment or deduction of liquidated damages shall in no way relieve the Contractor from discharging its other obligations under this Contract.

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11.4 Owner may recover the liquidated damages payable by the Contractor from any amounts due to it or which may subsequently become due to it under this Contract or any other contract.

11.5 For the avoidance of doubt it is clarified, that the Owner's right to receive liquidated damages in accordance with this Clause 11.0 is without prejudice to any other rights the Owner may have under Applicable Law or otherwise in connection with the breach of any other obligations hereunder by the Contractor.

11.6 The total amount of liquidated damages payable by the Contractor under Clause 11.1 and Clause 11.2 shall be limited to 15% (fifteen percent) of the Contract Price.

11.7 **INSURANCE**

11.7.1 Without prejudice to its obligations under this Contract or otherwise under Applicable Law, the Contractor, at its cost, shall arrange, secure and maintain all such insurance as may be required in connection with the performance of the Services and obligatory in terms of Applicable Law, to protect its interest and interest.

11.7.2 It shall be responsibility of the Contractor to maintain all necessary insurance coverage (including those for professional liability) to the extent both in time and amount to take care of all its liabilities either direct or indirect, in pursuance of the Contract.

11.7.3 All Insurer's right of subrogation against Owner for losses or claims arising out of the performance of the Contract shall be waived under such policies.

11.7.4 Neither failure to comply nor full compliance with the insurance provisions of this Contract shall limit or relieve the Contractor of its liabilities and obligations under this Contract.

12.0 **PERFORMANCE BANK GUARANTEE**

12.1 The Contractor shall, within 15 (fifteen) days of the Effective Date, provide to the Owner an unconditional and irrevocable performance bank guarantee of an amount equivalent to 10% (ten percent) of the Contract Price for implementation of Total Online monitoring system for Bus Reactor and due performance of its obligations under this Contract, with an initial validity of up to 90 (ninety) days beyond the Warranty Period, a format of which is attached as Annexure 3 (Format of Performance Bank Guarantee) ("**Performance Bank Guarantee**").

12.2 If, at the time of discharge of Performance Bank Guarantee, the Warranty Period has been extended pursuant to Clause 27.5 or if a dispute has been referred for resolution pursuant to Clause 34.0 (Settlement of Disputes), the Contractor shall, on or before 21 (twenty one) days before the expiry of the Performance Bank Guarantee, issue an extension of the existing Performance Bank Guarantee or issue a separate security in the form of an unconditional and irrevocable bank guarantee for an amount proportionate to the Contract Price for such part, valid till the extended Warranty Period or until final resolution of the dispute and payment of any amount due as a result thereof, as the case may be.

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12.3 The Performance Bank Guarantee to be submitted by Contractor shall be from an Acceptable Bank and in the form acceptable to the Owner and as prescribed under Annexure 3 (Format of Performance Bank Guarantee).

12.4 The Contractor acknowledges and agrees that the Performance Bank Guarantee shall be held by the Owner as security for the satisfactory completion of the obligations of the Contractor, in accordance with this Contract, including recovery of any amounts due to the Owner from the Contractor .The Owner shall have the unconditional option under the Performance Bank Guarantee to invoke and encash the same and shall be entitled to recover from such Performance Bank Guarantee, any amounts which may become due to the Owner from the Contractor.

12.5 In the event the credit rating of the Acceptable Bank which has provided the Performance Bank Guarantee falls below AA+ by Credit Rating and Information Services India Limited or below AA by ICRA Limited or below AA+ by Credit Analysis and Research Limited or below BBB Fitch Ratings, then the Contractor shall provide a fresh Performance Bank Guarantee from an Acceptable Bank which has a credit rating equal to or higher than the credit ratings mentioned in this Clause 12.5.

13.0 ENGINEERING DOCUMENTS, MANUALS AND TESTS CERTIFICATES

13.1 Engineering Drawings & Documents

13.1.1 The furnishing of engineering data by the Contractor shall be in accordance with the Technical Specifications. The review of these data by the Owner shall normally cover only general conformance of the data to the provisions of the Contract including Technical Specifications and interfaces, external connections and dimensions which might affect Plant layout. Such review by the Owner may not be a detailed review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and or/approval by the Owner shall not be construed by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements specified under the Contract including Technical Specifications.

13.1.2 Each drawing submitted by the Contractor shall be clearly marked with the name of the Owner, the Project title, the Contract No., the title of drawing, scale, date of drawing, the Contractor's drawing No., space for Owner' drawing No etc. In addition to the above information provided on drawings, each drawing shall carry a revision number, date of revision and brief details of revision carried out. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions shall be in metric units.

13.1.3 Within two (2) weeks from the Effective Date, the Contractor shall submit to Owner for his approval a list of all the drawings, documents, design calculations, material specifications, data-sheets etc proposed to be submitted by Contractor to the Owner for approval / reference identifying each by a serial number and descriptive title and giving the expected date of submission.

13.1.4 The Contractor shall satisfy the Owner about the validity of the design with reference to the requirements of Technical Specifications, engineering codes, Good Engineering & Manufacturing Practices and Applicable Laws.

13.1.5 Drawings submitted for approval / reference shall be signed by responsible representative of the Contractor and shall be of any of the following sizes in accordance with the Indian Standard: A0, A1, A2, A3 or A4.

13.1.6 The drawings and documents submitted by the Contractor shall be reviewed by the Owner as far as practicable within Two (2) weeks and shall be modified by the Contractor if any modifications and / or corrections are required by the Owner. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings and documents for approval within two (2) weeks from the date of receipt of commented drawings and documents from the Owner. Any delays arising out of failure by the Contractor to submit the revised drawings and documents within the time for resubmission specified above shall be to the Contractor's account. While resubmitting the drawings and documents Contractor shall incorporate Owner's drawing and document number in the respective drawings and documents. The Owner's drawing and document number shall be used thereafter for all purpose of reference.

13.1.7 Three (3) hard copies and one (1) soft copy of the drawings and documents shall be submitted by the Contractor to the Owner for approval/reference. One copy of such drawings and documents shall be returned to the Contractor by the Owner marked 'Approved / Approved with comments as noted / Marked with comments / Retained for information'. The Contractor shall thereupon furnish to the Owner, the revised drawings and documents after incorporating all corrections for final approval.

13.1.8 Supply of equipments/materials shall be in strict accordance with approved drawings and documents and no deviation shall be permitted without the written approval of the Owner, if so required.

13.1.9 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings (Approved / Approved with Comments as noted) shall be at the risk and cost of Contractor. Subject to approval by the Owner, the Contractor may make necessary changes in the drawings and documents which are necessary to make the equipment conform to the provisions and intent of the Contract including Technical Specifications. Approval of Contractor's drawings by the Owner shall not relieve the Contractor of any of his responsibilities and liabilities under the Contract.

13.1.10 Any expenses resulting from an error or omission in or from the delay in delivery of the drawings and documents mentioned in the Technical Specification shall be borne by the Contractor.

13.1.11 Drawings shall include all installation and detailed cabling drawings wherever applicable. All drawings shall be fully corrected to agree with actual 'as built' construction.

13.1.12 Upon completion of installation, the Contractor shall submit 'As built Drawings' and 'As built Documents' including As built datasheet in required No. of copies as specified in Technical Specifications.

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13.1.13 If at any time before Final Acceptance of the system, changes are made necessitating revision of the approved drawings and documents, the Contractor shall make such revisions and obtain approval of Owner as specified in Clause No. 13.1.5 and 13.1.6.

13.2 **Manuals and Test Certificates**

13.2.1 The Contractor shall submit to the Owner for his review and approval, draft installation, operation & maintenance manuals for all the equipments covered under the Contract, within the time agreed upon between the Owner and the Contractor. The final installation, operations & maintenance manuals, complete in all respects shall be submitted by the Contractor within 10 days of the commissioning of the system.

13.2.2 The Contractor shall furnish to the Owner spare parts catalogue.

13.2.3 The Contractor shall submit the following documents in line with Clause 13.1 and 13.2:

13.2.3.1	Printed Pamphlets / Catalogues	6 hard copies + 1 soft copy
13.2.3.2	Manuals (Preliminary)	6 hard copies + 1 soft copy
13.2.3.3	Manuals (Final)	6 hard copies + 1 soft copy
13.2.3.4	Manuals (Updated), if required	6 hard copies + 1 soft copy
13.2.3.5	Any other relevant information	6 hard copies + 1 soft copy
13.2.3.6	All Test Certificate in bound volumes	6 hard copies + 1 soft copy

14.0 **CONTRACTOR's OBLIGATIONS**

14.1 **General**

14.1.1 In addition to other specific obligations set out elsewhere in this Contract, the Contractor shall have the obligations set out in this Clause 14.0.

14.1.2 It shall be the responsibility of the Contractor to supply Equipment/Materials which shall be new and in good condition. Contractor shall supply the Materials which shall meet all the requirements provided under the Technical Specifications. Equipment selected shall be sufficient to meet the requirements of the system as mentioned in the Technical specifications.

14.1.3 The Contractor shall be fully responsible for preparing, packaging and loading the Materials on to the mode of transportation at the Loading Point, including for the payment of all packaging, loading and handling costs and expenses. Unloading of the materials at site, installation and commissioning of the system is also under the scope of contractor.

14.2 **Industrial Practice**

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14.2.1 The Contractor shall be responsible for performing its obligations under this Contract, including for associated purchases and/or subcontracting with due care and diligence and in accordance with Good Engineering & Manufacturing Practices, using sound supervisory procedures, and in a professional and workmanlike manner, in accordance with Applicable Law and the Technical Specifications and within the Time for Completion. The Contractor shall supply all Materials as per the specifications provided under the Technical Specifications. The Contractor shall ensure that the Materials shall be fit for the purpose for which each of them is intended as per the provisions of this Contract.

14.3 **Means and Methods**

14.3.1 The Contractor shall, at all times, be responsible for the efficiency and adequacy of its planning, co-ordination with its Subcontractors, design, securing of approvals, means and methods of performance, materials and equipment, irrespective of whether the Contractor acts as a result of any advice or reviews of the Owner.

14.3.2 The Contractor shall, whenever required by the Owner, submit details of the arrangements and methods which the Contractor proposes to adopt for performance of its obligations under this Contract. No significant alteration to these arrangements and methods shall be made without the same being previously notified to the Owner.

14.4 **Compliance with Laws**

14.4.1 The Contractor shall at all times be in compliance with all Applicable Laws, in the performance of its obligations under this Contract. The Contractor shall also ensure such compliance by its Subcontractors.

14.4.2 The Contractor shall at its cost, in a timely manner so as not to delay the progress of its obligations hereunder and in any event before the time required by Applicable Law, obtain all applicable Permits required for the completion of its obligations under this Contract.

14.4.3 The Contractor shall not, under any circumstances, cause or permit, in connection with the obligations to be performed hereunder, the discharge, emission or release of any hazardous substance and/or waste, pollutant, contaminant or other substance in violation of any Applicable Laws.

14.5 **Packaging**

14.5.1 **General**

14.5.1.1 All Materials shall be protected and securely packed and loaded in a manner commensurate with the transportation stresses and hazards encountered in such supply in accordance with internationally accepted transportation principles. The Contractor shall ensure that the packing provides adequate protection to the Materials from the rigors of multiple handlings, loadings and unloading. If any of the Materials are damaged, lost, stolen, destroyed or otherwise impaired prior to the completion of loading at the Loading Point, the Contractor shall, at its own cost and expense, restore or replace such affected Materials. The provisions of this Clause are designed to facilitate preservation, safe arrival, and expeditious movement of the

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Materials to the Site and provide the general requirements for packaging of the Materials. The provisions of this Clause are neither a packing manual, nor a substitute for internationally recognized packing practices and the Contractor shall be fully responsible for the quality of packaging.

14.5.2 **Packing Procedure**

14.5.2.1 The Materials shall be packed in accordance with standard practices of the industry and of the mode(s) of transportation to be utilized or expected to be utilized for transportation and as specifically notified by the Owner from time to time.

14.5.2.2 The Contractor shall provide packing and packaging to protect the Materials while in storage for up to 6 (six) months.

14.5.2.3 The Contractor will use its knowledge of the Materials to provide supplementary packaging when customary and usual packaging may not provide sufficient protection. The packaging shall be in a manner such that the Materials are protected against mechanical damage (shocks, rupture, breakage, loss, etc.) and corrosion (rain, salty atmosphere, sand, wind, etc.).

14.5.2.4 Additional appropriate packing shall be considered when the Materials, or any component thereof is required to be stored outside.

14.5.2.5 The Materials shall be clean and free from metallic filings, machining debris and cleaning media such as blasting grit, if applicable.

14.5.2.6 Contractor shall adhere to the requirements of Applicable Law governing treatment to prevent infestation and mold in wood used in pallets, skids, crates, boxes or any other items used as packing material.

14.5.2.7 Contractor shall ensure adequate additional boxing or crating for consolidated small packaged and/or loose items.

14.5.2.8 Each item in each package shall be labelled or marked so that it can easily be identified by the packing list. 1 (one) copy each of the final detailed packing list shall be affixed in water tight containment on the outside of each package, container or crate secured under a metal sheet, and one copy shall be placed inside the package, container or crate. The Contractor shall also apply standard symbols indicating care and precaution to be used in handling and storing of each package. For out-of gauge consignments, either heavy or over dimensional, the center of the package shall be marked and clearly indicate the lifting points.

14.5.2.9 All means, methods and techniques of packing utilized, shall be appropriate for the conditions and materials involved and in accordance with the current state of the art and keeping with delivery schedule.

14.5.3 **Protection Against Damage in Transit**

14.5.3.1 The Contractor shall prepare all Materials for delivery in such manner so as to ensure that the packing is adequate, is of minimum size and to protect such Materials from damage in transit. Further, the packing shall be such that the Materials shall withstand rough handling, storage in hot and humid climate

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prevailing at the Site and shall be in compliance with any size, weight or handling limitations that are applicable. The Contractor shall pack the Materials in such a manner so as to ensure that no damage is caused to the same while in transit or during storage.

14.5.4 **Hazardous Materials**

14.5.4.1 Hazardous Materials shall be packed only in certified containers or only with certified packaging material in accordance with Applicable Law, including BARC and DAE Rules. The Contractor shall clearly mark all packages containing Hazardous Materials with the appropriate symbols and placards.

14.5.4.2 The Contractor hereby fully indemnifies the Owner with respect to any liability arising on account of any escape of Hazardous Material.

14.6 **Corrupt/Fraudulent Practices**

14.6.1 The Contractor shall not, directly or indirectly, engage in any Corrupt Practice, Fraudulent Practice, Coercive Practice or Obstructive Practice during the negotiation of this Contract or at any time during the Term.

15.0 **TRANSFER OF TITLE**

15.1 **Title**

15.1.1 The title to the Materials manufactured in India and supplied directly by the Contractor shall be transferred to the Owner at the Loading Point upon completion of loading of the materials on to the mode of transportation.

15.1.2 The title to the materials manufactured in India and supplied directly by the Sub-contractor to the Owner, shall be transferred to the Owner during the transit by way of transfer of document of title to materials by the Contractor after loading of the materials at the Loading Point and delivery to the transporter for transportation.

15.1.3 The title to the materials manufactured outside India and supplied directly by the Contractor shall be transferred to the Owner at the Loading Point upon completion of loading of the materials on to the mode of transportation used for transporting it to India.

15.1.4 The title to the materials manufactured outside India and supplied directly by the Sub-contractor to the Owner, shall be transferred to the Owner during the transit by way of transfer of document of title to materials by the Contractor after completion of loading of the materials at the Loading Point on to the mode of transportation used for transporting it to India.

15.1.5 Ownership of Materials in excess of the requirement for successful completion of erection and commissioning of Facility shall revert to the Contractor after successful Completion of Supply of Materials and Taking-Over of Materials.

15.2 **Responsibilities of Contractor**

15.2.1 The Contractor shall continue to be responsible for the risk of loss or damage to the Materials up to the completion of loading of the Materials on to the mode of

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transportation and for the quality and performance of the Materials till the end of the Warranty Period.

16.0 **QUALITY ASSURANCE PROGRAM**

16.1 **Inspection**

16.1.1 To ensure the conformance of the Materials, whether manufactured by Contractor or by its Subcontractors, with the provisions of this Contract, Contractor shall adopt, as well as ensure adoption by its Subcontractor, suitable Quality Assurance Program. The Owner or its representative(s) shall have the right to inspect and/or to test the Materials to check their conformity with the provisions of this Contract.

16.1.2 The Quality Assurance Program, proposed for adoption by the Contractor, shall be submitted for review and approval of the Owner, within 20 (twenty) days of the Effective Date. It shall *inter alia* specify required inspections and tests to be carried out by Contractor as per Contract and applicable codes for all phases of manufacturing and supply, the procedures involved, the place where such inspections and tests shall be conducted, acceptance basis, acceptance criteria and the customer hold points (CHPs) beyond which manufacturing shall not proceed without specific clearance from Owner. The approved Quality Assurance Program shall form part of this Contract and shall be strictly adhered to.

16.1.3 In case of customer hold points / stage inspection, Contractor shall proceed from one stage to another only after the Materials have been inspected and tested by the Owner and / or their representative and permission has been given to proceed further. The procedure shall be adopted for any rectification / repairs suggested by Owner or their representative.

16.1.4 The Contractor shall give not less than 15 (fifteen) day's prior notice as to the time and place of any scheduled inspection. Contractor shall submit following documents along with inspection call notice:

16.1.4.1 All Non-destructive examination procedures, stress relief and weld repair procedure actually used during fabrication

16.1.4.2 Welder and welding operator qualification certificates

16.1.4.3 Welder identification list, welder' and welding operator' qualification procedure and welding identification symbols.

16.1.4.4 Material mill test reports on components as specified by the specification.

16.1.4.5 The inspection plan with verification, inspection plan check points, verification sketches, if used, and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.

16.1.4.6 Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

16.1.4.7 All Non-destructive examination result reports including radiography interpretation reports.

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16.1.4.8 Stress relief time temperature charts.

16.1.4.9 Factory test results for testing required as per applicable codes and standard referred in the specifications.

16.1.5 In the event the Contractor fails to provide the Owner and/or their representative(s) at least 15 (fifteen) days prior notice of scheduled inspections, the Contractor shall pay for any costs incurred by the Owner and / or their representative in conducting the inspection which are greater than the costs which would have been incurred with proper notice. Provided, all costs of the Owner or their representative shall be borne by Owner if 15 (fifteen) day's prior notice is provided by the Contractor.

16.1.6 Contractor shall provide at his own cost all facilities including labour, materials, electricity, fuel, water, stores, apparatus, instruments etc reasonably required by Owner and/or their representative for effectively carrying out such inspection and tests of the Materials in accordance with the Contract and applicable codes.

16.1.7 Owner may ask Contractor to perform any such inspection and tests which are not specified in Contract and Quality Assurance Program. Contractor shall perform such inspection and tests and Owner shall pay to the Contractor reasonable cost incurred in carrying out such inspection and tests.

16.1.8 Inspection and acceptance of the Materials by the Owner and / or their representative shall not limit the liabilities and responsibilities of the Contractor in any manner and shall not prejudice the right of the Owner to reject the Materials if it is found to be defective during inspection after receipt at Site or if it fails to achieve guaranteed performance specified in the Contract.

16.1.9 Materials shall be dispatched only after inspection at Contractor's / Subcontractor's works is carried out and Materials are found to be acceptable. However, Owner reserves the right to waive-off inspection by Owner and / or their representative and allow dispatch of Materials to Site without inspection.

16.1.10 Contractor shall be responsible for monitoring each Subcontractor's compliance with the approved Quality Assurance Program. The Owner shall have right to conduct audits of the Contractor's Quality Assurance Program. Contractor shall cooperate with and extend all support to Owner in carrying out such audits.

16.2 **Material Tests**

16.2.1 The Contractor shall provide, at his own cost, test pieces as required by the Owner to enable him to determine the quality of material supplied under this Contract. If any test piece fails to comply with the requirements, the Owner may reject the whole material represented by the test piece.

16.2.2 Plates, sheets and bar stock materials meant for components of vessels shall be subjected to ultrasonic testing in accordance with codes specified or approved equal.

16.2.3 All high pressure pumps, valves and other high pressure casting shall be subjected to radiographic testing in accordance with codes specified or approved equal

16.2.4 All forgings shall be subjected to ultrasonic and magnetic particle testing in accordance with codes specified or approved equal

16.2.5 All ferrous and non-ferrous pipes and tubes of 65mm size and under shall be subject to eddy current testing in accordance with codes specified or approved equal

16.2.6 All U-bent tubes made of copper alloy shall be stress relieved.

16.2.7 All materials used in manufacturing of Materials covered by the Contract shall also be subjected to one or more of the following non-destructive tests (NDT) – visual, dye penetration, magnetic particles, ultrasonic or radiographic. Salvaging of material due to unacceptable defect is to be attempted by the Contractor only after getting specific concurrence from the Owner and according to the approved procedures.

16.2.8 Unless otherwise specified, NDT tests shall be witnessed by the Owner.

16.3 **Welding**

16.3.1 All welding involved in the manufacturing of Materials shall be carried out in accordance with applicable codes or approved equal.

16.3.2 Welding Procedure and welder's qualifications shall be approved by the Owner, where applicable. Welders shall be tested as detailed in codes specified for pipe welding, vessel welding and structural welding and appropriate to the corresponding weld position using test pieces of appropriate parent metal to be used on the job. The Owner shall have the right to have any welder retested at any time during this Contract.

16.3.3 Approved methods of radiographic, ultrasonic or other non-destructive testing shall be carried out for the welding of seams in pipes and vessels. Recommendations of codes specified shall be followed where applicable

16.3.4 Weld coupon plates shall be tested subsequent to heat treatment.

16.3.5 Copies of all welding procedures, preheating, post-heating and stress relieving records, NDT records and other test results shall be made available upon request to the Owner.

16.3.6 Fabrication/inspection procedures for vessels, heat exchangers, pipes, tubes, valves, etc. shall be in accordance with codes specified or any other approved equal.

16.3.7 If the Contractor has special requirements relating to the welding procedures for welds at the terminals of the equipment to be procured by the Owner under separate specifications, the requirements shall be submitted to the Owner well in time.

16.4 Price for all inspection and tests to be carried out till Final Acceptance of Facility and during Warranty Period are included in Contract Price.

16.5 Nothing in this Clause 14.0 shall, in any way, release the Contractor from any of its Warranty or other obligations under this Contract.

17.0 **COMPLETION OF SUPPLY AND FINAL ACCEPTANCE OF FACILITY**

17.1 After Completion of Trial Operation and after satisfying itself about satisfactory completion of supply of Materials, Owner shall issue a final acceptance certificate to the Contractor (the **"Completion of Supply of Materials"**).

17.2 After Completion of Supply of Material, Owner shall take-over the Materials from Contractor. Upon taking over of the Materials, Owner shall become responsible for care, custody, operation and maintenance of Materials (the **"Taking-Over of Material"**).

18.0 **INDEMNIFICATION**

18.1 **Indemnification by Contractor**

18.1.1 Contractor agrees to defend, indemnify and hold harmless the Owner, its Affiliates, and all of their directors, officers, employees, agents and representatives ("**Owner Indemnified Parties**"), from and against any and all Losses arising:

18.1.1.1 By reason of Contractor's actual or asserted failure to comply with any Applicable Law or any provision of this Contract. If the Contractor fails to comply with the requirements mentioned above and as a result fines, penalties or other assessments are imposed upon either the Contractor or the Owner by any Government Agency under any Applicable Law, then the Contractor shall be liable to pay all such fines, penalties or other assessments;

18.1.1.2 From actual or asserted violation or infringement of rights in any patent, copyright, proprietary information, trade secret or other property right caused or alleged to be caused by the use of materials, equipment, methods, processes, designs or information supplied by Contractor or its Subcontractors in performance of its obligations under this Contract. Should any Materials supplied by Contractor become, or appear likely to become, the subject of a claim of infringement of a patent, copyright or other property right, Contractor shall, at the Owner's option, either procure for the Owner the right to continue using such Materials or replace same with equivalent, non-infringing Materials, provided that any such replacement is of equal quality as the infringing Materials;

18.1.1.3 From injury to or death of any Person (including employees of the Owner, Contractor and Contractor's Subcontractors or any third party) or from damage to or loss of property (including the property of the Owner or a third party) arising directly or indirectly out of this Contract or out of any acts of omission or commissions of Contractor or its Subcontractors. Contractor's indemnity obligations hereunder include claims and damages arising from non-delegable duties of the Owner or arising from use by Contractor of facilities furnished to Contractor by the Owner; or

18.1.1.4 From present or future Environmental Claims directly or indirectly related to or arising out of the actual or alleged existence, generation, use, delivery, collection, treatment, storage, transportation, recovery, removal, discharge or disposal of Hazardous Material at the Plant and/or adjacent areas solely to the extent arising out of the gross negligence or Willful Misconduct of the Contractor, its Subcontractors in the performance of its obligations under this Contract.

18.1.2 Contractor's indemnity obligations shall apply regardless of whether the Owner Indemnified Party was concurrently negligent, whether actively or passively, excepting only where the Losses are caused solely by the negligence or Willful Misconduct of, or by defects in design furnished by the Owner Indemnified Party. Contractor's defense and indemnity obligations shall include the duty to reimburse any attorneys' fees and expenses incurred by the Owner Indemnified Party for legal action to enforce Contractor's indemnity obligations.

18.1.3 With respect to claims by employees of Contractor or its Subcontractors on the Owner Indemnified Party, the indemnity obligations created under this Clause 18.1 shall not be limited by the fact of, amount, or type of benefits or compensation payable by or for Contractor, its Subcontractors under any workers' compensation, disability benefits, or other employee benefits acts or regulations, and Contractor waives any limitation of liability or immunity arising from workers' compensation or such other acts or regulations.

18.1.4 The Owner shall be entitled to retain from payments otherwise due to Contractor such amounts as shall reasonably be considered necessary to satisfy any claims, suits or liens for damages that fall within Contractor's indemnity obligations under this Clause 18.1, until such claims, suits or liens have been settled and satisfactory evidence to that effect has been furnished to the Owner.

18.1.5 Contractor acknowledges that specific payment has been incorporated into the Contract price as legal consideration for Contractor's indemnity obligations as provided in this Contract.

18.2 **Indemnification by Owner**

18.2.1 Owner agrees to defend, indemnify and hold harmless the Contractor, its Affiliates, and all of their directors, officers, employees, agents and representatives ("**Contractor Indemnified Parties**") from and against any and all Losses arising out of or resulting from claims of third parties for any damage to or destruction of property of, or death of or bodily injury to, any Person due to any gross negligence or Willful Misconduct of the Owner in the course of performance of its obligations under this Contract; provided that the foregoing obligations shall not apply to the extent the Contractor Indemnified Parties are negligent or to the extent such Losses are caused by the acts of omission or commissions of the Contractor Indemnified Parties.

18.3 **Defense of Claims**

18.3.1 The indemnifying Party shall be entitled, at its option, and expense and with counsel of its selection, to assume and control the defense of any claim, action, suit or proceeding in respect of, resulting from, relating to or arising out of any matter for which it is obligated to indemnify the other Party hereunder, provided it gives prompt notice of its intention to do so to the indemnified Party and reimburses the indemnified Party for the reasonable costs and expenses incurred by the indemnified Party in connection with the defense of such claim, action, suit or proceeding, prior to the assumption by the indemnifying Party of such defense.

18.3.2 Notwithstanding the provisions of Clause 18.3.1, unless and until the indemnifying Party acknowledges in writing its obligation to indemnify the indemnified Party and

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assumes control of the defense of a claim, suit, action or proceeding in accordance with Clause 18.3.1, the indemnified Party shall have the right, but not the obligation, to contest, defend and litigate, with counsel of its own selection, any claim, action, suit or proceeding by any third party alleged or asserted against such Party in respect of, resulting from, related to or arising out of any matter for which it is entitled to be indemnified hereunder, and the reasonable costs and expenses thereof shall be subject to the indemnification obligations of the indemnifying Party hereunder.

18.3.3 Neither Party shall be entitled to settle or compromise any such claim, action, suit or proceeding without the prior written consent of the other Party; provided, however, that after agreeing in writing to indemnify the indemnified Party, the indemnifying Party may settle or compromise any claim without the approval of the indemnified Party. Except where such consent is unreasonably withheld, if an indemnified Party settles or compromises any claim, action, suit or proceeding in respect of which it would otherwise be entitled to be indemnified by the other indemnifying Party without the prior written consent of the other indemnifying Party, the other indemnifying Party shall be excused from any obligation to indemnify the indemnified Party making such settlement or compromise in respect of such settlement or compromise.

18.3.4 Following the acknowledgment of the indemnification and the assumption of the defense by the indemnifying Party, the indemnified Party shall have the right to employ its own counsel and such counsel may participate in such action, but the fees and expenses of such counsel shall be at the expense of such indemnified Party.

18.4 In the event that the indemnity provisions in this Contract are contrary to the laws of India, then the indemnity obligations applicable hereunder shall be construed to be to the fullest extent allowed by Applicable Law.

18.5 Provision of this Clause 18.0 shall survive termination or expiry of this Contract.

19.0 **LIMITATION OF LIABILITY**

19.1 Both Owner and Contractor understand and agree that there shall be absolutely no personal liability on the part of any of the members, shareholders, officers, employees, directors, agents, authorized representatives or Affiliates of the Owner or Contractor for the payment of any amounts due hereunder, or performance of any obligations hereunder.

19.2 With the exception of those provision of this Contract providing for the payment of liquidated damages, neither the Contractor nor the Owner shall be liable to the other as a result of any action or inaction under this Contract or otherwise for any special, indirect, incidental or consequential losses such as but not limited to loss of profit, loss of revenue, loss of power, loss of opportunity, loss of goodwill, loss of contracts or cost of capital. It is hereby agreed that this limitation of liability shall not apply in respect of claims for which either Party is indemnified under Clause 18.0 (Indemnification). Nothing in this Clause 19.0 shall reduce the Contractor's liability for liquidated damages in accordance with the provisions of this Contract.

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19.3 The aggregate liability of the Contractor with respect to all claims arising out of or in connection with performance or non-performance of this Contract whether in contract, warranty, tort or otherwise shall not exceed the Contract Price, provided that this limitation shall not apply in case of negligence, Willful Misconduct or liabilities arising out of indemnity provisions in this Contract.

19.4 The provisions of this Contract constitute Contractor's and Owner's exclusive liability, respectively, to each other, and Contractor's and Owner's exclusive remedy, respectively, to each other, with respect to the obligations under this Contract.

20.0 **SUSPENSION**

20.1 Owner reserves the right, at its convenience, to suspend and reinstate performance of the whole or any part of this Contract without invalidating the provisions of this Contract. Orders for suspension or reinstatement of the performance of this Contract shall be issued to the Contractor in writing.

20.2 Upon receiving any such notice of suspension, Contractor shall promptly suspend further performance of this Contract to the extent specified, and during the period of such suspension shall take proper care of and protect all supplies Contractor has with it for performance of its obligations under this Contract. Upon the request of the Owner, the Contractor shall promptly deliver to the Owner copies of outstanding Subcontracts of Contractor and shall take such action with respect to such Subcontracts as may be directed by the Owner. Contractor shall use its best efforts to mitigate costs associated with suspension. Owner may, at any time, withdraw the suspension of performance of the Contract as to all or part of the suspended obligations by written notice to the Contractor specifying the effective date and scope of withdrawal, and Contractor shall resume diligent performance of its obligations for which the suspension is withdrawn on the specified effective date of withdrawal.

20.3 The Time for Completion shall be extended for a period equal to the duration of the suspension provided the suspension is not due to some default on the part of Contractor.

20.4 If such suspension continues for a continuous period of 180 (one hundred and eighty) days, at the end of such period, Contractor or Owner may, by a further 30 (thirty) days prior written notice, terminate the Contract and in such case Owner shall pay to the Contractor costs in accordance with Clause 32.6 of this Contract as if such termination was a termination under Clause 32.4 of this Contract.

21.0 **CHANGE IN CONTROL**

21.1 The current shareholding of the Contractor is provided in Annexure 6 (Current Shareholding of the Contractor). From the Effective Date no change in Control of the Contractor shall be permitted without the prior written consent of the Owner.

22.0 **PROGRESS REPORT AND APPLICABLE LABOR LAWS**

22.1 The Contractor shall submit formal written and quantitative reports to the Owner on the progress of the manufacturing and supply of Materials in a format approved by the Owner and in sufficient detail to permit the Owner to assess performance.

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Within 10 (ten) days of the submission of each such report and at such other times as the Owner may reasonably request, the Contractor and the Owner shall meet to discuss progress. Each monthly progress report shall be submitted no later than the 5th day of the month following that in respect of which it is made, but may report on actual progress only up to the 25th day of the month and anticipated progress thereafter. Monthly progress reports shall include the followings:

22.1.1 executive summary;

22.1.2 description of the design, engineering, procurement, manufacturing, inspection, testing and supply activities performed during the preceding month;

22.1.3 updated Project Schedule showing progress up to the end of the month (as percentages completion of the activities broken down into significant elements of the supply of Materials), current schedule of activities and targets for the next month;

22.1.4 design & engineering, procurement, raw material & components availability, manufacturing and inspection status for the previous month and current months showing planned vs. actual, monthly and cumulative.

22.1.5 updated billing schedule showing the billing and payment status and cash flow forecast;

22.1.6 areas of concern;

22.1.7 Corrective Action Plan;

22.1.8 such other information and supporting documentation as the Owner may reasonably request;

22.2 Contractor shall submit six (6) hard copies and one soft copy of the progress report.

22.3 All progress review meeting shall be held at Palatana or New Delhi as advised by Owner.

22.4 In the event performance of the Contract is not in compliance with the schedule established for such performance, Owner may, in writing, require the Contractor to submit its plan for schedule recovery, or specify in writing the steps to be taken to achieve compliance with such schedule, and/or exercise any other remedies under this Contract. Contractor shall thereupon take such steps as may be directed by Owner or otherwise necessary to improve its progress without additional cost to Owner.

22.5 **APPLICABLE LABOUR LAWS**

22.5.1 The Contractor shall comply with all the rules and regulations under the Applicable Law during the performance of the Services under this Contract.

22.5.2 The Contractor shall comply with all Applicable Laws with respect to employment of labour (issued by the Central Government or the State Government as the case may be).

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22.5.3 The Contractor shall *inter alia* comply with the provision of the Payment of Wages Act, 1936, Minimum Wages Act, 1948, Employees Liability Act, 1938, Workmen's Compensation Act, 1923, Industrial Disputes Act, 1947, Maternity Benefits Act, 1961, Employees' Provident Funds and Miscellaneous Provisions Act, 1952, Contract Labour (Regulation and Abolition) Act, 1970, Inter State Migrant Labour Act, 1979 and Employees State Insurance Act, 1948 or any modification thereof or any other law relating thereto and rules made there under from time to time.

22.5.4 The Contractor shall obtain all Permits required under Applicable Law in connection with the Contractor Staff employed by it for performing the Services including but not limited to licenses required under Contract Labour (Regulation and Abolition) Act, 1970 and rules made there under; the registration under the Employees' Provident Funds and Miscellaneous Provisions Act, 1952 and obtaining the Employee Provident Fund (EPF) Code. All registration and statutory inspection costs and expenses (including payment of fees), if any, in respect of the performance of the Services pursuant to this Contract shall be to the account of the Contractor.

22.5.5 The Contractor shall pay to the labour, employed by it, either directly or through Subcontractors, wages in accordance with the provisions of the Minimum Wages Act, 1948 and the Contract Labour (Regulation and Abolition) Act, 1970 as prevalent in Tripura.

22.5.6 The Contractor shall cover contract labourers to be engaged by them during the Term for the purpose of provident fund benefits as per rules under the Contract Labour (Regulation and Abolition) Act, 1970 and the Employees' Provident Funds and Miscellaneous Provisions Act, 1952.

22.5.7 The Contractor shall submit to the Owner on the 10th (tenth) day of every month a return on the prescribed form for the payment of wages under the provisions of the Minimum Wages Act, 1948 and the Contract Labour (Regulation and Abolition) Act, 1970 as prevalent in Tripura. Failure of the Contractor to submit such a form shall be considered as breach of this Contract.

22.5.8 If Owner as "Principal Employer" is held liable to pay contribution, etc. under any Applicable Law or court decision in respect of any Contractor Staff, then Contractor would reimburse the amount of contribution so paid by the Owner and in addition the Contractor shall keep the Owner fully indemnified in this regard.

22.5.9 In the event of the Contractor committing a default or breach of any of the provisions of the Applicable Law as mentioned in this Clause 22.5, as amended from time to time, or in furnishing any information or submitting or filling any form, register/slip under the provisions of such Applicable Law, the Owner shall be at liberty to take recourse to any action it may deem fit, under the circumstances, to protect its own interest. Further, all amounts as may become due for payment to the concerned authorities/agencies on account of such defaults or breach shall be settled by the Owner after recovering the same from the Contractor. The Owner shall be entitled to deduct such amounts from the Contract Price payable to the Contractor under this Contract

23.0 SUBCONTRACTING & LIST OF COUNTRIES

23.1 Contractor shall not subcontract any portion of the Contract.

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23.2 Contractor shall ensure that supply of materials including repaired and replacement material are manufactured and shipped from the countries listed below in clause 23.4 (**"List of countries"**)

23.3 Contractor shall also ensure that any Firmware Upgrades, Patches, Hot Fixes etc. shall have been developed and tested in the countries listed under clause 23.4.

23.4 List of Countries

23.4.1 United States of America

23.4.2 Europe

23.4.3 Australia

23.4.4 India

23.4.5 Singapore

23.4.6 Malaysia

23.4.7 Thailand

23.4.8 Japan

23.4.9 Mexico

23.4.10 South Korea

23.5 Contractor shall furnish Owner original documents showing manufacturing and shipment details of the material. Any material manufactured and shipped other than the countries mentioned under clause 23.4 shall not be accepted. Contractor shall submit original Manufacturer's Authorization Form (MAF) as per format attached as Annexure-8.

24.0 **LIEN**

24.1 To the full extent permitted by Applicable Law, Contractor hereby waives and releases any and all rights of unpaid seller's lien and similar rights for payment for goods, equipment, or materials furnished by the Contractor in performance of the obligations hereunder and granted by Applicable Law to Persons supplying materials, equipment, goods and other things, which Contractor may have against the goods supplied under this Contract to the Owner.

24.2 Contractor shall at all times promptly pay for all services, materials, equipment and labor used or furnished by Contractor in the performance of the obligations under this Contract and supply of the Materials and shall, to the fullest extent allowed by Applicable Law, at its expense keep all properties belonging to the Owner, including the Materials after the title has been transferred to the Owner, free and clear of any and all of the above mentioned liens and rights of lien arising out of goods, equipment or materials furnished by Contractor or its employees, contractors or Subcontractors in the performance of the obligations under this Contract. If

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Contractor fails to release and discharge any lien or threatened lien against the property of the Owner arising out of performance of the obligations under this Contract within seven (7) days after receipt of written notice from the Owner to remove such claim of lien, the Owner may, at its option, discharge or release the claim of lien or otherwise deal with the lien claimant, and Contractor shall pay the Owner any and all costs and expenses of the Owner in so doing, including reasonable attorneys' fees incurred by the Owner.

25.0 **FORCE MAJEURE**

25.1 Force majeure is herein defined as any cause which is beyond the reasonable control of the Contractor or the Owner, as the case may be, which the affected Party could not foresee or with a reasonable amount of due diligence could not have foreseen, which could not have been prevented or overcome by the affected Party through the exercise of reasonable skill or care, which does not result from the affected Party's negligence or the negligence of its agents, employees or Subcontractors (as the case may be), and which substantially affects the performance of the obligations under this Contract ("**Force Majeure**"), such as:

25.1.1 Natural phenomena, including but not limited to floods, droughts, earthquakes, pandemics, epidemics, cyclone, lightning, storm, plague;

25.1.2 Lawful strikes and lawful lockouts and other generalized labour action occurring within India (excluding such events which are attributable to Contractor);

25.1.3 Act of terrorism or sabotage, act of any Government Agency, including but not limited to war (whether declared or undeclared), invasion or armed conflict, revolution, riot, civil commotion, quarantines, embargoes, in each case occurring inside India or directly involving India;

25.1.4 Radioactive contamination or ionising radiation or chemical contamination originating from a source in India or resulting from another Force Majeure event;

25.1.5 Fire or explosion, except as may be attributable to the Contractor;

25.1.6 An act of God;

25.1.7 Any act, failure to act, restraint or regulation, of any Government Agency (excluding actions that constitute remedies or sanctions lawfully exercised as a result of breach by the affected Party of any Applicable Law which is not discriminatory in nature); or

provided either Party shall within 7 (seven) days from the occurrence of any such cause notify the other Party in writing.

25.2 For avoidance of doubt, it is clarified that lack of funds shall not be construed as an event of Force Majeure.

25.3 Contractor shall not be entitled to, and hereby expressly waives recovery of, any damages suffered by reason of delays of any nature and extension of time shall constitute the sole remedy of the Contractor for delays under this Clause.

25.4 Neither Party shall be considered to have defaulted in the performance of any of its obligations under this Contract, when and to the extent such failure of performance shall be due to a Force Majeure event.

25.5 **Obligation to cure Force Majeure Diligently**

25.5.1 If either Party claims an event of Force Majeure, then the Party claiming the event shall:

25.5.1.1 Provide prompt notice and in any event within 7 (seven) days from the occurrence of such Force Majeure event, to the other Party of the occurrence of Force Majeure event, stating whether it claims relief under this Clause 25.0 by giving reasons of such event, expected duration of such event and probable impact of such event on the performance of its obligations hereunder;

25.5.1.2 Exercise all reasonable efforts to continue to perform its obligations hereunder;

25.5.1.3 Consult with the other Party, agree upon the action to be taken and expeditiously take action to correct or cure the event or condition excusing performance;

25.5.1.4 Exercise all reasonable efforts to mitigate or limit damages to the other Party to the extent such action will not adversely affect its own interests;

25.5.1.5 Furnish weekly reports with respect to its progress in overcoming the adverse affects of such event or circumstances; and

25.5.1.6 Provide prompt notice to the other Party of the cessation of the event or condition giving rise to its excuse from performance.

25.5.2 The affected Party shall not be obliged, when complying with its obligations under this Clause 25.5, to take any steps which would be beyond its reasonable control. The suspension of the obligations hereunder of the affected Party shall be of no greater scope and no longer duration than is reasonably necessitated by the Force Majeure event.

25.6 So long as the affected Party has at all times since the occurrence of the Force Majeure event complied with the obligations of Clause 25.5 and continues to so comply then, the affected Party shall not be liable for any failure or delay in performing its obligations under or pursuant to this Contract during the existence of a Force Majeure event; provided, however, that no relief shall be granted to the affected Party pursuant to this Clause 25.6 to the extent that such failure or delay would have nevertheless been experienced by the affected Party had the Force Majeure event not occurred.

25.7 If the performance of this Contract is prevented, hindered or delayed for a continuous period of 180 (one hundred eighty) days from the beginning of a Force Majeure event or for an aggregate period of more than 270 (two hundred seventy) days during the Term, due to a Force Majeure event, then the Parties shall mutually decide further course of action. If mutual settlement cannot be arrived at within 30 (thirty) days, either Party shall have the right to terminate this Contract in accordance with Clause 32.3.2.

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26.0 **REPRESENTATIONS AND WARRANTIES**

26.1 The Contractor represents and warrant that:

26.1.1 The Contractor is a company duly organized, validly existing and in good standing under the jurisdiction of its incorporation. The Contractor has full power, authority and legal right to execute and deliver and perform its obligations under this Contract. This Contract has been duly executed by its legal representative and constitutes a legal, valid and binding obligation of the Contractor, enforceable in accordance with its terms except to the extent that such enforcement may be limited by any Bankruptcy Event, agreement of creditors, insolvency, moratorium or similar laws affecting generally the enforcement of lenders rights;

26.1.2 The execution and delivery of, and performance by, the Contractor of its obligations under this Contract are not in violation of, or in conflict with, any provision of the Contractor's organizational or authorizing documents, and do not constitute a default under any contracts, agreements or other instruments to which the Contractor is a party or by which it is bound, and are not in violation of, or in conflict with, any term or provision of any law applicable to it;

26.1.3 The Contractor is not in default under any loan agreement, mortgage, deed of trust, indenture executed by it or any other agreement evidencing indebtedness to which it is a party or by which it or its property is bound or affected to the lenders;

26.1.4 There is no legal action, suit, proceeding, inquiry or investigation against the Contractor before or by any Government Agency or such other relevant authority as per laws applicable to it, of which the Contractor has received legal notice or of which it has otherwise become aware, that could adversely affect its ability to comply with its obligations under this Contract;

26.1.5 The Contractor has reviewed or examined and has the requisite knowledge and understanding with respect to the Site, the Technical Specifications, and all other factors and conditions affecting the performance of the Contractor's obligations under this Contract and accepts the same and agrees that the Site, the battery limits and such specifications, information, requirements, obligations, rules and procedures are satisfactory and will not prevent or impair or have any adverse effect on the performance by the Contractor of its obligations under this Contract;

26.1.6 It is fully experienced and properly qualified to supply the Materials and perform its obligations hereunder, and that it is properly equipped, organized and financed to fulfill its obligations and responsibilities under this Contract; and

26.1.7 It is properly licensed and qualified to do business in all governmental jurisdictions in which the Materials are to be delivered. Upon written request by Owner, Contractor shall furnish to them such evidence as Owner may require relating to the Contractor's ability to fully perform the obligations under this Contract.

26.2 The Owner represents and warrant that:

26.2.1 The Owner is a company duly organized, validly existing under Applicable Laws. The Owner has full power, authority and legal right to execute and deliver and perform its obligations under this Contract. This Contract has been duly executed

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by its legal representative and constitutes a legal, valid and binding obligation of the Owner, enforceable in accordance with its terms except to the extent that such enforcement may be limited by any Bankruptcy Event, agreement of creditors, insolvency, moratorium or similar laws affecting generally the enforcement of Lender's rights;

26.2.2 The execution and delivery of, and performance by the Owner of its obligations under this Contract are not in violation of, or in conflict with, any provision of the Owner's organizational or authorizing documents, and do not constitute a default under any contracts, agreements or other instruments to which the Owner is a party or by which it is bound, and are not in violation of, or in conflict with, any term or provision of any Applicable Law;

26.2.3 The Owner is not in default under any Loan Agreement, mortgage, deed of trust, indenture executed in relation to any Loan Agreement or any other agreement evidencing indebtedness to which it is a party or by which it or its property is bound or affected to the Lenders;

26.2.4 There is no legal action, suit, proceeding, inquiry or investigation against the Owner before or by any Government Agency of which the Owner has received legal notice and which adversely affects its ability to comply with its obligations under this Contract.

27.0 **WARRANTY AND WARRANTY PERIOD**

27.1 The Contractor hereby warrants to the Owner that the Materials supplied under this Contract shall (the "**Warranty**"):

27.1.1 comply strictly with the terms of this Contract, all specifications, drawings and standards referred to in the Technical Specifications or this Contract or furnished by the Owner hereafter, in accordance with Good Engineering & Manufacturing Practices and Applicable Law;

27.1.2 be first-class in every particular and free from defects and deficiencies in design, engineering, material and workmanship; and

27.1.3 shall be new, merchantable, of the most suitable grade and fit for their intended purposes.

27.1.4 shall not become obsolete or shall not be proclaimed as 'End of Life' by the Original Equipment Manufacturer (OEM) during Warranty Period.

27.1.5 shall not be proclaimed as 'End of Sale' by the OEM within 60 (sixty) months from the date of Final Acceptance of Material.

27.1.6 shall ensure availability of spares for a minimum of 15 (fifteen) years from the date of Final Acceptance of Material.

27.2 Contractor shall be liable for any defects in the Materials supplied and workmanship of the Services provided by it for a period of 60 (Sixty) months after the date of Completion of Supply of Materials and Taking-Over of Materials by the Owner (the "**Warranty Period**").

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27.3 Without limitation of any other rights or remedies of the Owner, if any defect in the Materials supplied and Services provided under this Contract in violation of the foregoing warranties arises within the Warranty Period, Contractor shall, upon receipt of written notice of such defect, at no cost to the Owner, promptly furnish replacement Materials or parts thereof necessary to correct such defect or repair/modify the defective Materials, so as to meet the specifications.

27.4 If any replacement, repair or modification is of such a character which may affect the subsequent performance of the Facility or any part thereof in accordance with the Technical Specifications, Owner may within 30 (thirty) days after such replacement, repair or modification give to the Contractor notice requiring the Contractor to demonstrate the adequacy and efficacy of the replacement, repair or modification.

27.5 In the event Contractor shall have been notified of any defects in the Materials in violation of Contractor's foregoing warranties and its has failed to promptly and adequately correct such defects, Owner shall have the right to correct or to have such defects corrected for the account of Contractor, and Contractor shall promptly pay to the Owner the costs incurred in correcting such defects. In the event the Contractor replaces the defected Materials, then such replaced Materials, as the case may be, shall be warranted by the Contractor in accordance with the warranties set forth in Clause 27.1 for a period of 60 (sixty) months from the date of replacement of such Materials, as the case may be.

27.6 Contractor shall include, as a minimum, the foregoing warrantee requirements in any Subcontract that it executes.

27.7 The acceptance of the Materials, as the case may be, by the Owner shall in no way relieve the Contractor of its obligation under this Clause.

27.8 In respect of goods supplied by the Subcontractors to the Contractor where a longer warranty (more than 60 (sixty) months) is provided by Subcontractors, the Owner shall be entitled to the benefit of such longer warranty period.

27.9 At the end of Warranty Period set forth in clause 27.2 above, Contractor's liability ceases except for the Latent Defects. The Contractor's liability for Latent Defects shall be limited to a period of ten (10) years from the date of Final Acceptance of Materials.

27.10 Contractor shall take back to back support / agreement from OEM to meet the Service Level Agreements (SLA) as defined in Technical Specification. Contractor shall furnish evidence of such support Contract with OEM with respect to this Contract.

27.11 Contractor shall furnish Warranty / support certificates from OEMs for all equipments, software etc.

27.12 The Contractor shall be responsible for payment of all costs, taxes (including all indirect taxes) and duties incurred in the course of performance of its obligations under this Clause 27.0.

28.0 **CONTRACTOR TO INFORM ITSELF FULLY**

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28.1 Contractor shall be deemed to have carefully examined the Technical Specifications, the Site location and the Plant and fully acquainted itself with Site conditions and all other conditions relevant to the performance of this Contract. Contractor shall be deemed to have assumed the risk of such conditions and will, regardless of such conditions or negligence of the Owner, if any, fully complete the supply of Materials for the Contract Price without further recourse to the Owner. Information on the Site and local conditions at such Site, furnished by the Owner in specifications or otherwise is not guaranteed by the Owner and is furnished only for the convenience of the Contractor.

28.2 The Contractor acknowledges that the Technical Specifications provided by the Owner may not be complete in every detail. Contractor shall comply with their manifest intent and general purpose, taken as a whole, and shall not make use of any errors or omissions therein to the detriment of the Owner. In the event the Contractor, in the performance of its obligations hereunder, encounters or comes across any conflict, error, omission or discrepancy in the specifications of the Materials, or in Site conditions, the Contractor shall promptly notify Owner in writing and Owner shall issue written instructions to be followed in relation to such conflict, error, omission or discrepancy. If Contractor proceeds with the supply of Materials prior to receiving such instructions, then required corrections shall be at Contractor's expense.

29.0 **CHANGE / VARIATION ORDER**

29.1 The scope of supply of Materials shall be subject to change by additions, deletions or revisions thereto by Owner. Contractor shall be notified of such changes by providing additional and / or revised drawings, specifications, exhibits or other written notification.

29.2 Contractor shall inform Owner, within three (3) days of receipt of notification of change, about impact of notified change on Contract Price and / or Time for Completion. Within 10 days of notifying impact of change, Contractor shall submit to Owner:

29.2.1 price of performing change along with material take-off, detailed calculations of price for performing change and supporting documents, for cases requiring amendment of Contract Price; and

29.2.2 modified Time for Completion along with necessary justification, for cases requiring amendment of Time for Completion.

29.3 Contractor shall not perform changes in the scope of supply of Materials notified in accordance with Clause 29.1 until Owner has approved in writing the price for performing changes and any adjustment in the Time for Completion for performing change, except as set forth in Clause 29.4 and 29.5.

29.4 Notwithstanding Clause 29.3, Owner may expressly authorize Contractor in writing to perform the change prior to approval of price for change and / or modification of Time for Completion. Contractor shall not suspend supply of Materials during the review and negotiation of any change, except as may be directed by Owner pursuant to Clause 20.0 (Suspension of Services). In the event Owner and

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Contractor are unable to reach timely agreement regarding any change, Contractor shall comply with Clause 30.0 (Claims).

29.5 Contractor shall perform only such changes in the scope of supply of Materials which have been notified in writing. If any oral notice or instruction received from Owner involves change in the Contract Price, or Time for Completion, Contractor shall forthwith ask Owner to notify such instructions in writing. Any costs incurred by Contractor in performing such changes not notified in writing shall be to Contractor's account. Contractor waives any and all rights to claim compensation from Owner for performing such changes in scope of supply of Materials not notified in writing by Owner.

30.0 **CLAIM**

30.1 If, for any reason, Contractor considers that an event has occurred pursuant to which it has a right to claim compensation from Owner or an extension of Time for Completion, Contractor shall notify Owner in writing of the existence of such claim (the **"Claim"**) within three (3) days of occurrence of such event and within ten (10) days of notifying Claim, Contractor shall submit to Owner details of Claim as per provisions of Clause 30.2. Contractor shall substantiate its Claim with payroll documents, paid invoices, receipts, records of performance and other documents satisfactory to Owner and subject to its verification. Owner shall not be liable for, and Contractor hereby waives, any claim or potential claim which have not been notified by Contractor in accordance with provisions of this Clause 30.1.

30.2 After examining Claim submitted by Contractor, Owner shall determine admissibility of the Claim and the extent, if any, to which the Contract Price and Time for Completion is to be changed and outcome shall be informed to Contractor. If Contractor disputes Owner's decision and notifies Owner within five (5) working days of receiving Owner's Decision, Contractor may seek to resolve the dispute in accordance with Clause 34.0 (Settlement of Disputes). If Contractor decides to proceed pursuant to Clause 34.0 (Settlement of Disputes), Contractor agrees to limit its claim to the amount claimed by it in accordance with Clause 30.1. In no event shall any supply be halted, whether or not the claim can be resolved to Contractor's satisfaction, and Contractor shall be bound by the terms and conditions of this Contract to supply the Materials without delay till its successful completion.

30.3 The following shall not constitute changes and Contractor has no right to make any claim in relation thereto:

30.3.1 Instructions, interpretations, decisions or acts by Owner which are:

30.3.1.1 to achieve compliance with the Contract by Contractor; or

30.3.1.2 to correct errors, omissions, poor engineering, defective materials and workmanship or other failure of the Contractor to comply with the Contract;

30.3.2 Delay in the completing supply of Materials or any additional work caused by Contractor.

30.3.3 Any materials supplied by Contractor arising out of Owner's comments on Contractor's submittals to the extent that such comments are consistent with the Contract.

30.4 If Contractor fails to follow the requirements of Clause 30.1, it shall have waived any right to make any claim in respect of the events referred to in Clause 30.1. Contractor's sole remedy in respect of any claim will be as provided in Clause 30.2. No claim by Contractor in relation to events referred to in Clause 30.1 shall be allowed after final payment is made.

30.5 Owner shall not be bound to any adjustments in the Contract Price or scheduled time unless expressly agreed to by Owner in writing.

31.0 **BACKCHARGE**

31.1 A backcharge is a cost sustained by Owner and chargeable to Contractor for the Owner's performance of obligations that is the responsibility of Contractor.

31.2 Without limitation and by way of example only, backcharge may result from:

31.2.1 Obligations performed by the Owner, at Contractor's request, which are within Contractor's scope of supply of Materials under this Contract;

31.2.2 Costs sustained by the Owner as a result of Contractor's non-compliance with the provisions of this Contract or Contractor's act of omission or negligence; or

31.2.3 Costs incurred by the Owner to fix all defects, deficiencies or errors that may appear in the Materials during the Warranty Period.

31.3 Upon identification by the Owner of an actual or anticipated backcharge, the Owner will issue a backcharge notice to Contractor. This notice shall describe the backcharge work to be performed, the schedule period for performance, the cost to be charged by the Owner to Contractor for the backcharge and other terms.

31.4 A backcharge shall consist of:

31.4.1 Labor: at actual cost plus 25% (twenty five percent) to cover payroll additives;

31.4.2 Materials: at actual contractor and freight invoice cost delivered to jobsite;

31.4.3 Equipment: at actual third party rental cost or at Owner's equipment rental rates, whichever may be applicable;

31.4.4 Subcontracts: At actual cost;

31.4.5 All taxes, levies, duties and assessments attributable to the backcharge work; and

31.4.6 25% (twenty-five percent) shall be added to the foregoing for indirect costs, overhead, supervision and administration.

31.5 Within 24 (twenty-four) hours after receipt of the backcharge notice, Contractor shall fax back to the Owner a signed copy of the backcharge notice, indicating either

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acceptance of the backcharge or agreement to perform the described backcharge work within the indicated schedule period for performance, utilizing Contractor's supplied labor, material and equipment, as applicable.

31.6 Contractor will be required to sign the backcharge notice before commencement of the backcharge work by the Owner or others. In the event Contractor refuses to sign, Owner shall, at its option, proceed with the backcharge work and charge the backcharge cost to Contractor's account. 30 (thirty) days after commencement of the backcharge work or on completion of the backcharge work, whichever occurs earlier, Owner will invoice Contractor for the incurred backcharge cost and the Contractor shall forthwith pay the same.

32.0 **TERMINATION**

32.1 **Termination by Owner for Contractor's Event of Default**

32.1.1 Each of the following events, unless occurring solely as a result of breach by the Owner of its obligations under this Contract or a Force Majeure event, shall constitute an event of default and the Owner may terminate this Contract by giving 30 (thirty) days written notice of termination to the Contractor other than in case of Clauses 32.1.1.5 where the Owner may terminate this Contract by giving 7 (seven) days written notice ("**Contractor's Event of Default**"):

32.1.1.1 Contractor refuses or neglects to comply with any reasonable order given to it in writing by the Owner in connection with the obligations of the Contractor under this Contract;

32.1.1.2 Failure of the Contractor to perform its obligations under this Contract and supply Materials in a manner so as to achieve Completion of Supply of Materials as per the Time for Completion specified in Clause 10.2 and such failure continues after written notice is provided to the Contractor by the Owner and the Contractor has not cured such default within 30 (thirty) days from the date of such notice.

32.1.1.3 Failure of the Contractor to comply with or fulfill its Warranty obligations under Clause 27.0 (Warranty and Warranty Period);

32.1.1.4 Abandonment of its obligations under the Contract by the Contractor;

32.1.1.5 Contractor indulging in Corrupt Practices or Coercive Practices or Fraudulent Practices or Obstructive Practices during the signing of this Contract or during the Term in the opinion of the Owner;

32.1.1.6 Any Bankruptcy Event or insolvency of the Contractor; provided, that in the case of involuntary bankruptcy proceedings, the Contractor shall have 60 (sixty) days cure period after the commencement of such proceedings to stay or lift such proceedings;

32.1.1.7 Transfer or charge by the Contractor of any of its rights or obligations under this Contract without prior written consent of the Owner;

32.1.1.8 Any change in the Control of the Contractor which is not in accordance with Clause 21.0 (Change in Control);

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32.1.1.9 Any act or omission by the Contractor such that the Owner is or is likely to be or become in breach of any of its obligations under this Contract or constitutes or is likely to give rise to a Owner's event of default as mentioned under Clause 32.2;

32.1.1.10 Contractor ceases to carry on its business;

32.1.1.11 Failure of the Contractor to comply with an Arbitral Award within 30 (thirty) days of the Arbitral Award or within such time as prescribed under such award, whichever is earlier;

32.1.1.12 Contractor has incurred or is liable for liquidated damages in excess of the amount set out in Clause 11.6;

32.1.1.13 A breach by the Contractor of any of the terms of the contracts for providing civil construction works and installation services dated on or about the date of this Contract;

32.1.1.14 Failure by the Contractor to perform any obligation under this Contract with due diligence and expedition including any breach of Applicable Laws and such failure continues after written notice is provided to the Contractor by the Owner; provided, that the Contractor shall have up to 30 (thirty) days after such notice is given to cure such default or to diligently commence and continue in good faith to cure such default prior to any such termination (provided that in no event shall such cure period exceed 120 (one hundred and twenty) days including the 30 (thirty) days of notice period); or

32.1.1.15 If any of the representations and warranties provided by the Contractor under Clause 26.1 or during the negotiation of this Contract is incorrect, false or misleading.

32.2 **Termination by Contractor for Owner's Event of Default**

32.2.1 Each of the following events, unless occurring as a result of a breach by the Contractor of its obligations under this Contract or a Force Majeure event, and subject to the conditions defined elsewhere in this Contract shall constitute an event of default and the Contractor may terminate this Contract by giving 30 (thirty) days written notice of termination to the Owner ("**Owner's Event of Default**"):

32.2.1.1 Failure by the Owner to pay to the Contractor any undisputed amount due and payable under this Contract, which is not less than 25% (twenty-five percent) of the Contract Price and that remains unpaid for a period of 90 (ninety) days or more from the due date for such payment;

32.2.1.2 Any willful and persistent material breach of this Contract by the Owner and such breach continues for 60 (sixty) days after written notice is provided to the Owner by the Contractor; provided, that the Owner shall have further 30 (thirty) days after such expiry of above period to cure such breach or to diligently commence and continue in good faith to cure such breach prior to any such termination; or

32.2.1.3 Any Bankruptcy Event or insolvency of the Owner; provided, that in the case of involuntary bankruptcy proceedings, the Owner shall have 60 (sixty) days cure

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period after the commencement of such proceedings to stay or lift such proceedings.

32.3 **Termination due to Force Majeure Events**

32.3.1 The Owner shall have a right to forthwith terminate this Contract if the performance of this Contract is prevented, hindered or delayed due to a Force Majeure event for a continuous period of 90 (ninety) days from the beginning of a Force Majeure event.

32.3.2 If the performance of this Contract is prevented, hindered or delayed due to a Force Majeure event for a continuous period of 180 (one hundred eighty) days from the beginning of a Force Majeure event or for an aggregate period of more than 270 (two hundred seventy) days during the Term of this Contract, and the Parties cannot mutually decide further course of action within 30 (thirty) days thereafter, either Party shall have the right to terminate this Contract by giving the other Party a 30 (thirty) days written notice of termination.

32.4 **Termination for Convenience by Owner**

32.4.1 Owner may terminate this Contract without assigning any reason by giving thirty (30) days written notice of termination to the Contractor.

32.5 **Termination Procedure**

32.5.1 Notice of termination shall be given to the other Party specifying the termination date with effect from which this Contract shall be terminated ("**Termination Date**") except for the obligations or duties that are stated to survive termination or are to be carried out after termination or owed by a Party at the time of or as a result of such termination. Termination notice shall also specify in reasonable detail the circumstances giving rise to termination of this Contract.

32.6 **Payment on Termination**

32.6.1 Owner shall not be liable to make any further payments to the Contractor until the costs of execution and all other expenses incurred by the Owner in completing the scope of supply of Materials have been ascertained (the **"Cost of Completion"**). If the Cost of Completion when added to the total amounts already paid to Contractor as at the date of termination exceeds the total amount which would have been payable to the Contractor for supply of Materials, the Contractor shall upon demand, pay to the Owner the amount of such excess. Any such excess shall be deemed a debt due by the Contractor to the Owner and shall be recoverable accordingly. If there is no such excess the Contractor shall be entitled to be paid the difference (if any) between the Cost of Completion and the total of all payments received by the Contractor as on the date of termination.

32.6.2 In the event of termination for convenience by Owner as per Clause 32.4, the Contractor shall be paid compensation, equitable and reasonable, dictated by the circumstances prevalent at the time of termination.

32.6.3 Contractor shall not be entitled to any prospective profits or any damages.

32.7 **Obligation upon Termination**

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32.7.1 Contractor shall discontinue supply of Materials from the Termination Date.

32.7.2 Contractor shall advise Owner of its outstanding Subcontracts pertaining to performance of the terminated supply of Materials and, upon request, furnish Owner with complete copies.

32.7.3 Contractor shall place no further Subcontracts except as may be necessary for completion of such portion of the scope for supply of Materials which is not terminated.

32.7.4 Contractor shall promptly make every reasonable effort to procure cancellation, upon terms satisfactory to Owner, of all Subcontracts to the extent they relate to the scope for supply of Materials terminated or, as directed by Owner, shall assign them to Owner, in form satisfactory to Owner, such of its Subcontracts as are designated by Owner or shall take such other action relative to such Subcontracts as may be directed by Owner.

33.0 **GOVERNING LAW AND JURISDICTION**

33.1 This Contract shall be governed by the laws of India.

33.2 The courts of New Delhi shall have exclusive jurisdiction in all matters arising under this Contract, including execution of arbitration awards.

33.3 The United Nations convention on contracts for the international sale of goods does not apply to this Contract.

34.0 **SETTLEMENT OF DISPUTES**

34.1 The Parties hereto agree that any dispute or difference arising out of or in connection with this Contract shall, to the extent possible, be settled promptly and amicably between the Parties. Parties further agree to provide each other with reasonable access during normal business hours to any and all non-privileged records, information and data pertaining to any such disputes.

34.2 All unsettled disputes or differences arising out of or in connection with this Contract which cannot be amicably resolved by the Parties shall in the first instance be decided by the Owner in accordance with provisions of Clause 34.3 below.

34.3 **Owner's Decision**

34.3.1 If any dispute or difference of any kind whatsoever shall arise between the Owner and the Contractor, arising out of this Contract whether during the performance of the obligations under this Contract or after its completion or whether before or after the termination, Abandonment or breach of this Contract, such dispute or difference cannot be amicably settled by the Parties in accordance with Clause 34.1, it shall, in the first place, be referred to and settled by the Managing Director of the Owner, who, within a period of 30 (thirty) days after being requested to do so, shall give written notice of its decision to the Contractor.

34.3.2 Save as hereinafter provided, such decision in respect of every matter so referred shall be final and binding upon the Parties until the Completion of Supply of Materials under this Contract and shall forthwith be given effect to by the Parties

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who shall comply with all such decisions, with all due diligence, whether it requires arbitration, as hereinafter provided or not.

34.3.3 If after the Owner has given written notice of its decision to the Contractor and no notice for arbitration has been communicated to it by the Contractor within 30 (thirty) days from the receipt of such notice, the said decision shall become final and binding on the Parties.

34.3.4 The Owner's decision (or the failure of the Owner to give decision within the time specified in Clause 34.3.1) and issuance of a written notice for arbitration pursuant to Clause 34.3.3 shall be a condition precedent to the right to request arbitration. It is the intent of this Contract that there shall be no delay in the performance of obligations and the decision of the Owner, as rendered, shall be promptly observed.

34.3.5 In the event of the Owner failing to notify its decision, as aforesaid, within 30 (thirty) days after being requested, or in the event of a Party being dissatisfied with any such decision, either Party may require that the matters in dispute be referred for arbitration as provided in Clause 34.4.

34.4 **Arbitration**

34.4.1 All disputes or differences in respect of which the decision, if any, of the Owner has not become final or binding as aforesaid, shall be settled by arbitration, under and in accordance with the provisions of the Indian Arbitration and Conciliation Act, 1996 (the "**Arbitration Act**") or any statutory modification, in the manner hereinafter provided. The Place, Venue and Seat of arbitration shall be New Delhi, India.

34.4.2 The arbitration shall be conducted in accordance with the Arbitration Act by 3 (three) arbitrators, 1 (one) each to be nominated by the Contractor and the Owner and the 3rd (third) to be nominated by the 2 (two) arbitrators nominated by the Parties at the commencement of arbitration proceedings. The 3rd (third) arbitrator so appointed shall act as the presiding arbitrator.

34.4.3 If one Party fails to appoint its arbitrator within 30 (thirty) days after the other Party has named its arbitrator, the Party which has named an arbitrator may request the President of the Institution of Engineers to appoint the second arbitrator on behalf of such Party. If the 2 (two) arbitrators appointed by both Parties do not succeed in appointing a 3rd (third) arbitrator within 30 (thirty) days after the latter of the 2 (two) arbitrators has been appointed, the 3rd (third) arbitrator shall, at the request of either party, be appointed by the Chairman of OTPC.

34.4.4 The decision of the majority of the arbitrators ("**Arbitral Award**") shall be final and binding upon the Parties. The expense of the arbitration shall be paid as may be determined by the arbitrators. The arbitrators may, from time to time, with the consent of both the Parties increase the time for making the award. In the event of any of the aforesaid arbitrators dying, neglecting, resigning or being unable to act for any reason, it will be lawful for the Party concerned to nominate another arbitrator in place of the outgoing arbitrator.

34.4.5 The arbitrators shall have full powers to review and/or revise any decision, opinion, directions, certification or valuation of the Owner in consonance with this Contract, and neither party shall be limited in the proceedings before such arbitrators to the

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evidence or arguments put before the Owner for the purpose of obtaining the said decision.

34.4.6 No decision given by the Owner in accordance with the foregoing provisions shall disqualify it from giving evidence before the arbitrators on any matter whatsoever relevant to the dispute or difference referred to the arbitrators as aforesaid.

34.5 During settlement of disputes including arbitration proceedings, both Parties shall be obliged to carry out their respective obligations under this Contract.

34.6 Parties agree that neither Party to this Contract shall be entitled for any interest on the amount of award.

34.7 The provisions of this Clause 34.0 shall survive termination of this Contract.

35.0 **CHANGE IN LAW**

35.1 If after the Effective Date there is a Change in Law which is expected to result in the increase or decrease in the Contract Price by an amount of Rs. 500,000 (Rupees Five Lakh Only) or more, then either Party may request the other for a revision of the Contract Price in accordance with Clause 35.2, to reflect any such increase or decrease in costs. Such additional or reduced costs shall not be separately paid or credited if the same has already been accounted for in the Contract Price.

For the avoidance of doubt, it is clarified that any revision to the Contract Price would be restricted to direct transactions between the Parties.

35.2 In case of a Change in Law affecting the Contract Price, the Contractor or the Owner, as the case may be, shall provide notice to the other, of such request, setting forth the proposed amount of, and the relevant details and calculations relating to, such increase or decrease in the Contract Price. Promptly upon, and in any event within 7 (seven) days of, the Contractor or the Owner, as the case may be, receiving such request (such date of receipt the **"Change in Law Request Date"**), the Parties shall discuss such proposed increase or decrease, in good faith and within 60 (sixty) days of the Change in Law Request Date, mutually agree upon a revised Contract Price.

36.0 **ASSIGNMENT**

36.1 Except as expressly provided in this Clause, neither Party may assign its rights or obligations hereunder directly or indirectly, whether by pledge, assignment, sale of assets or sale or merger (statutory or otherwise), without the prior written consent of the other Party.

36.2 Notwithstanding the foregoing, it is agreed that, without the consent of the Contractor:

36.2.1 The Owner may assign or create a security interest over its rights and interest under or pursuant to this Contract or any movable property of the Owner or any rights or assets of the Owner, in favour of any of the Lenders; or

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36.2.2 The Owner may assign this Contract or its rights or obligations hereunder to any Subsidiary or Affiliate of the Owner.

36.3 The holder of any security interest in this Contract shall not be prevented or impeded by the Contractor from enforcing such security interest. The Contractor shall execute all consents to assignment and/or acknowledgements of any security interest as are requested by the Owner to give effect to the foregoing or to perfect any security interest, and shall provide such certificates and opinions of counsel addressed to the Owner and the Lenders as may be requested in connection with any financing of the Plant. The Contractor agrees that such consents and acknowledgements shall, *inter alia*, include:

36.3.1 an agreement by the Contractor to allow the holder of such security interest to cure defaults by the Owner;

36.3.2 an acknowledgement by the Contractor that the Owner is not in default under this Contract due to such assignment;

36.3.3 representations and warranties by the Contractor;

36.3.4 a prohibition against amending, assigning or terminating this Contract without the written consent of the holder of such security interest; and

36.3.5 a consent by the Contractor to allow the assignment of the Contract to the successors-in-interest of the holder of such security interest after foreclosure hereon.

36.4 The Contractor acknowledges and agrees that the Lenders and providers of insurance will review this Contract and may require changes there to as a condition for providing financing and/or insurance, and the Contractor agrees to consider any such requirements in good faith and otherwise to co-operate with the Lenders/insurers in executing such amendments to this Contract or providing such other letters of consent and comfort as may be reasonably requested by the Lenders/insurers.

37.0 **RELEASE OF INFORMATION**

37.1 The Contractor shall not communicate or use in advertising, publicity, sales releases or in any other medium, photographs or other reproduction of, or description of the Site or the Plant, dimensions, quantity, quality or other information, concerning this Contract, the Plant, the Site or the Project unless prior written permission has been obtained from the Owner.

38.0 **CONFIDENTIAL INFORMATION**

38.1 Subject to Clause 38.2, each Party shall keep all documents, data, photographs, technical information or other information provided directly or indirectly by the other Party in connection with this Contract ("**Confidential Information**") private and confidential for a period of 6 (six) years from the Effective Date and shall not, without the consent of the other Party, publish or divulge to any third party, any Confidential Information or any particulars thereof, whether such Confidential

Information has been provided prior to, during or following termination of this Contract.

38.2 Each Party shall be entitled to disclose the Confidential Information without the prior written consent of the other Party, if such Confidential Information:

38.2.1 was furnished prior to this Contract without restriction;

38.2.2 is or becomes available within the public domain (other than by breach of the foregoing obligation of confidentiality);

38.2.3 is received by either Party from a third Party without restriction and not in breach of this Contract;

38.2.4 is independently developed by either Party;

38.2.5 is required to be provided to any contractors/subcontractor, subject to inclusion of terms similar to the provision of this Clause 38.0 in the agreement with such contractor/subcontractor;

38.2.6 is required to be provided to the Lenders;

38.2.7 if and to the extent required to be provided by the rules of a relevant and recognized stock exchange or securities commission;

38.2.8 if and to the extent required to be provided under Applicable Law or pursuant to an order of any court of competent jurisdiction provided that the original disclosing Party is given notice and adequate time to seek a protective order applicable to the information, if practicable, before it is disclosed;

38.2.9 if and to the extent required to enforce any right or remedies under this Contract;

38.2.10 if required to be provided to any insurer under a policy of insurance related to this Contract;

38.2.11 if required to be provided to directors, employees and officers of such Party provided that the disclosing Party determines in good faith that the recipient has a legitimate need to see such Confidential Information; and the recipient has been made aware of and has agreed to be bound by the requirements of this Clause 38.0;

38.2.12 in case of the Owner, if required to be provided to any of its Affiliates; or

38.2.13 in case of the Owner, if required to be provided to such other parties to whom the Owner may be reasonably required to disclose such information.

38.3 **Confidentiality of Intellectual Property and Information**

38.3.1 Each Party shall:

38.3.1.1 make available to the other Party without charge such materials, documents and data as would normally be made available to the other Party in connection with the supply obligations hereunder (except any internal cost accounting or cost reporting

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data or any materials documents and data protected by legal privilege or which is subject to any duty of confidentiality to any third party) acquired or brought into existence in any manner whatsoever by each of them in connection with the Contract as the other may reasonably request for the purposes of exercising its rights or carrying out its duties or performing its obligations under this Contract; and

38.3.1.2 use all reasonable endeavors to make available such materials and documents and data acquired or brought into existence by third parties as the other Party may reasonably request for the purpose referred to in Clause 38.3.1.1 above and as would normally be made available by Persons acting in accordance with Good Engineering & Construction Practice.

38.3.2 Neither Party shall without the prior written authority of the other Party publish alone or in conjunction with any other Person any article or other material relating to any dispute arising under this Contract nor impart to any radio or television program or any other medium any information regarding any such dispute.

38.3.3 All documents, papers, computer discs, magnetic tapes or other records made or created wholly in relation to the performance by the Contractor of its obligations under this Contract containing Confidential Information shall be and remain the property of the Owner, and shall be handed over by the Contractor to the Owner during the Term on the Owner giving the Contractor 2 (two) days notice and in any event immediately on the termination or expiry of this Contract.

39.0 INTELLECTUAL PROPERTY

39.1 Ownership and License of Intellectual Property

39.1.1 If any intellectual property is developed by the Contractor and/or its employees, agents, Contractor, representatives or Subcontractors for the purpose of performing the obligations under this Contract during the Term, such intellectual property shall belong to the Owner.

39.1.2 The Owner shall, subject to any applicable third party restrictions, grant the Contractor during the Term a royalty-free, non-exclusive, personal and non-transferable license to use the intellectual property which is owned by or licensed to the Owner by third parties only to the extent necessary to enable the Contractor to perform its obligations under this Contract. Such licenses shall not carry the right to grant sublicenses.

40.0 PATENT RIGHTS AND ROYALTIES

40.1 Royalties and fees for patents covering materials, articles, apparatus, devices, equipment or processes relating to the Materials shall be deemed to have been included in the Contract Price. Contractor shall satisfy all demands that may be made at any time for such royalties or fees and it alone shall be liable for any damages or claims for patent infringements and shall keep the Owner indemnified in that regard. Contractor shall, at its own cost and expense, defend all suits or proceedings that may be instituted for alleged infringement of any patent involved in the Materials, and, in case of an award of damages, Contractor shall pay for such award. In the event of any suit or other proceedings instituted against the Owner,

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the same shall be defended at the cost and expenses of Contractor who shall also satisfy/comply any decree, order or award made against Owner.

40.2 Contractor hereby represents to the Owner that, as of the Effective Date, Contractor has received no notification of any rightful patent infringement claim which would prejudice the Owner's right to use the Materials.

41.0 **FIELD QUALITY ASSURANCE AND INSPECTIONS**

41.1 To ensure the conformance of the Services, whether performed at the Site, by Contractor or by its Subcontractors, with the provisions of this Contract, Contractor shall adopt, as well as ensure adoption by its Subcontractor, suitable Field Quality Program. The Owner or its representative(s) shall have the right to inspect and/or to test the Services to check their conformity with the provisions of this Contract.

41.2 The Field Quality Program, proposed for adoption by the Contractor, shall be submitted for review and approval of the Owner, within 30 (thirty) days of the Effective Date. It shall *inter alia* specify required inspection and tests to be carried out by Contractor as per Contract and applicable codes for all phases of erection, testing and commissioning, the procedures involved, acceptance basis, acceptance criteria and customer hold points (CHPs) beyond which work shall not proceed, without the specific clearance of the Owner. The approved Field Quality Program shall form part of this Contract and shall be strictly adhered to.

41.3 In case of stage inspection, the Contractor shall proceed from one stage to another only after the component of the work is inspected and tested by the Owner or their representative(s) and permission given to proceed further. The procedure shall be adopted for any rectifications/repairs suggested by the Owner or their representative(s).

41.4 No part of the work shall be covered up without carrying out inspection and tests specified in the Field Quality Program. Contractor shall uncover such part of the work which have been covered up without carrying out inspection and tests specified in Field Quality Program and them up after carrying out inspection and tests specified in Field quality Program. Cost for such uncovering and covering up shall be borne by Contractor.

41.5 Contractor shall provide reasonable advance notice to Owner for witnessing inspection and tests specified in Field Quality Program.

41.6 Contractor shall provide at his own cost all facilities including labour, materials, electricity, fuel, water, stores, apparatus, instruments etc reasonably required by Owner and/or their representative for effectively carrying out such inspection and tests in accordance with the Contract and applicable codes.

41.7 Owner may ask Contractor to perform any such inspection and tests which are not specified in Contract and Field Quality Program. Contractor shall perform such inspection and tests and Owner shall pay to the Contractor reasonable cost incurred in carrying out such inspection and tests.

41.8 Contractor shall also be responsible for monitoring each Subcontractor's compliance with the Field Quality Program. The Owner shall have the right to conduct audits of

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the Contractor's Field Quality Program. Contractor shall cooperate with and extend all support to Owner in carrying out such audits.

41.9 Price for all inspection and tests to be carried out till Final Acceptance of Facility and during Warranty Period are included in Contract Price.

41.10 Inspection and acceptance of the Services by the Owner and / or their representative shall not limit the liabilities and responsibilities of the Contractor in any manner and shall not prejudice the right of the Owner to reject the Services if it is found to be defective subsequently or if Facility fails to achieve performance guarantee under the Contract. Nothing in this Clause 41.0 shall, in any way, release the Contractor from any of its Warranty or other obligations under this Contract.

42.0 **COMPLETION AND FINAL ACCEPTANCE OF FACILITY**

42.1 **Pre-commissioning Tests**

42.1.1 After successful completion of erection of Facility, Contractor shall notify the same to Owner and seek approval of Owner for proceeding with pre-commissioning tests specified in Technical Specifications (the **"Pre-commissioning Tests"**). Contractor shall proceed with Pre-commissioning Tests after receipt of approval from Owner.

42.1.2 Contractor shall submit to Owner for his approval, at least 7 (seven) days before scheduled start of Pre-commissioning Tests, procedures for Pre-commissioning Tests for each equipment and systems. Contractor shall proceed with Pre-commissioning Tests of all equipment & systems of the Facility as per approved procedure for Pre-commissioning Tests.

42.1.3 Owner shall inform Contractor about defects and deficiencies observed in equipments and systems during Pre-commissioning Tests. Contractor shall rectify such defects and deficiencies and re-perform Pre-commissioning Tests for defective equipments and systems.

42.1.4 After successful completion of Pre-commissioning Tests of each equipment and systems, test protocols shall be signed jointly by Owner and Contractor.

42.2 **Commissioning Tests**

42.2.1 After successful completion of Pre-commissioning Tests of the all the equipments and systems of the Facility and signing of test protocols, Contractor shall notify the same to Owner and seek approval of Owner for proceeding with commissioning tests. Contractor shall proceed with Commissioning Tests after receipt of approval from Owner.

42.2.2 Contractor shall submit to Owner for his approval, at least 7 (seven) days before scheduled start of Commissioning Tests, procedures for Commissioning Tests for each equipments and systems. Contractor shall proceed with Commissioning Tests of each equipments and systems of the Facility as per approved procedure for Commissioning Tests.

42.2.3 Owner shall inform Contractor about defects and deficiencies observed in equipments and systems during Commissioning Tests. Contractor shall rectify such

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defects and deficiencies and re-perform Commissioning Tests for defective equipments and systems.

42.2.4 After successful completion of Commissioning Tests of each equipment and systems of the Facility, test protocols shall be signed jointly by Owner and Contractor.

42.3 **Trial Operation**

42.3.1 After successful completion of Commissioning Tests of the Facility, Contractor shall notify the same to Owner and seek approval of Owner for proceeding with trial operation of the Facility specified in Technical Specification (the **"Trial Operation"**). Contractor shall proceed with Trial Operation after receipt of approval from Owner.

42.3.2 Minimum duration of Trial Operation shall be 3 (three) days during which Facility including all associated sub-systems and auxiliaries shall be run in integrated manner at rated full load / part load as made available by the Owner.

42.3.3 During Trial Operation, Facility shall necessarily be operated uninterruptedly for at least seventy two (72) hours at its rated full load.

42.3.4 In the event of interruptions to the Trial Operation, for which Contractor is responsible, Trial Operation shall be restarted.

42.3.5 As part of Trial Operation of the Facility, following shall be demonstrated by the Contractor:

42.3.5.1 Sustained capability of the Facility;

42.3.5.2 Reliability of the equipment and auxiliaries;

42.3.5.3 Adequacy of various auxiliaries, ancillaries and systems & controls;

42.3.5.4 Capability of each equipment of the Facility to correctly perform the functions for which it is specified; and

42.3.5.5 Safety requirements.

42.3.6 Owner shall inform Contractor about defects and deficiencies in Facilities observed during Trial Operation. Contractor shall rectify minor defects and deficiencies and re-perform necessary tests to demonstrate removal of defects and deficiencies. For defects and deficiencies in Facilities which may adversely affect the performance of the Facility, various tests to be performed by Contractor after removal of defects and deficiencies shall be jointly agreed between Owner and Contractor.

42.3.7 After successful completion of Trial Operation of the Facility and removal of major defects, test protocols for Trial Operation shall be jointly signed by Contractor and Owner.

42.4 After successful completion of Trial Operation of the Facility and signing of test protocols, Contractor shall notify the Owner about completion of Facility. After satisfying itself about satisfactory completion of Facility, within seven (7) days of

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receipt of notification from Contractor for successful completion of Facility, Owner shall issue a provisional acceptance certificate to the Contractor (the **"Final Acceptance of Facility"** or the **"Commissioning of Facility"**).

42.5 After Final Acceptance of Facility, Owner shall take-over the Facility from Contractor. Upon taking over of the Facility, Owner shall become responsible for care, custody, operation and maintenance of Facility (the **"Taking-Over of Facility"**).

43.0 **GUARANTEED PERFORMANCE**

43.1 The Contractor shall maintain the performance guarantees as set out in the Clause 43.2 during Warranty Period (the **"Performance Guarantee"**).

43.2 **Annual Online monitoring system for Bus Reactor Availability**

43.2.1 Annual Online monitoring system for Bus Reactor Availability (the **"Annual Online monitoring system for Bus Reactor Availability"**) shall be 99.5% (ninety-nine and half of one percent) minimum.

43.2.2 In case Annual Online monitoring system for Bus Reactor Availability is less than 99.5% (ninety-nine and half of one percent), liquidated damage shall be payable as specified in Clause 11.2

43.2.3 Annual Online monitoring system for Bus Reactor Availability shall be calculated as follows:

43.2.4 A = [TSH – (TUD – TEPD)] *100/TSH; wherein:

43.2.4.1 A = Annual Online monitoring system for Bus Reactor Availability (in %);

43.2.4.2 TSH = Total Service Hour (in hours)

43.2.4.3 TUD = Total Unscheduled Downtime (in hours);

43.2.4.4 TEPD = Total Excused Performance Downtime (in hours)

43.2.4.5 Total Service Hour in any Operating Year shall be total number of hours during the period under consideration e.g. 8760 (eight thousand seven hundred and sixty) hours for a normal year or 8784 (eight thousand seven hundred and eighty-four) hours for a leap year starting at 00:00 hrs of the first day of first month and 24:00 hrs of the last day of the last month of the relevant operating year;

43.2.4.6 Unscheduled System Downtime shall mean the time when Online monitoring system for Bus Reactor is not available fully for functional use and which is outside Scheduled Downtime;

43.2.4.7 Scheduled Downtime is the planned Online monitoring system for Bus Reactor maintenance downtime jointly agreed by the Owner and the Contractor in advance; and

43.2.4.8 Excused Performance Downtime is the time when Online monitoring system for Bus Reactor is not available fully for functional use for reasons which is excused in the Contract.

43.2.5 The Contractor shall ensure that no Scheduled Downtime occurs for a period greater than the Scheduled Downtime period agreed between the Owner and the Contractor. Any increase in the agreed Scheduled Downtime period shall be considered as Unscheduled System Downtime for calculating Annual Online monitoring system for Bus Reactor Availability

44.0 **AMENITIES TO BE PROVIDED BY OWNER AND CONTRACTOR**

44.1 Following amenities at Site shall be provided by Owner:

44.1.1 Material storage area, as available at site, shall be provided to Contractor by Owner. However, securing the area in order to ensure safe and secure storage of materials brought to Site shall be done by Contractor.

44.2 Following amenities at Site shall be provided by Contractor:

44.2.1 The Contractor shall provide all the construction equipment, tools, tackles, scaffoldings etc required for performing Services under the Contract. It shall submit a list of all such materials to the Owner before the commencement of construction at Site. These equipments, tools, tackle, scaffoldings etc shall not be removed from the Site without written permission of the Owner.

44.2.2 The Contractor shall provide appropriate lighting and fencing for performing the Services round the clock in safe manner and protecting the Facility.

44.2.3 The Contractor shall make his own arrangement for telephone, fax and internet facilities.

44.2.4 The Contractor shall provide the necessary first-aid facilities for all Contractor Staff working at Site. Adequate number of Contractor Staff shall be trained in administering first-aid.

44.2.5 The Contractor shall keep the entire area allotted to it clean and free from rubbish, debris, etc. during the Term. The Contractor shall employ adequate number of special personnel to thoroughly clean its work area, at least once in a day. All rubbish and scrap material shall be stacked or disposed of in a place to be identified by the Owner. Materials and stores shall be so arranged as to permit easy cleaning of the area. In areas where equipment might drip oil and cause damage to the floor surface, a suitable protective cover of a flame resistant, oil proof sheet shall be provided by Contractor to protect the floor from such damage.

44.2.6 After Taking-Over of Facility by the Owner, the Contractor shall remove all rubbish and scrap material from the Site and leave the Site and the Facility clean and safe.

45.0 **WAIVER**

45.1 **No Waiver of Rights**

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The failure of either Party to enforce at any time any of the provisions of this Contract or any rights in respect thereto or to exercise any option therein provided, shall in no way be construed to be a waiver of such provisions, rights or options or in any way to affect the validity of this Contract. The exercise by either Party of any of its rights herein shall not preclude or prejudice either Party from exercising the same or any other right it may have hereunder.

45.2 **Payments Not to Affect Right of the Owner and Liability of Contractor**

No sum paid on account by the Owner shall affect or prejudice the rights of the Owner against the Contractor or relieve the Contractor of its obligations for the due performance of its obligations under this Contract, including supply of Materials or be interpreted as approval of the Materials delivered.

46.0 **VALIDITY AND SURVIVAL OF PROVISIONS**

46.1 **Validity of Provisions and Severability**

The provisions of this Contract are severable. In the event any provision or condition of this Contract shall be held to be invalid, void or otherwise unenforceable, such prohibition, invalidity or unenforceability shall not affect the validity or enforceability of any other provisions and conditions of this Contract. The Parties agree in such circumstances to negotiate an equitable amendment to the provisions of this Contract to give effect to the original intention of the Parties.

46.2 **Survival of Provisions**

The provisions of this Contract which by their nature are intended to survive the termination or expiry of this Contract shall continue as valid and enforceable obligations of the Parties notwithstanding any such termination or expiry.

47.0 **LANGUAGE AND MEASURES**

47.1 The governing language for the Contract shall be English. All documents pertaining to this Contract including specifications, schedules, notices, correspondences or any other document shall be written in English language. The metric system of measurement shall be used exclusively in this Contract.

48.0 **NOTICES**

48.1 All notices, reports, certificates or other communications to be given by one Party to the other under this Contract shall be in writing and by letter or facsimile transmission or electronic mail (save as in case of major issues relating to this Contract, such as notices of tests, arbitration, termination, etc.) and shall be deemed to be duly given when delivered (in the case of personal delivery), when dispatched (in the case of facsimile transmission or electronic mail, provided that the sender has received a receipt indicating proper transmission) or 3 (three) days after being dispatched by an internationally recognized courier (in the case of a letter) to such Party at its address or facsimile number or electronic mail address specified in Clauses 48.2 and 48.3 below, or at such other address or facsimile number as such Party may hereafter specify for such purpose to the other Party by notice in writing.

48.2 Address for Notice to Owner:

Attn: Managing Director
ONGC Tripura Power Company Limited
10th Floor, Core-4 and Central,
Scope Minar, Laxmi Nagar,
New Delhi – 110092
Fax: +91-11-22017731
Email: sanil.namboodiripad@otpcindia.in

48.3 Address for Notice to Contractor:
Attn: Managing Director
401/Labh Complex, Atladra
Vadodara, Gujarat-390012
Fax: +91-265-2680160
Email: jitin@utilitypowertest.com

48.4 For the avoidance of doubt it is provided that in case of a facsimile transmission, a positive transmission report from the sender's machine will be conclusive evidence of receipt in the absence of evidence to the contrary.

49.0 **CONTRACTUAL RELATIONSHIP**

49.1 The Contractor shall act as an independent contractor performing this Contract. This Contract does not create any agency, partnership, joint ventures or joint relationship between the Parties. Subject to the compliance of this Contract, Contractor shall be solely responsible for the manner in which the Materials are supplied. All employees, representatives or Subcontractors engaged by the Contractor in performing this Contract shall be under the complete control of the Contractor and shall not be deemed to be employees of the Owner and nothing contained in this Contract or in any Subcontract awarded by the Contractor shall be construed to create any contractual relationship between any such employees or representative or Subcontractors and the Owner. Contractor shall be responsible for its acts, defaults or negligence and acts, defaults or negligence of its agencies, servant, employees, workmen or Subcontractors.

49.2 Nothing contained in this Contract or any Subcontract awarded by Contractor shall create any contractual relationship between any Subcontractor and Owner.

50.0 **COPIES OF CONTRACT AND COUNTERPARTS**

50.1 This Contract shall be signed in 2 (two) originals. The Contractor shall be provided with 1 (one) signed original and the other one will be retained by the Owner.

50.2 Subsequent to signing of this Contract, the Contractor, at its own cost, shall provide the Owner with at least 5 (five) photocopies of this Contract within 30 (thirty) days after the signing of this Contract.

51.0 **ENTIRE AGREEMENT**

51.1 This Contract constitutes the entire understanding between Parties hereto with respect to the subject matter hereof and supersedes all communication, negotiations

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and agreement (whether written or oral) of the Parties with respect hereto made prior to the date of this Contract.

51.2 There are no understandings or agreements between the Owner and the Contractor which are not fully expressed herein including the Annexures referred to in this Contract.

51.3 No modifications of this Contract shall be valid unless the same is agreed in writing between the Parties hereto and issued as an amendment in writing to this Contract.

Please acknowledge receipt and send one copy of this 'Work Order' duly signed and stamped as a token of your unconditional and unequivocal acceptance within 7 days.

Thanking you,
Yours faithfully,
for ONGC TRIPURA POWER COMPANY LIMITED

21. Feb. 2023

Samarjeet Thakur
Head Corporate (C&M)

ONGC-Tripura Power Co. Ltd. Palatana, Tripura

Received & Accepted
For Utility Power Test
Authorized Signatory

Enclosures:

Annexure-1 : Contract Price

Annexure-2 : Technical Specifications

Annexure-3 : Format for Performance Bank Guarantee

Annexure-4 : Format for Advance Bank Guarantee

Annexure-5: List of Acceptable Banks

Annexure-6: DELETED

Annexure-7: Guaranteed Performance

Annexure-8: DELETED

Annexure-9: Site Conditions

Annexure-10: Deleted

Annexure-1

CONTRACT PRICE

Sl. No.	Description	PRICE IN FIGURES (INR)
I	**SUPPLY PRICE**	
IA	Price for supply of Equipment and Materials required for implementing complete online monitoring system for Bus Reactor and associated systems at OTPC Palatana Plant.	**41,38,500/-**
IB	All applicable taxes, duties and levies on IA above.	**7,44,930/-**
	Total Price: Supply including Taxes, Duties and Levies (IA + IB)	**48,83,430/-**
II	**INSTALLATION SERVICES, TRAINING & FREIGHT PRICE**	
IIA	Price for insurance, unloading, handling, storage, preservation at site, erection, testing and commissioning and training services for implementing complete online monitoring system for Bus Reactor and associated systems at OTPC Palatana Plant.	**2,32,500/-**
IIB	All applicable taxes, duties and levies on IIA above.	**41,850/-**
IIC	Freight for the total supplies	**46,500/-**
IID	All applicable taxes, duties and levies on IIC above.	**8,370/-**
	Total Price: Installation and Training Services including Taxes, Duties and Levies (IIA + IIB + IIC + IID)	**3,29,220/-**
III	**TOTAL CONTRACT PRICE FOR SUPPLY, INSTALLATION & TRAINING SERVICES (in Figures) INR (I + II).**	**52,12,650/-**
IV	**TOTAL CONTRACT PRICE FOR SUPPLY, INSTALLATION & TRAINING SERVICES (in Words) INR (I + II)**	**Rupees Fifty-Two Lakhs Twelve Thousand Six Hundred and Fifty Only**

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Annexure-2

TECHNICAL SPECIFICATIONS

(Attached)

ONGC TRIPURA POWER COMPANY LIMITED

TECHNICAL SPECIFICATION

FOR

ONLINE MONITORING SYSTEM FOR BUS REACTOR

OTPC

TECHNICAL SPECIFICATIONS FOR ONLINE MONITORING SYSTEM FOR BUS REACTOR AT OTPC PLANT, PALATANA, TRIPURA

TABLE OF CONTENT

UTILITY POWER TEST DELHI

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1.0 Scope:

The scope of supply and implementation of complete online Transformer Monitoring System for BUS REACTOR shall include design, manufacture, testing, supply, erection and commissioning. The intended system shall be suitable for monitoring the transformers in whole. All sensors, acquisition units, cables, processors, software, computers, cabinets and other accessories required for successful operation and performance are included in the scope of the contractor. All control & instrumentation cables shall be screened and armored. All power cables shall be steel armored.

Transformers identified for implementation of "Real Time Condition Monitoring Solution". The specifications of this transformer is given below:

BUS REACTOR

Power Rating: 80 MVAR, Voltage Rating: 400 KV, Vector Group: YN, (3 HV + 1 Neutral Bushing). Ok

2.0 General Requirements:

2.1 Bus reactors should be equipped with an on-line condition monitoring and expert system. Such a system should support the operation and maintenance of a transformer/reactor with regard to at least following aspects:

(a) With use of sensors, sophisticated modeling and diagnostic functions it should help to detect incipient faults at an early stage, in order to avoid a catastrophic outage of the transformer/reactor. Ok

(b) It should provide tools which enable the user to operate a transformer/reactor close to its thermal limits, with taking into account thermal aging and avoiding critical hot spot temperature. It should support advanced management of possible overload conditions. Unit can continuously measure other critical parameters such as oil temperatures, load current, water content in oil, and cooling status which are complementary to the DGA information. It further incorporates on-board calculations based on the very latest IEC®/IEEE® thermaland moisture models standards and computed from the specific transformer characteristics obtained from the name-plate and test reports of the transformer OK

(c) It should enable the user to perform condition-based maintenance of the reactor transformer. OK

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(d) It should enable the user to have an overview at a glance about the transformer by clear visualization of transformer condition by traffic lights within software user interface and with LEDs on control cubical in the field. OK

2.2 All components of the reactor (active part, bushings, cooling system) should be monitored by one single fan-less Intelligent Electronic Device (IED), so that correlations can be built between the information coming from various components in order to build consistent, comprehensive diagnostics. It should be possible to monitor all transformers and reactors at one substation with one single monitoring IED to allow data correlation ofadjacent transformers/reactors. OK

2.3 Configuration of a monitoring system consisting of sub-systems for condition monitoring of bushing not produced by the manufacturer of the offered monitoring system is not permitted. OK

2.4 The monitoring modules for data acquisition shall be installed at thetransformer/reactors. All monitoring modules at one substation shall be connected to onesingle monitoring IED which shall be installed either in the control room or in the monitoring module at the power transformer by means of field bus ring topology in orderto ensure the communication, even the field bus communication between the monitoring modules is interrupted at any point. The IED shall be equipped with a redundant flash memory and should have the capability of monitoring up to a minimum of 15 transformer/reactor units at one substation. The use of a monitoring IED/server equipped with moving parts such as fans and hard disks is not permitted. OK

2.5 The heart of the system shall be comprehensive and advanced numerical models of the transformer/reactor implemented on the monitoring IED, taking into account design, results of design calculation as well as results of comprehensive tests of the power transformer/reactor such as but not limited to the following: OK

(a) Thermal model

(b) Aging model

(c) Tap changer model

(d) Moisture model

(e) Bushing model

(f) Overload model

(g) Cooling model

3.0 Scope of Work:

The scope includes design, development, supply, installation, commissioning, testing and onsite training of OTPC personnel for implementation of a "Real Time Condition Monitoring Solution" for 400 KV Bus Reactor.

The solution shall include On Line Monitoring of the following parameters for BusReactor: OK

(a) 9 Gas in oil and moisture

(b) Partial Discharge of the Transformer

(c) Tan Delta & capacitance of the Bushings

(d) Load current

(e) Ambient temperature

(f) Top oil temperature

(g) Bottom oil temperature

(h) Transformer winding moisture tracking

(i) Radiator Bank Temperature monitoring.

The acquired data shall be available over OTPC Intranet and necessary alarms can be integrated with the existing SCADA (MaxDNA) network. OK

All equipment provided by the manufacturer shall be new, free from defects and of same type standard and quality set forth in the specifications. The scope of equipment to be furnished and services to be provided under the contract are outlined hereinafter and the same is to be read in conjunction with the provisions contained in other clauses. The scope of work under the contract shall be deemed to include all such items, which although are not specifically mentioned in the bid documents and / or in Bidder's proposal, but are required to make the equipment / system complete for its safe, efficient, reliable and trouble free operation. NO EXTRA COST implication to OTPC shall be considered on account of supply & installation of these unaccounted items. The Contractor must consider the cost of technicians and labors required for commissioningof equipment's along with materials at site as complete erection and commissioning is in Contractor's scope. OK

4.0 Technical Specifications:

The on-line monitoring device shall combine in a single system and measure the following:

(a) Partial Discharge (PD) in the transformer main tank and bushings; OK

(b) Relative variations of capacitance and power factor of each bushing; OK

(c) Gas contents in the insulating oils in the transformer main tank using photo-acoustic spectroscopy or NIR technology. The equipment shall measure each gas individually and give results in ppm. Moisture should also be measured in ppm. OK

4.1 The monitoring system shall be housed in a single IP56 acquisition box, wall or stand mounted, to be placed near the transformer. OK

4.2 No additional software shall be required for commissioning the system and to visualize the data. OK

4.3 Central Server/ Computer must be supplied to manage multiple online DGA, Bushing monitor and Partial Discharge system. OK

4.4 Dissolved Gas analysis, Partial Discharge and Bushing monitoring results can be displayed in different formats in which all the data points are linked together. OK

4.5 Furthermore, the system shall:

(a) Include data storage (>1 year) OK

(b) web-server and integrated modem OK

(c) be GPS free and no active electronics placed on the top of transformer OK

(d) be connected to SCADA or DCS using known protocols such as Modbus, DNP3 or IEC61850 OK

(e) support RS232, RS485, Fiber optic, 3G, Ethernet carriers OK

(f) include 3 x LED Indicators (Power, Service, Alarm) and Alarm relay contacts OK

4.6 Dissolved Gas Analysis:

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(a) Be capable of correlating all 9 fault gases, moisture-in-oil, oil temperature, and ambient temperature to the transformer load. OK

(b) Gas Analyzing shall be on the Photo Acoustic Spectroscopy (PAS) or NIR (Near Infra-Red) Spectro-photometry or any other competing technology without the need of any consumables. OK

(c) Be required to have a separate oil inlet pipe and separate oil return pipe to ensure quality of oil sampling. OK

(d) Have an embedded web-server to allow remote access using any smart device (such as smart phone or tablet) based on the user providing access via Ethernet or SIM. OK

(e) Not require download and install of any third-party software for communication with the online DGA monitor. OK

(f) Have an on board 7 inch color touchscreen HMI to allow review of data, graphs and the password protected control of settings. OK

(g) Supply access to Instructions on how to take a manual oil sample accessible via the touch screen HMI OK

(h) The supplier shall be capable of providing a team of transformer experts to support and enhance the customer experience providing monitor support and technical transformer service. Costs for these services will be agreed with the customer in advance based on a per project or transformer basis. OK

(i) The user interface shall provide the following Dissolved Gas Analysis via its 7" on board OK

(j) HMI:

- DGA Graph Trending OK
- DGA Instantaneous Values OK
- DGA Scheduling OK
- DGA Online Monitor Alarm Management OK
- Cross Data Trending OK
- Data Export to User device OK

4.7 Software:

The monitoring IED should allow generating HTML-based web pages in English language that provide an easy and user-friendly presentation of the acquired and analyzed on-line data as well as historical data. It shall include a built-in web server generating HTML5 web pages to support access the user interface using any popular Internet browser without use of any proprietary software. OK

The operating software used in the monitoring server shall be the multitasking and real-time operating system such as QNX. OK

The software of the monitoring IED must include and not limiting to the following:

(a) The expert system provides the user with recommendations and information to optimize the operation and maintenance of the transformer/reactor by means of algorithms for analyzing the on-line acquired variables which are implemented in the software. OK

(b) Dissolved gas analysis and diagnostic tool according to MSS, Doernenburg,Rogers, extended Rogers, IEC 60599, Duval and Key Gas. OK

(c) Diagnostic tools:

- Furfural determination
- Oil conditions acc. VDE 0370/IEC60422
- Classification of risk acc. IEEE C57.104-2008 OK
- Evaluation of paper insulation condition acc. IEC 60599 OK

(d) Report generator, which automatically creates protocols with status information about the transformer/reactors and its main components. OK

(e) Simulator tool, which predict chosen parameters such as but not limited to load factor, hot-spot temperature, aging rate, losses and moisture of insulation paper to analyze the transformer and monitoring system´s behavior. OK

(f) The monitoring IED shall provide long term storage of all acquired and analyzed data (15 years plus) from all connected transformer/reactors at one substation. It must be possible to download the contents of the data memory to a remote PC through Ethernet OK.

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(g) In case the values will exceed individually defined limits the system generates an alarm record which is also saved in the database. In addition, the alarm signal can be sent to the control room by either standard protocols or closing of relay contacts. E-mail notifications and alarm massages should be customizable to specific local needs. OK

Initially, the on-line data acquired by means of the monitoring modules are to be held in the RAM memory of the monitoring IED with a high timely resolution. The monitoring system should have the capability of resolution and processing of the measured values in millisecond grid. In order to optimize the storage capacity, the individual data of the different on-line channels are stored as timely mean or maximum values in the historical database (data reduction). However, events, e.g. tap changing, shut down of the transformer, energizing of the transformer, or alarms, are to be saved with time stamp and high timely resolution in millisecond grid. OK

The system shall provide the capability of synchronizing its internal clock from anexternal source. OK

It must be possible to communicate with SCADA by means of standard protocols such as IEC 60870-5-101, IEC 60870-5-104, IEC 61850 (reports) certified by KEMA, Modbus or DNP3.0. OK

4.8 Bushing Monitoring shall:

(a) By direct measurement of bushing capacitance and Tan Delta by Schering bridge principle. OK

(b) be connected at the bushings Test Tap, through properly designed adaptors, including protections in order to disallow the Test Tap pin to remain floating, even with the signal cable disconnected from the adaptors. OK

(c) Provide hourly summary, indicating:

- Transformer Status (ON/OFF) OK
- Current Polar Plot (through web app) OK
- Relative (%) and Referenced (pf) Capacitance, Relative (%) and Referenced (%) Power Factor OK
- Top oil, Bottom oil, Tap Changer and Environmental Temperatures, plus Humidity. Data shall be provided through additional sensors added to the system. OK

4.9 PD solution must have:

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(a) Each partial discharge monitoring system shall be based on UHF technique and immune from noise from electrical connections at bushings, line corona etc.

(b) PD monitoring should be done by providing 2 nos. of UHF sensors of drain valve type suitable for PD frequency range of 100MHz to 1500MHz with fully shielded sensor and extra port for functionality check and calibration signal.

(c) PD monitoring module shall be based on wide band signal processing technique and should be immune from noise by using transformer tank as faraday cage.

(d) The PD monitoring system should be provided with PD monitoring software for trending of PD activity and generating advance warning. PD Measurement by proposed Perception Software.

(e) PD monitoring shall be installed and commissioning by Contractor to existing drain valve of DN50/DN80 size based on availability. Not Applicable

(f) Contractor to submit the PD data analysis within 15 days of system commissioning and also provide PD assessment once every 6 months for next three years since first commissioning free of charge

(g) Simultaneous (no multiplexing) and 24-hours-continuous acquisitions (not scheduled) in all 4 channels (with option for additional 4)

(h) Automatic and real time noise rejection (no manual clustering), with gating option on fourth channel

(i) >50 MS/s sampling rate, >20 V peak-peak input measuring range, <1 mV Sensitivity at full scale with 12 bit resolution

(j) Hourly summary, indicating:

- Transformer Status (ON/OFF)
- Amplitude (Volts and nC) and Repetition Rate of PD signals in each Phase
- Additional PRPD pattern in both Volt and nC for each phase,

(k) The system must be commissioned, configured and interrogated without installing any software, by just using common web-browser

4.10 Central Server:

ONGC Tripura Power Co. Ltd. Palatana, Tripura

It must:

(a) Display the list of all monitored devices Ok

(b) Display the status of all monitored devices (connected, not connected, alarm active) Ok

(c) Allow direct connection to the monitored device Ok

(d) Periodically retrieve the data from each monitoring device Ok

(e) Display the Condition Group of each monitoring device (good, normal, defective, faulty, failure) Ok

(f) Upgrade each device when a new software release is available Ok

(g) Notify alarms through email Ok

(h) Provide secure connection with proper user credentials and user roles Ok

4.11 Parameters

H_2	5 - 5,000 PPM OK
CH_4	1 – 50,000 PPM 2 – 50,000 PPM
C2H6	1 – 50,000 PPM OK
C2H4	1 – 50,000 PPM OK
C2H2	0.1 – 50,000 PPM 0.5 – 50,000 PPM
CO	1 – 50,000 PPM OK
CO2	3 – 50,000 PPM 20 – 50,000 PPM
O2	100 - 50,000 (± 10%) OK (±5%)
N2	100 - 150,000 (± 15%) 10000 - 100,000 (± 15%)
H20 (RS)	1 - 100% RS OK
Accuracy	± 5% or ± LDL (whichever is greater) OK (H2 –5% and rest all Gases 3%)

4.12 DATA- DGA

Measurement frequency	1 - 24 hrs. OK
Data Storage	GB micro-SD card, 15+ years OK (Internal data storage)

4.13 Bushing Monitoring

Input channels	2 sets of 3 phases, simultaneous acquisition on all channels OK
Simultaneous channels	3 (up to 6) Not Applicable
Sensors	Bushing Tap Adaptors OK
Input measuring range	0 - 200mA (2-200 mA)
Accuracy	Amplitude: 0.1%, Relative Phase Angle: 0.05° Current : 0.01mA Phase Angle : 0.01 degree
Resolution	12 bit Ok
Sampling rate	>10 kS/s LF for bushing 100 kHz HF for PS 100Mhz
Power system frequency	50 - 60Hz, ± 0.01 Hz Ok

4.14 DATA- Partial Discharge and Bushing

Acquisition mode	Continuous Ok
Trending	Hourly, daily, weekly, monthly Ok
Storage	> 1 year Ok

4.15 Alarms

High-vis LED's	Red, Amber, Green Ok
Alarm relay contact	4 x NO or NC, user configurable Ok

4.16 I/O

Analog inputs	3 x PT100, 3 x 4 - 20 mA, 1 x Load CT Ok
Digital inputs	5 x 24V isolated Ok

4.17 Communication Options

Protocols	Modbus, DNP3 & IEC61850 Ok
Carriers	RS232, RS485, Ethernet, Fiber, 3G Ok
HMI	7" High Resolution Colour LCD Ok

4.18 Power

Power	90 - 250 VAC, 47 - 63 Hz, 300W max Ok

4.19 Environment

Tripura Power Co. Ltd. Palatana, Tripura

Operating temperature	-40 to +55 °C (option for -60 °C) Ok
Operating humidity	5 - 95% RH, non-condensing Ok
Oil temperature range	-40 to +120 °C Ok

IP Rating	IP56 Ok

4.20 Data to be Acquired by the Monitoring system:

The following acquired variables should be recorded by the monitoring system:

(a) Load current on HV side Ok

(b) Over currents and short circuit currents on HV side Ok

(c) Top oil temperature Ok

(d) Bottom oil temperature Ok

(e) Winding temperatures (from Fiber-Optic Temperature Indicator) Ok

(f) Gas-in-oil content [ppm] Ok

(g) Relative moisture of oil (water activity) [%] Ok

(h) Operating voltages on HV side directly at the bushing test tap by means of sensing devices installed at the bushing test tap No

(i) Transient over-voltages detection (up to 1.2/50 micro second lightning impulse) No

(j) Ambient temperature Ok

(k) Circuit state of each fan and pump Ok(On/Off)

(l) In- and outlet temperatures of cooling unit No

(m) Circuit state of protection devices (e.g. Buchholz-Relay, overpressure relief device, ...) No

It must be possible to retrofit additional sensors in the future in order to extend the monitoring functionalities. It should be also possible to integrate existing transformers in the monitoring system. Ok

The transformer monitoring system shall be able to fully integrate DGA equipment for individual detection of Hydrogen (H2), Methane (CH4), Ethane (C2H6), Ethylene (C2H4), Acetylene (C2H2), Carbon monoxide (CO), Carbon dioxide (CO2), Oxygen (O2), Nitrogen (N2) and moisture (H2O), based on PAS (Photo Acoustic Spectroscopy) or NIR (Near Infra-Red).

The DGA sensor shall not use any consumables like carrier or calibration gases. Ok

4.21 Information to be provided by the System:

On the base of received on-line measurements, it should calculated/analyzed for each transformer/reactor individually:

(a) Apparent power (MVA) Ok

(b) Load factor No

(c) Number of over currents and short-circuit currents on HV side No

(d) Last over current and short-circuit current on HV side No.

(e) Actual losses No.

(f) Top oil temperature according to thermal model Ok

(g) Hot spot temperature in accordance with IEC 60076-7 Ok with IEEE C-57.91-2011

(h) Ageing rate in accordance with IEC 60076-7 Ok

(i) Lifetime consumption in accordance with IEC 60076-7 Can not access IEC

(j) Gas in oil gradient [ppm/day] OK

(k) Water content in oil [ppm] OK

(l) Moisture of insulation paper OK

(m) Bubbling temperature OK

(n) Bubbling safety margin OK

(o) Breakdown voltage of insulation oil No

(p) Overload capacity No

(q) Emergency overloading time when overloading No

(r) Number of transient over-voltages on HV bushings (up to 1.2/50 micro second lightning impulse)No

(s) Last transient over-voltage on HV bushings (up to 1.2/50 micro second lightning impulse) No

(t) Change of capacitance of condenser bushings on HV bushings OK

(u) On-line capacitance of condenser bushings on HV bushings OK

(v) Capacitive displacement currents on HV bushings OK

(w) Cooling efficiency (thermal resistance Rth) OK

(x) Cooling Power NO

(y) In- and outlet temperatures difference of cooling unit OK DGA900 plus measures top and bottom oil temp.

(z) Sum of switched load current until service

NO

(aa) Time of inrush current NO

(bb) Switching time NO

(cc) Index of switched energy NO

(dd) Maximum power consumption of sector 1

NO

(ee) Maximum power consumption of sector 2

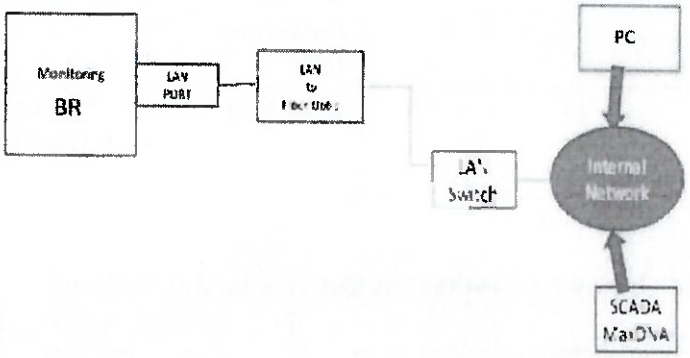
NO

(ff) Maximum power consumption of sector 3 NO

5.0 Schematic Diagram

The Monitoring Unit shall have a configuration as shown below:

ONGC Tripura Power Co. Ltd. Palatana, Tripura



6.0 Sensor Schedule:

Following sensors shall be minimum provided for Bus Reactor:

Sl no	Type of sensor	Quantity Per Transformer	Application	Performance Parameter
1	RTD/Pt100	1	Top oil temperature	To measure top oil temperature as a function of load
2	RTD/Pt100	1	Bottom oil temperature	To measure bottom oil temperature and evaluating the cooling efficiency of the Transformer
3	RTD/Pt100	1	Ambient temperature	To measure the ambient temperature to evaluate the differential of the top oil temperature and the ambient temperature to understand the extent of heating of the Transformer oil.
4	Humidity sensor	1	Humidity in the atmosphere	To understand the moisture content in air and its associated impact on the Transformer oil
5	Bushing Tap Coupler Sensors	4	Tan Delta, Capacitance of the Bushings and Partial Discharge	To measure the overall health of the Bushings and the insulation level/defects of the Transformer (Partial Discharge)

			of the Transformer Tank	
6	Load CT	3	Load Current	To measure the load current of the Transformer.

7.0 Bill of Material, Approved Makes and Services for Bus Reactor:

Sl.	Item	Qty	Make/Model	Remarks
1.	Total Transformer Monitoring Solution as per the specifications for Reactor Transformer and consisting of the following: • Partial Discharge (PD) in the transformer main tank and bushings; • Bushing Monitoring System - Relative variations of capacitance and power factor of eachbushing; • On-line DGA - Gas contents in the insulating oils in the transformer main tank using photo-acoustic spectroscopy technology or NIR (Near Infra-Red) Spectro-photometry. The equipment shall measure each gas individually and give results in ppm. Moisture should also be measured in ppm. The monitoring system shall be housed in a single IP56 acquisition box, wall or stand mounted, to be placed near the transformer. Schematic Drawing is attached in the Specifications for reference	01	Camlin/GE/MTE or equivalent make	Ok, with GE make Model DGA 900 Plus for On Line DGA Using PAS Technology and electrical PD and bushing Monitoring 02 Separate boxes will be installed nearby transformer (Hub and analysis) and the both boxes will connect with single server for remote communication.
2.	Sensors i. Top Oil Temperature Sensor ii. Bottom Oil Temperature Sensor iii. Ambient Temperature Sensor iv. Humidity Measuring Sensor	 1 nos. 1 nos. 1 nos. 1 nos.	Camlin/GE/MTE or equivalent make	Ok Ge make

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Sl.	Item	Qty	Make/Model	Remarks
	v. Bushing Tap Coupler Sensors vi. Load CT vii. PD CT in Neutral	4 nos. 3 nos. 1 nos		
3	LAN Switch	1 Lot.	Moxa / Advantech / Cisco	Ok
4	Installation & Commissioning and Integrated Testing	1 Lot		Ok

The above list is tentative. Contractor must provide all the additional materials for fulfillment of the technical specification.

8.0 Compliance sheet:

The bidder must fill the Compliance Sheet given below for the ease of evaluation.

General Compliance for Bus Reactor

Sl. No.	Description	Yes / No	Remarks
1.	On-line monitoring device to measure a. Partial Discharge (PD) in the transformer main tank and bushings;	YES	
	b. relative variations of capacitance and power factor of each bushing	YES	
	c. gas contents in the insulating oils in the Bus Reactor.	YES	
	d. shall combine together in a single system	YES	
2.	The Monitoring system shall be housed in a single wall or stand mounted IP56 enclosure near to transformer	YES	
3.	Solution should include data storage(>1yr)	YES	
4.	System should have embedded web server & integrated modem	YES	
5	System should have 3 LED Indicators (Power, Service and Alarm)	YES	
6	System should have 4 X NO or NC user configurable Alarm Relay Contact	YES	
7	On board 7 inch colour touch screen HMI to review	YES	

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	data, graphs and password protected control of setting		
8	Other than web server based application no other software shall be used to commission, configure and interrogate	YES	GE engineer will use different software tool for commissioning purpose.

A. Dissolved Gas Analysis

Sl. No.	Description	Yes / No	Remarks
1.	System is capable to correlate all 9 fault gases, moisture in oil, oil temperature and ambient temperature to the transformer load	YES	
2.	System should have a separate oil inlet and oil return pipe for Bus Reactor	YES	
3.	Should have remote access using smart device(smart phone or tablet)	YES	By windows
4.	Not required to download or install any third party software to communicate with DGA monitor	YES	
5.	Supplier is capable to provide a team of transformer experts to support and enhance the customer experience providing monitor support and technical service.	YES	

B. Bushing Monitoring System

Sl. No.	Description	Yes / No	Remarks
1.	Bushing Monitoring system shall be connected at the bushings Test Tap, through properly designed adaptors, including protections in order to disallow the Test Tap pin to remain floating, even with the signal cable disconnected from the adaptors.	YES	
2.	Provide Hourly Summary indicating (a) Transformer Status (ON/OFF) (b) Current Polar Plot (throughweb app) (c) Relative (%) and Referenced (pf) Capacitance, Relative (%) and Referenced (%) Power Factor.	YES	

C. PD solution

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Sl. No.	Description	Yes / No	Remarks
1	Simultaneous (no multiplexing) and 24 hours continuous data acquisition in all 4 channels	No	Not applicable for GE make
2	Automatic and real time noise rejection (no manual clustering),	Yes	
3	>50 MS/s sampling rate, >20 V peak-peak input measuring range, <1 mV Sensitivity at full scale with 12 bit resolution	Yes	For Bushing Monitoring 100 KHz and PD 100 MHZ
4.	Provide Hourly Summary indicating: (a) Transformer Status (ON/OFF) (b) Amplitude (Volts and nC) and Repetition Rate of PD signals in each Phase (c) Additional PRPD pattern in both Volt and nC for each phase		Yes

D. Sensors & Others

Sl. No.	Description	Yes / No	Remarks
1	Should provide sensors to measure a) Top oil, b) Bottom oil, c) Environmental Temperatures d) Humidity e) Load CT	Yes Yes Yes Yes Yes Yes	
2	Data shall be provided through additional sensors added to the system.	Yes	

E. Integrated System & Communication

Sl. No.	Description	Yes / No	Remarks
1	Display the list of all monitored device	Yes	
2	Display the status of all monitored device	Yes	
3	Direct access to the monitored device	Yes	
4.	Periodical retrieval of data from each monitoring device	Yes	

5	Display of Condition Group (good, normal,	Yes	

Sl. No.	Description	Yes / No	Remarks
	defective, faulty, failure) of each monitoring device	Yes	
6	Firmware upgradation of each device when a new software release is available	Yes	
7	Notify alarm through email	Yes	
8	Secure connection with proper user credential and user role	Yes	
9	SCADA or DCS compatible using standard protocols like Modbus, DNP3 or IEC61850	Yes	
10	Data Communication carriers Supports RS232, RS485, Fibre Optic, Ethernet and 3G	Yes	RS 232 shall not be provided

9.0 Warranty Requirement

Contractor shall be liable for any defects in the materials supplied and workmanship of services provided by it for period of 60 months from the date of commissioning of the online monitoring system for the bus reactor. Yes

10.0 SERVICE LEVEL AGREEMENT (SLA) OK

10.1 Contractor shall give operational guarantees covered in the contract. This includes Transformer Monitoring System availability.

10.2 Availability / Uptime will be computed based on availability of the Transformer Monitoring System including accessories supplied and implemented by Contractor to the OTPC users.

10.3 Response may be telephonic, email, remote or onsite. In case the issue cannot be resolved telephonically or by email or by remote support, the Contractor shall need to provide onsite assistance within response resolution window.

10.4 Typical resolution time will be applicable if Transformer Monitoring Systems are not available to the OTPC's users.

10.5 A monthly report shall be submitted at the end of every month indicating availability / uptime etc. Tools / in-built facility to measure availability / uptime of system shall be provided by the Contractor.

10.6 Availability Measurements:

Priority	Measurement / Criteria	Response time	Maximum Resolution Time

	Priority	Measurement / Criteria	Response time	Maximum Resolution Time
10.6.1	Priority 1	The defect results in the failure of the complete Transformer Monitoring System, and/or of a sub-system, and/or of a software unit (program or module) within the system where impact on business is severe; there is an interruption of an important business process for one or several business units that cannot be remedied by a manual workaround.	Up to thirty (30) minutes	Four (04) Hours
10.6.2	Priority 2	The defect results in the failure of the complete Transformer Monitoring System, and/or of a sub-system, and/or of a software unit (program or module) within the system. There is no way to make the failed component(s) work completely. However, there are acceptable processing alternatives which willyield the desired result.	Within one (01) hour	Eight (08) Hours
10.6.3	Priority 3	The defect does not result in a failure, but causes the system to produce incorrect, incomplete, or inconsistent results, or the defect impairs the system usability. No significant effect on the business is expected and a manual workaround is available. A general improvement in the system is required.	Within four (04) hours	Twenty Four (24) Hours

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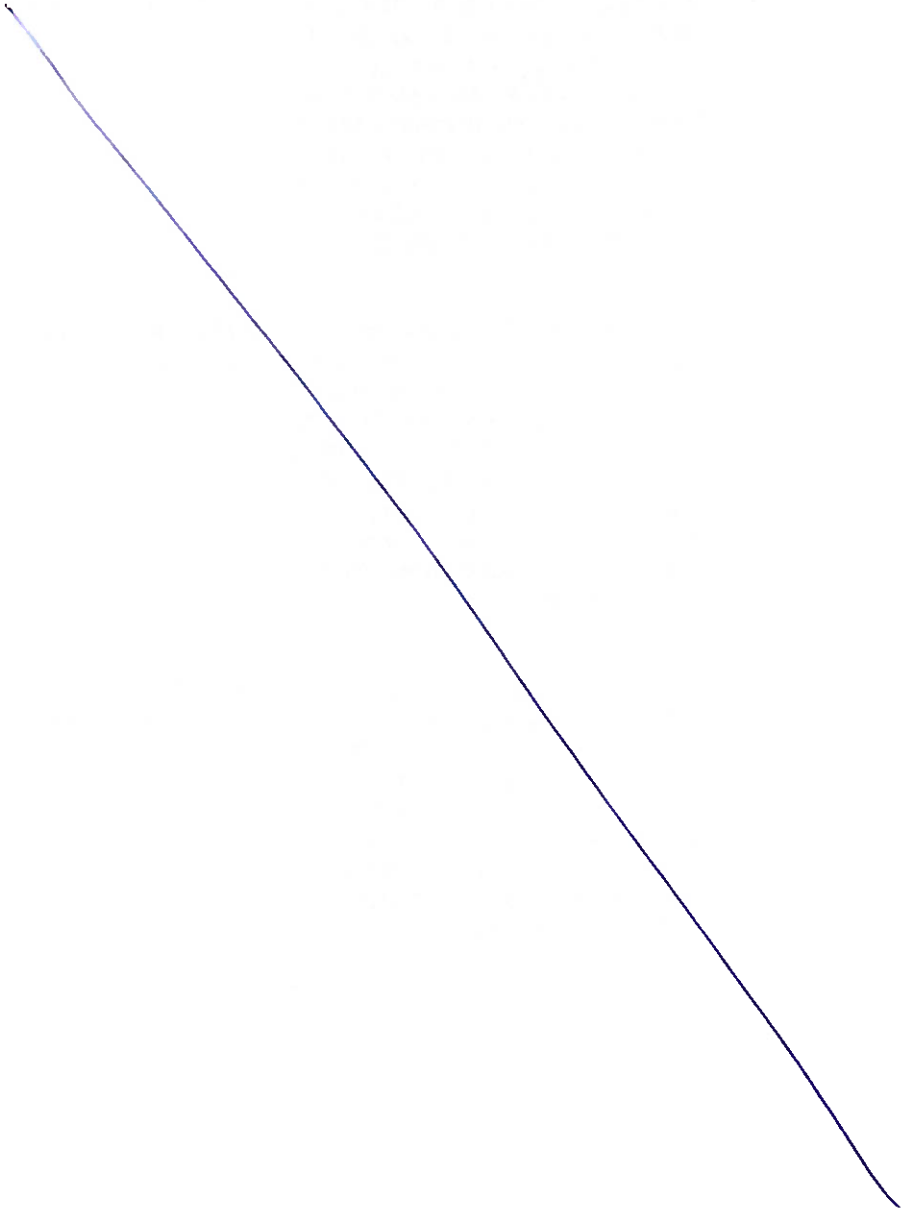

Annexure-3

FORMAT FOR PERFORMANCE BANK GURANTEE

(To be stamped in accordance with Stamp Act)

Bank Guarantee No.

Date

To,
ONGC Tripura Power Company Limited
10th Floor, Core-4 and Central,
Scope Minar, Laxmi Nagar
New Delhi – 110092
Phone: +91-11-22404700

Dear Sirs,

At the request and for the account of our client _____ having its registered office at _____ (hereinafter referred to as the "Contractor", which expression shall, unless inconsistent with the context or meaning thereof, include its successors and assigns), and in consideration of ONGC Tripura Power Company Ltd having its registered office in **ONGC Tripura Power Company Limited, Udaipur-Kakraban Road, Palatana P.O., District Gomti, Tripura-799116.** (India) (hereinafter referred to as the "Owner", which expression shall, unless inconsistent with the context or meaning thereof, include its successors and assigns) having awarded the contract for _____at 2x363.3 MW Combined Cycle Power Plant at Palatana, Tripura, India under reference no. _____ dated _____ to the Contractor (as amended, supplemented or modified from time to time in accordance with the terms thereof, hereinafter referred to as the "Contract") and the Contractor having agreed to provide a contract performance guarantee to the Owner for the full and faithful performance of each of Contractor's payment and other obligations under the Contract in an amount equal to Rs _____ [Rupees _____] (as such, amount may change pursuant to terms of the Contract, hereinafter "Aggregate Maximum Amount"),

we, _____, having our head office at _____ (hereinafter referred to as the "**Bank**", which expression shall, unless inconsistent with the context or meaning thereof, include its successors and assigns) do hereby irrevocably and unconditionally guarantee and undertake to pay to the Owner, immediately on receipt of written demand, any and all monies which the Owner certifies that it is entitled to draw hereunder pursuant to the terms and conditions of the Contract to the extent of the Aggregate Maximum Amount for the claim (s) arising up to the End Date (as defined below) without any demur, reservation, contest, recourse or protest and without any reference to the Contractor. Any such demand made by the Owner on the Bank under this Guarantee shall be (a) conclusive evidence that the Owner is entitled to demand payment thereof from the Bank pursuant to the terms and conditions of the Contract and (b) binding on the Bank, in each case notwithstanding any difference between the Owner and the Contractor or any dispute pending before any court, tribunal, arbitrator or any other authority

Multiple drawings may be made under this Guarantee. The Aggregate Maximum Amount under this Guarantee shall be automatically reduced by the amount paid to the Owner against demands for payment under this Guarantee.

ONGC Tripura Power Co. Ltd. Palatana, Tripura

This Guarantee may be amended to extend the then current End Date upon the written request of the Contractor, but this Guarantee shall not otherwise be amended, and the Aggregate Maximum Amount shall not be reduced without the prior written consent of the Owner.

The Owner shall have the fullest liberty, without affecting in any way the liability of the Bank under this Guarantee, from time to time to extend the time for performance of the Contract by the Contractor. The Owner shall have the fullest liberty, without affecting the liability of the Bank under this Guarantee, to postpone from time to time the exercise of any powers vested in the Owner or of any right which the Owner might have against the Contractor, to exercise the same at any time in any manner, and either to enforce or to forbear to enforce any covenants in the Contract or any other course or remedy or security available to the Owner. The Bank shall not be released of its obligations under this Guarantee by any exercise by the Owner of its liberty with reference to the matters aforesaid or any of them or by reason of any other act of forbearance or other acts of omission or commission on the part of the Owner or any other indulgence shown by the Owner or by any other matter or thing whatsoever which under law would, but for this provision, have the effect of relieving the Bank from such obligations.

The Bank also agrees that the Owner, at its option, shall be entitled to enforce this Guarantee against the Bank as a principal debtor in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee the Owner may have in relation to the Contractor's liabilities.

The Bank's liability under this Guarantee is limited to the Aggregate Maximum Amount and it shall remain in force up to and including _____, 202_ (such date as may be extended, the "End Date"). The End Date shall be extended from time to time for such period as may be desired by the Owner and accepted by the Contractor on whose behalf this Guarantee has been issued. The Bank hereby agrees to notify the Owner in writing by registered mail not less than 30 (thirty) days prior to any expiration or other cancellation of this Guarantee if for any reason this Guarantee will expire according to its terms or will otherwise be cancelled and the validity of this Guarantee has not been extended beyond the then current End Date. This Guarantee shall expire on the End Date whether returned to us or not, but, Owner may raise a claim occurred on or prior to End Date on Bank within 2 (two) months of End Date of this Guarantee and Bank will honour such claim(s), and no claims will be honoured thereafter.

Dated this ___ day of _____, 2023___ at _____

WITNESS

(Signature)_____ (Signature) _____

(Name) ---------- (Name) ----------

(Official Address) (Designation with Bank stamp)

Attorney as per Power of Attorney
No.
Dated

Note: Currency of this Bank Guarantee shall be INR (Indian Rupees). This Bank guarantee shall be provided under a cover letter from the bank which is duly signed by 2 (two) authorized officers of such bank.

ONGC Tripura Power Co. Ltd. Palatana, Tripura

Annexure-4

FORMAT FOR ADVANCE BANK GURANTEE

(To be stamped in accordance with Stamp Act)

Bank Guarantee No.

Date

To,
ONGC Tripura Power Company Limited
10th Floor, Core-4 and Central,
Scope Minar, Laxmi Nagar
New Delhi – 110092
Phone: +91-11-22404700

Dear Sirs,

At the request and for the account of our client ..... having its registered office ..... (hereinafter referred to as the **"Contractor"**, which expression shall, unless inconsistent with the context or meaning thereof, include its successors and assigns), and in consideration of ONGC Tripura Power Company Ltd having its registered office at **ONGC Tripura Power Company Limited, Udaipur-Kakraban Road, Palatana P.O., District Gomti, Tripura-799116.** (India) (hereinafter referred to as the **"Owner"**, which expression shall, unless inconsistent with the context or meaning thereof, include its successors and assigns) having awarded the contract for _____ at 2x363.3 MW Combined Cycle Power Plant at Palatana, Tripura, India under reference no. _____ dated _____, to the Contractor (as amended, supplemented or modified from time to time in accordance with the terms thereof, hereinafter referred to as the **"Contract"**) and the Owner having agreed to make advance payments to the Contractor as provided therein in an amount not to exceed **Rs** _____ (**Rupees** _____) (as such amount may change pursuant to conditions of the Contract, hereinafter **"Aggregate Maximum Amount"),**

we, _____, having our head office at _____ (hereinafter referred to as the **"Bank"**, which expression shall, unless inconsistent with the context or meaning thereof, include its successors and assigns) do hereby irrevocably and unconditionally guarantee and undertake to pay to the Owner, immediately on receipt of written demand, any and all monies which the Owner certifies that it is entitled to draw hereunder pursuant to the terms and conditions of the Contract to the extent of the Aggregate Maximum Amount for claim(s) arising up to the End Date (as defined below) without any demur, reservation, contest, recourse or protest and without any reference to the Contractor. Any such demand made by the Owner on the Bank under this Guarantee shall be (a) conclusive evidence that the Owner is entitled to demand payment thereof from the Bank pursuant to the terms and conditions of the Contract and (b) binding on the Bank, in each case notwithstanding any difference between the Owner and the Contractor or any dispute pending before any court, tribunal, arbitrator or any other authority.

This Guarantee may be amended to extend the then-current End Date upon the written request of the Contractor Owner with due consent of the, but this Guarantee shall not otherwise be amended, and the Aggregate Maximum Amount shall not be reduced without the prior written consent of the Owner.

The Owner shall have the fullest liberty, without affecting in any way the liability of the Bank under this Guarantee, from time to time to extend the time for performance of the Contract by the Contractor. The Owner shall have the fullest liberty, without affecting the liability of the Bank

ONGC Tripura Power Co. Ltd. Palatana, Tripura

under this Guarantee, to postpone from time to time the exercise of any powers vested in the Owner or of any right which the Owner might have against the Contractor, to exercise the same at any time in any manner, and either to enforce or to forbear to enforce any covenants in the Contract or any other course or remedy or security available to the Owner. The Bank shall not be released of its obligations under this Guarantee by any exercise by the Owner of its liberty with reference to the matters aforesaid or any of them or by reason of any other act of forbearance or other acts of omission or commission on the part of the Owner or any other indulgence shown by the Owner or by any other matter or thing whatsoever which under law would, but for this provision, have the effect of relieving the Bank from such obligations.

The Bank also agrees that the Owner, at its option, shall be entitled to enforce this Guarantee against the Bank as a principal debtor in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee the Owner may have in relation to the Contractor's liabilities.

The Bank's liability under this Guarantee is limited to the Aggregate Maximum Amount and it shall remain in force up to and including [_____, 20__] (such date as may be extended, the "**End Date**"). The End Date shall be extended from time to time for such period (not exceeding one year), as may be desired by the Contractor on whose behalf this Guarantee has been issued. The Bank hereby agrees to notify the Owner in writing by registered mail not less than 30 (thirty) days prior to any expiration or other cancellation of this Guarantee if for any reason this Guarantee will expire according to its terms or will otherwise be cancelled and the validity of this Guarantee has not been extended beyond the then current End Date. This Guarantee shall expire on the End Date whether returned to us or not, but, Owner may raise a claim occurred on or prior to End Date on Bank within two months of End Date of this Guarantee and Bank will honour such claim(s), and no claims will be honoured thereafter.

Dated this ___ day of _____, 20___ at _____

WITNESS

(Signature)_____ (Signature) _____

(Name) ---------- (Name) ----------

(Official Address) (Designation with Bank stamp)

Attorney as per Power of Attorney
No.
Dated

Note: Currency of this Bank Guarantee shall be INR (Indian Rupees). This Bank guarantee shall be provided under a cover letter from the bank which is duly signed by 2 (two) authorized officers of such bank.

ONGC Tripura Power Co. Ltd. Palatana, Tripura

Annexure-5

LIST OF ACCEPTABLE BANKS

Foreign banks

Sl. No.	Name of Bank
1.	Citigroup, USA
2.	HSBC Holdings, United Kingdom
3.	Standard Chartered

Indian banks

Sl.No	Name of Indian Banks
1.	Allahabad Bank
2.	Bank of Baroda
3.	Bank of India
4.	Canara Bank
5.	Indian Bank
6.	Oriental Bank of Commerce
7.	Punjab National Bank
8.	State Bank of India
9.	Axis Bank
10.	ICICI Bank
11.	Indusind Bank
12.	HDFC Bank

OTPC-Tripura Power Co. Ltd. Palatana, Tripura

Annexure-6

DELETED

Annexure-7

GUARANTEED PERFORMANCE

Following are the functional guarantees for the Bus Reactor Monitoring System:

Sl	Parameters	Guaranteed Value
1.0	Availability during Guarantee Test / Trial Operation	**99.50%**
2.0	Availability during 1st Operating Year / 1st Warranty Year	**99.50%**
3.0	Availability during 2nd Operating Year/ 2nd Warranty Year	**99.50%**
4.0	Availability during 3rd Operating Year/ 3rd Warranty Year	**99.50%**
5.0	Availability during 4th Operating Year / 4th Warranty Year	**99.50%**
6.0	Availability during 5th Operating Year / 5th Warranty Year	**99.50%**

1. Availability shall be calculated as follows:

   A = [TSH – (TUD-TEPD)]*100/TSH

   Where,

   A = Availability (in %)

   TSH = Total Service Hour;

   TUD = Total Unscheduled Downtime (Hour); and

   TEPD = Total Excused Performance Downtime (Hour)

2. Total Service Hour during guarantee test shall be 24 x 30 = 720 Hours
3. Total Service Hour in any operating year shall be 24 x 365 / 366 i.e. 8760 / 8784 Hours
4. Unscheduled downtime shall mean the time when Bus Reactor Monitoring System is not available for functional use and which is outside scheduled downtime
5. Scheduled downtime is the planned Bus Reactor Monitoring System Maintenance downtime jointly agreed by Owner and Contractor in advance.
6. Excused performance downtime is the time when Bus Reactor Monitoring System is not available for functional use for reason which is excused in the Contract.

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Annexure-8

DELETED

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Annexure-9

SITE

SITE CONDITIONS - OTPC GAS POWER PLANT AT PALATANA, TRIPURA

Ambient temperature:

Maximum / Minimum temperature: 37.5 °C and 6.7°C

Daily maximum mean temperature: 30.5 °C

Daily minimum mean temperature: 20.5 °C

Design temperature for electrical

Equipment/device/System: 40 °C

Rainfall:

Average annual rainfall: 2000 mm

Max. Recorded in 24 Hrs : 164.9 mm

Period of Monsoon (Avg) Showers: May to October

Relative Humidity: Varies up to 100%

Maximum RH: 100%

Minimum RH: 40%

Mean RH: 77%

Winter season:

December to February: Heavy fog for about two months in a year.

Seismic data: (Data from FI)

Seismic intensity: As per IS-1893.

Zone: V

Importance factor: 0.36

Wind data: (Data from FI)

Max Wind Speed: 55 m/s

OTPC-Tripura Power Co. Ltd. Palatana, Tripura

Annexure-10

DELETED

ONGC-Tripura Power Co. Ltd. Palatana, Tripura

ONGC Tripura Power Company Limited

Udaipur-Kakraban Road, Palatana P.O., District Gomati, Tripura - 799105, Phone: 0381-2363714, Fax: 0381-2363716

WORK ORDER

WO No.: 1800000180

6th September 2023

M/s Utility Power Test
509, Imperial Tower,
C-Block, Naraina Vihar,
New Delhi - 110028

Kind Attn: **Mr. Parveen Sharma**

Dear Sir,

Subject: **Work Order for Supply and Implementation of Online Monitoring System for ICT-2, LR-1 & 2 at OTPC 2 x 363.3 MW Gas Based Combined Cycle Power Plant at Palatana, Tripura.**

ONGC Tripura Power Company Limited, a public limited company incorporated under the Indian Companies Act, 1956 and having its registered office at ONGC Tripura Power Company Limited, Udaipur-Kakraban Road, Palatana P.O., District Gomti, Tripura-799116 (hereinafter referred as "**OTPC**" or "**Owner**" which expression shall include its successors and permitted assigns); is pleased to issue the Work Order for **Supply and Implementation of Online Monitoring System for ICT-2, LR-1 & 2 at Palatana Power Plant** to **Utility Power Test** having its registered office at 401, Labh Complex, opp. Pramukhswami Hospital, Atladra, Vadodara – 390012. (hereinafter referred to as the "**Contractor/ Supplier**" which expression shall include its successors and permitted assigns).

The Owner and the Supplier are hereinafter referred to individually as a "**Party**" and collectively as the "**Parties**".

WHEREAS:

1. The Owner is implementing Online Monitoring System for ICT-2, LR-1 & 2 along with all associated systems at 2 x 363.3 MW combined cycle power plant at Palatana, which is about 60 (sixty) km from capital city Agartala in the State of Tripura (the "Project").

2. The Owner, based on a transparent bidding process, has selected the Contractor as the successful bidder for implementing Online Monitoring System for ICT-2, LR-1 & 2 and associated systems.

3. The Contractor represents that it has the necessary specialized knowledge, expertise and infrastructure for implementing the system and to perform its obligations under this Contract.

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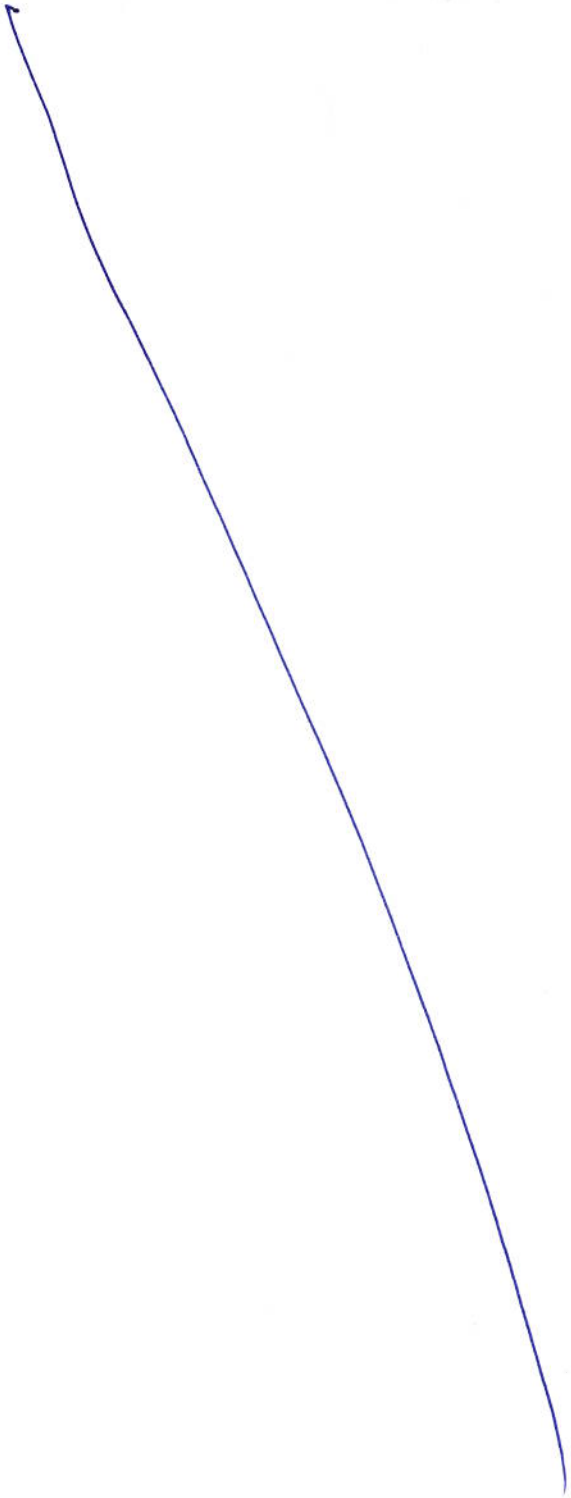

4. The Owner desires to engage the Contractor to set up and implement the Online Monitoring System for ICT-2, LR-1 & 2 and associated systems in accordance with the terms and conditions specified in this Contract.

5. The Contractor is willing and has agreed to provide and implement the required Online Monitoring System for ICT-2, LR-1 & 2 along with all associated systems for the Contract Price in accordance with the terms and conditions specified in this Contract.

6. The Owner and the Contractor desire to enter into this Contract pursuant to which the Contractor shall supply, install and commission the system and the Owner shall engage the contractor to supply, install and commission the system, pursuant to the terms and conditions herein set forth.

NOW, THEREFORE, IN CONSIDERATION OF THE MUTUAL COVENANTS HEREIN SET FORTH, THE PARTIES AGREE AS FOLLOWS:

1.0 **DEFINITION AND INTERPRETATION**

When used in the Contract, the following terms shall have the meanings specified in this Article 1.0:

1.1 "**Abandonment**" means the substantial cessation of the performance of the obligations under this Contract for a continuous period of 1 (one) day i.e. 24 (twenty-four) continuous hours and which cessation is not excused under this Contract.

1.2 "**Acceptable Bank**" means a bank listed in Annexure 5 (List of Acceptable Banks).

1.3 "**Affiliate**" means, with respect to a Person, any entity which directly or indirectly:

(i) owns or Controls such Person;

(ii) is owned or Controlled by such Person; or

(iii) is under common ownership or Control with such Person.

1.4 "**Applicable Law**" means the substantive or procedural laws of India, whether now or hereafter in effect, including all legislations, acts, rules, regulations, notifications, laws, statutes, awards, orders, decrees, judgments, injunctions, ordinances, codes, requirements, Permits, licenses, Directives, approvals, instructions, standards of any Government Agency, having the force of law.

1.5 "**Arbitral Award**" shall have the meaning ascribed to it in Clause 34.4.4.

1.6 "**Arbitration Act**" shall have the meaning ascribed to it in Clause 34.4.1.

1.7 "**Bankruptcy Event**" means commencement, whether voluntarily or involuntarily, of any proceedings relating to the rescheduling of obligations, bankruptcy, re-organization, insolvency or judicial liquidation or any other similar proceedings.

1.8 **"Change in Law Request Date"** shall have the meaning ascribed to it in Clause 35.2.

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1.9 "**Claim**" shall have the meaning ascribed to it in Clause 30.1.

1.10 "**Coercive Practice**" means impairing or harming, or threatening to impair or harm, directly or indirectly, any Person or property to influence any Person's participation or action in relation to negotiation or performance of this Contract.

1.11 "**Commissioning Spares**" shall have the meaning ascribed to it in Clause 5.2.1.

1.12 **"Completion of Supply of Materials"** shall have the meaning ascribed to it in Clause 17.1.

1.13 "**Confidential Information**" shall have the meaning ascribed to it in Clause 38.1.

1.14 "**Consumables**" shall have the meaning ascribed to it in Clause 5.4.1.

1.15 "**Contract Price**" shall have the meaning ascribed to it in Clause 7.1.1.

1.16 "**Control**" means, with respect to any Person, (i) the possession, directly or indirectly, of the power to direct or cause the direction of the management and policies of such Person whether through the ownership of voting securities, by agreement or otherwise or the power to elect more than one-half of the directors of such Person; or (ii) the possession, directly or indirectly, of a voting interest of more than 50% (fifty percent); or (iii) the power to veto decisions of such Person, whether through ownership of voting securities, by contract, or otherwise.

1.17 "**Corrupt Practice**" means (i) the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence the actions of any Person connected with the negotiation, signing or performance of this Contract (for avoidance of doubt, offering of employment to or employing or engaging in any manner whatsoever, directly or indirectly, any official of the Owner who is or has been associated or dealt in any manner, directly or indirectly with the negotiation, signing or performance of this Contract or has dealt with matters concerning the Contract or arising there from, before or after the execution thereof, at any time prior to the expiry of 1 (one) year from the Effective Date such official resigns or retires from or otherwise ceases to be in the service of the Owner, shall be deemed to constitute influencing the actions of a Person connected with the negotiation, signing or performance of this Contract); or (ii) engaging in any manner whatsoever, whether during the negotiation of the Contract or after the execution of the Contract, as the case may be, any Person in respect of any matter relating to the Project or the Contract, who at any time has been or is a legal, financial or technical adviser of the Owner in relation to any matter concerning the Project.

1.18 "**Cost of Completion**" shall have the meaning ascribed to it in Clause 32.6.1.

1.19 "**Directive**" means any directive issued by a Government Agency.

1.20 "**Direct Tax**" shall have the meaning ascribed to it in Clause 9.1.

1.21 "**Effective Date**" means the date of this Work Order no. 1800000180.

1.22 **"Facility"** or **"Facilities"** means the Equipment and Materials to be supplied and installed, along with all associated Services including design, fabrication,

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manufacture, supply, transportation, painting, erection, testing and commissioning to be carried out by the Contractor under the Contract.

1.23 **"Final Acceptance of Facility"** shall have the meaning ascribed to it in Clause 42.2.

1.24 "**Force Majeure**" shall have meaning ascribed to it in Clause 25.1.

1.25 "**Fraudulent Practice**" means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation.

1.26 "**Good Engineering & Manufacturing Practices**" means the exercise of that degree of skill, diligence, prudence, foresight, and engineering & manufacturing practice taking into account Indian conditions, generally followed internationally by highly qualified, prudent professionals in similar industry including in the procurement, manufacturing, inspection, testing, packing etc in relation thereto; which in any such case should have been expected to accomplish the desired result at the lowest cost, consistent with licensing and regulatory considerations, environmental considerations, reliability, safety and expedition. Good Engineering & Manufacturing Practices is not intended to be limited to the optimum practice, method or act, to the exclusion of all others, but rather to be a spectrum of possible practices, methods or acts employed by owners and contractors.

1.27 "**Government Agency**" means any local, State Government in India or the Government of India or any national authority, inspectorate, ministry, department, instrumentality or agency thereof or any corporation (to the extent acting in a legislative, judicial or administrative capacity and not as a contracting party with the Owner) or commission under the direct or indirect control of such local or State Government or the Government of India or any political subdivision thereof or any court, tribunal, judicial body, quasi judicial authority or statutory Person (whether autonomous or not) of the Republic of India which has jurisdiction over the Parties to, or the subject matter of, this Contract or any of the Project Agreements, and this definition includes, for the avoidance of doubt, any authority that may affect the Owner's or the Contractor's ability to perform any or all of its or their obligations under this Contract or any authority that gives consents or permits (including Permits) within India.

1.28 "**Governmental Authorizations**" means all approvals, authorizations, permits, licenses, consents, clearances, etc., received or required to be received from Government Agency for the Plant.

1.29 "**Hazardous Material**" means (i) "hazardous materials", "hazardous substances", "toxic substances" or "contaminants" as those terms are defined under any Environmental Law, or any other Applicable Laws, (ii) petroleum and petroleum products, including crude oil and any fractions thereof, (iii) any other hazardous, radioactive, toxic or noxious substance, material, pollutant or solid, liquid or gaseous waste, and (iv) any substance that, whether by its nature or its use, is subject to regulation under any Applicable Law or with respect to which any applicable Environmental Law or any Government Agency requires environmental investigation, monitoring or remediation.

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1.30 "**Indirect Taxes**" shall have the meaning ascribed to it in Clause 9.2.

1.31 "**INR**" or "**Rs**" or "**Indian Rupees**" means the legal currency of the Republic of India.

1.32 "**Latent Defects**" means defects inherently lying within the material or arising out of design deficiency which do not manifest themselves during Warranty Period.

1.33 "**Lenders**" means any and all lenders and institutions providing credit, including interim and long-term financing (including any leveraged lease or any other refinancing thereof) in respect of the development, design, engineering, construction, and operation of the Plant, and their respective successors and assigns, including any trustee, agent or designee acting on their behalf.

1.34 NOT USED

1.35 "**Loading Point**" means the factory/warehouse or the point of delivery of the Materials by the Contractor or by any of its Subcontractors or its suppliers.

1.36 "**Losses**" means any and all liabilities, losses, damages, claims, costs, obligations, charges and expenses (including reasonable attorneys' fees) of whatsoever kind or nature and it does not include indirect and consequential losses.

1.37 "**Maintenance Tools & Tackles**" shall have the meaning ascribed to it in Clause 5.5.1.

1.38 "**Mandatory Spares**" shall have the meaning ascribed to it in Clause 5.3.1.

1.39 "**Materials**" shall have the meaning ascribed to it in Clause 4.2.

1.40 "**Obstructive Practice**" means and includes (i) deliberately destroying, falsifying, altering, or concealing of evidence material to the investigation or making false statements to investigators in order to materially impede an Owner's investigation into allegations of a corrupt, fraudulent, coercive or collusive practice; and/or threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation, or (ii) acts intended to materially impede the exercise of the Owner's inspection and verification rights provided for under this Contract.

1.41 "**Operating Year**" means the consecutive 12 (twelve) month period starting from 00:00 hrs of the date of the Final Acceptance of Facility.

1.42 "**Owner's Event of Default**" shall have the meaning ascribed to it in Clause 32.2.1.

1.43 "**Owner Indemnified Parties**" shall have the meaning ascribed to it in Clause 18.1.1.

1.44 "**Performance Bank Guarantee**" shall have the meaning ascribed to it in Clause 12.1.

1.45 "**Person**" means, unless specified otherwise, a natural person, corporation, society, partnership, joint venture, unincorporated association or other entity.

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1.46 **"Plant"** means 2 x 363.3 MW gas based combined cycle power plant set-up at Palatana, Tripura including associated Facilities.

1.47 "**Project**" shall have the meaning ascribed to it in Recital 1.

1.48 "**Quality Assurance Program**" means the quality assurance program provided by the Contractor and approved by the Owner in accordance with the provisions of Clause 16.0.

1.49 **"Services"** shall have the meaning ascribed to it in Clause 4.0

1.50 "**Site**" means the land/and or other places on, into or through which the work is to be executed under the Contract or any adjacent land, path or street through which work is to be executed under the Contract or any adjacent land, path or street which may be allotted or used for the purpose of carrying out the Contract.

1.51 "**Subcontract**" means any contract entered into by the Contractor or its subcontractor with a third party for carrying out any of the responsibilities or obligations of the Contractor under this Contract.

1.52 "**Subcontractor**" means any Person carrying out any of the responsibilities or obligations of the Contractor under this Contract under or pursuant to a Subcontract.

1.53 "**Subsidiary**" shall have the meaning ascribed to it in Section 4 of the Companies Act, 1956.

1.54 "**Contractor's Event of Default**" shall have the meaning ascribed to it in Clause 32.1.1.

1.55 "**Contractor Indemnified Parties**" shall have the meaning ascribed to it in Clause 18.2.1.

1.56 **"Taking-Over of Material"** shall have the meaning ascribed to it in Clause 17.2.

1.57 "**Technical Specifications**" means the specifications for Implementing Online Monitoring System for ICT-2, LR-1 & 2 attached as Annexure-2.

1.58 "**Term**" shall have the meaning ascribed to it in Clause 3.1.1.

1.59 "**Termination Date**" means the date upon which termination pursuant to Clause 32.5.1 takes effect.

1.60 "**Time for Completion**" shall have the meaning ascribed to it in Clause 10.2.

1.61 "**Warranty**" shall have the meaning ascribed to it in Clause 27.1.

1.62 "**Warranty Period**" shall have the meaning ascribed to it in Clause 27.2.

1.63 "**Willful Misconduct**" means, with respect to any Party or Person an intentional or reckless, disregard by such Party or Person, of Applicable Law, any common duty of care, any provision of this Contract, any other document prepared pursuant to this

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Contract or of Prudent Utility Practice, and relating to the performance by such Party of its obligations there under, but shall not include any error of judgment or mistake made in good faith.

1.64 **Rules of Interpretation**

In the interpretation of this Contract, unless the context otherwise requires:

1.64.1 the singular includes the plural and vice versa and in particular (but without limiting the generality of the foregoing) any word or expression defined in the singular has the corresponding meaning used in the plural and vice versa;

1.64.2 a reference to any gender includes the other genders;

1.64.3 a reference to a Clause, Article, Annexure or Recital is a reference to a Clause, Article, Annexure or Recital in this Contract;

1.64.4 the Annexures to this Contract form part of this Contract and will be of full force and effect as though they were expressly set out in the body of this Contract. The provisions of this Contract and the Annexures hereto shall be interpreted harmoniously and only if the provisions of this Contract cannot be interpreted harmoniously with the Annexures or vice-versa on account of inconsistencies or ambiguities then the provisions of this Contract shall prevail over the Annexures;

1.64.5 in case of any discrepancy between words and figures, the words shall prevail over the figures;

1.64.6 a reference to a statute shall be construed as including all statutory provisions consolidating, amending, modifying, supplementing or replacing the statute referred to;

1.64.7 a reference to "writing" includes printing, typing, lithography and other means of reproducing words in a visible form;

1.64.8 any date of any period set forth in this Contract shall be such date or period as may be adjusted pursuant to the terms and conditions of this Contract;

1.64.9 titles or captions of Clauses or Articles contained in this Contract are inserted as a matter of convenience only, and in no way define, limit, extend, describe or otherwise affect the interpretation, meaning or intent of this Contract or the interpretation, meaning or intent of any term or provision contained herein;

1.64.10 the rule of construction, if any, that a contract should be interpreted against the Party responsible for the drafting and preparation thereof, shall not apply; and

1.64.11 reference to any agreement, deed, document, instrument, or the like shall mean a reference to the same as may have been duly amended, modified or replaced. For the avoidance of doubt, it is clarified that a document shall be construed as amended, modified or replaced only if such amendment, modification or replacement is executed in compliance with the provisions of such document(s).

2.0 **EFFECTIVE DATE OF CONTRACT**

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2.1 This Contract shall become effective on the date of this Work Order no. 1800000180 and the obligations of the Contractor to supply Materials and implement the system shall also commence from such date ("**Effective Date**").

3.0 **TERM AND AUTHORIZATION TO PROCEED**

3.1 **Term**

3.1.1 This Contract shall become effective on the Effective Date and unless terminated earlier in accordance with the provisions of this Contract, this Contract shall remain valid, in full force and in effect till completion of Warranty Period ("**Term**").

3.2 **Authorization to Proceed**

3.2.1 Work Order shall be considered as authorization to proceed. Contractor shall commence performance of its obligations from the date of Work Order and shall continue to perform its obligations as provided in this Contract during the Term.

4.0 **SCOPE OF WORK**

4.1 The Contract is for supply of Materials, equipment, installation of the entire system and training of Owner staff by the Contractor in accordance with the terms and conditions of this Contract.

4.2 The Contractor shall supply Complete Online Monitoring System for ICT-2, LR-1 & 2 and associated mechanical, electrical and instrumentation materials including Commissioning Spares, Mandatory Spares, Maintenance Tools & Tackles, and Consumables etc required till Taking-over of Facility by Owner in accordance with the terms and conditions specified in this Contract and as set out in detail in the Technical Specifications.

4.3 The Contractor's obligations include design, engineering, procurement, manufacturing, testing, inspection, packaging, Insurance, supply, delivery, Installation, commissioning of the complete system in accordance with the terms and conditions of this Contract (**"Work").** Providing training to the OTPC staff to use the system efficiently, effectively and in entirety is also in the scope of contractor.

4.4 The Contractor shall provide all the services required for successful implementation of Online Monitoring System for ICT-2, LR-1 & 2 and associated systems, including transportation of materials to site, unloading, storage, handling at site, insurance, installation, testing, commissioning, and putting the complete online monitoring system for ICT-2, LR-1 & 2 and associated system into successful operation, as set out in further detail in the Technical Specifications.

4.5 All the services required for successful completion of Work is in the scope of Contractor. The services shall be provided in such a manner so that hook-up of the Facility with existing equipments and systems shall require minimum time. Any modification required in the existing equipments and systems for hooking it with Facility, without adversely affecting the performance of existing equipments and systems, shall be included in services. Contractor shall be responsible for any loss or damage to the existing equipments and systems while performing services.

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4.6 The Contractor agrees that the scope of service also includes all temporary work, ancillary work, enabling work etc including dewatering of surface and subsurface water, construction of approach road required for performing services.

4.7 Materials shall be supplied complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such materials and/or needed for erection, completion and safe operation of the Materials as required by applicable code though they may not have been specifically specified in Technical Specifications unless included in the list of exclusions.

4.8 The Contractor expressly agrees that the scope of Work shall also include all such supply and services which may not have been specifically mentioned in this Contract or the Technical Specifications but which may be necessary for the successful fulfillment of Contractor's obligation under this Contract as per Good Engineering & Construction Practices and such services shall be performed by the Contractor without any additional cost to the Owner.

4.9 As part of the scope of its obligations under this Contract, the contractor shall procure and pay for, in its own name as an independent contractor and not as an agent of the Owner, all materials, equipment, manufacturing, fabrication etc. necessary in connection with the supply of Materials in accordance with this Contract. All such Materials shall be new, fit for purpose and free from any improper workmanship or defects and properly warranted or guaranteed to the extent required by Clause 27.0 (Warranty and Warranty Period) and comply with all Applicable Laws.

4.10 The Contractor shall, at all times during the Term, supply the Materials as per approved drawings & documents, Technical Specifications, applicable Indian / International Codes and Applicable Laws and Good Engineering and Manufacturing Practices.

4.11 Except as otherwise expressly provided in this Contract, the Contractor agrees and acknowledges that it shall perform all its obligations and responsibilities under this Contract at its own risk, cost and expense.

5.0 SPARES, CONSUMABLES AND MAINTENANCE TOOLS & TACKLES

5.1 All the spares for the equipment under the Contract shall strictly conform to the technical specification and documents and shall be identical to the corresponding main equipment / components supplied under the Contract and shall be fully interchangeable.

5.2 Commissioning Spares

5.2.1 The Contractor shall supply along with the Materials, commissioning spares considering allowances as per experience of the Contractor to cover wastage / breakage during transportation, storage, handling, construction, erection, testing and commissioning (**"Commissioning Spares"**). The Contractor shall be fully responsible for ensuring availability of adequate quantities of Commissioning Spares at the Site. If Commissioning Spares supplied are found to be inadequate, the Contractor shall supply additional Commissioning Spares promptly at his own cost.

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5.3 **DELETED**

5.4 **Consumables**

5.4.1 All the consumables such as oils, lubricants, chemicals etc., required till commissioning of the system shall be supplied by the Contractor (**"Consumables"**).

5.4.2 Contractor shall also furnish consumption rates of Consumables along with estimated annual requirements and ordering specification to enable the Owner to procure these in time for operation & maintenance of system

5.5 **Maintenance Tools & Tackles**

5.5.1 Contractor shall supply all the special tools & tackles, appliances and lifting devices for the effective maintenance of the equipment and components covered under this Contract (**"Maintenance Tools & Tackles"**). Price for Maintenance Tools & Tackles is included in Contract Price. Maintenance Tools & Tackles shall be dispatched simultaneously with equipments and components.

5.5.2 Maintenance Tools & Tackles shall not be used for installation of equipments & components.

6.0 **STAFFING AND AUTHORITY**

6.1 **Contractor's Staff**

6.1.1 The Site shall be staffed adequately to perform the Work in accordance with Good Engineering & Construction Practices and the provisions of this Contract, including but not limited to, in a prudent, efficient, reliable and safe manner.

6.1.2 The minimum staff to be deployed at Site, both in supervisory as well as workmen categories, shall not be less than what is specified in the Staffing Plan. However, in order to fully meet the Contractor's obligation and perform the Work as defined in this Contract, if any additional manpower, beyond those specified in Staffing Plan, is required to be deployed by Contractor at Site, same shall be deployed by Contractor without any delay and without any additional cost to the Owner.

6.1.3 All personnel engaged in the performance of the Work shall be qualified to perform, licensed to the extent required by Applicable Law and sufficiently trained & experienced in the duties to which they are assigned and shall satisfy the standards of performance provided in this Contract. Contractor shall demonstrate that the personnel provided under this Contract are properly trained, competent to perform the work assigned and are aware of the HES Policy.

6.1.4 Contractor shall provide experienced manpower employed by them preferably on their direct role. Resident Construction Manager, 1 (one) electrical engineer and 1 (one) control & instrumentation engineer shall necessarily be employees on the direct role of the Contractor. CV of Resident Construction Manager, electrical engineers and control & instrumentation engineers shall be submitted to Owner for their review and concurrence at least fifteen (15) days prior to their deployment at site. Owner shall reserve the right to accept or reject proposed Resident

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Construction Manager, electrical engineers and control & instrumentation engineers. Resident Construction Manager, electrical engineer and control & instrumentation engineer shall be deployed at site only after approval of their CV by Owner. Resident Construction Manager, electrical engineer and control & instrumentation engineer shall have at least fifteen (15), seven (7) and seven (7) years of experience respectively in supervising similar work out of which Resident Construction Manager shall have three (3) years of experience as Resident Construction Manager for similar work.

6.1.5 Contractor shall provide experienced and qualified operation and maintenance personnel required till completion of Pre-commissioning Tests, Commissioning Tests, Initial Operation and Trial Operation and during Guarantee Tests.

6.1.6 The Contractor shall be responsible for maintaining strict discipline and good order amongst its personnel and those of its Subcontractors at all times.

6.1.7 Contractor shall bear the entire responsibility, liability and risk relating to coverage of Contractor Staff under Applicable Law including but not limited to Workmen's Compensation Act, 1923, Industrial Disputes Act, 1947, Maternity Benefits Act, 1961, Employees' Provident Funds and Miscellaneous Provisions Act, 1952, Contract Labour (Regulation and Abolition) Act, 1970, Employees State Insurance Act, 1948, Factories Act, 1948 and any other relevant act/regulations as will be applicable during the Term.

6.1.8 Contractor shall also be solely responsible for the payment of all benefits to the Contractor Staff under Applicable Law, such as provident fund, bonus, retrenchment compensation, leave, etc., and shall keep the Owner indemnified in this regard against any claims. The Owner shall be entitled to, if it is noticed that Contractor is in default, make such payment, solely at its discretion and recover such amounts as deemed fit from any sum due and payable to Contractor by the Owner.

6.1.9 Contractor shall be responsible for making any overtime payment for providing services under this Contract and Owner shall not bear any liability whatsoever in this regard.

6.1.10 It shall be responsibility of Contractor to take care of the boarding, lodging, travel arrangements, immigration clearance and visas for all Contractor Staff engaged in providing services.

6.1.11 Contractor shall arrange local transportation facility for all Contractor Staff.

6.1.12 The hours of work at the Site shall be decided by the Owner and the Contractor shall adhere to it. Working hours in each shift shall normally be eight (8) hours per day - Monday through Saturday.

6.1.13 No personnel involved in the provision of Work under this Contract shall be deemed employees of the Owner. Neither Party shall be deemed to be a successor to the other Party under any union, labor, or collective bargaining agreement, or any other similar agreement, to which such Party is or may in the future be a party.

6.1.14 The Contractor shall ensure that required Contractor Staff is always available at the Site. If in the opinion of Owner, number of Contractor Staff deployed at site to

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perform services is not adequate to meet the time schedule for completion of services, he may direct Contractor to mobilize additional manpower within reasonable time. In the event of failure of Contractor to mobilize additional manpower as directed by Owner, Owner may mobilize additional manpower at risk and cost of Contractor. Such manpower mobilized by Owner shall be treated as Contractor Staff.

6.2 **Authority of Resident Construction Manager**

6.2.1 The Resident Construction Manager appointed by Contractor shall be authorized and empowered to act for and on behalf of the Contractor on all matters concerning this Contract and its obligations hereunder. In all such matter, the Contractor shall be bound by the written communication, direction, request and decision given or made by the Resident Construction Manager. The Resident Construction Manager will direct and manage Contractor's resources and shall have full responsibility for performing the services.

6.2.2 The Resident Construction Manager will report to the Owner's designated officer in matters relating to performance of the services.

6.3 **Owner's Staff**

6.3.1 Owner shall appoint a project manager (such Person the "**Project Manager**") who shall be assisted by the other Owner's Staff. The Owner may, from time to time, appoint any other Person as the Project Manager in place of the Person previously so appointed, and shall provide not less than 7 (seven) days notice of the name of such other Person to the Resident Construction Manager.

6.3.2 Contractor shall report to the Project Manager.

6.3.3 Project Manager or Persons authorized by him shall co-ordinate with Contractor and supervise performance of services.

6.3.4 The Project Manager may, at any time, assign duties and/or delegate to any Person, any of the powers and duties vested in it, upon notice to the Contractor. The Project Manager may also revoke such assignment or delegation and give notice of the same to the Contractor.

6.4 **General Personnel Requirement**

6.4.1 Contractor shall employ Contractor Staff including labour in sufficient numbers to ensure workmanship of the degree specified in this Contract and to the satisfaction of the Owner. The Contractor shall employ labour in sufficient numbers to maintain the required rate of progress and workmanship of the degree specified in the Contract and to the satisfaction of the Owner.

6.4.2 The Contractor is expected to employ only such Persons, for the performance of services, who have requisite experience of particular work.

6.4.3 The Contractor shall employ only qualified and medically fit Persons who are not below 18 (eighteen) years of age.

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6.4.4 No female staff or labour shall be employed for night shifts or after darkness.

6.4.5 Contractor's Staff shall wear identification badges at all times while on work at Site.

6.4.6 Contractor shall employ local people under unskilled workmen category.

6.4.7 Local people shall be given preference by Contractor in employment of staff and skilled workmen wherever local people with requisite skills are available.

6.4.8 Contractor shall comply with labour rules, regulations and statutes as specified in Clause 22.0 (Applicable Labour Laws).

6.4.9 All Contractor Staff shall be considered employees of Contractor only and Owner shall have no relation whatsoever with the Contractor Staff.

6.4.10 The Contractor Staff shall work exclusively at the Site and they shall not be transferred / deputed to any other site of the Contractor, without prior written consent of the Owner.

6.4.11 For smooth functioning, the Contractor shall ensure that requisite number of the Contractor Staff shall be fluent in the local language of India spoken at the Site.

6.5 **Discipline of Workmen**

6.5.1 The Contractor shall adhere to the disciplinary rules, regulations and procedures set by the Owner in respect of Contractor Staff at Site. The Owner shall be at liberty to object to the presence of any Contractor Staff at the Site if, in the opinion of the Owner, such Person's conduct is inappropriate or such Person is incompetent or negligent or otherwise undesirable or if there is malfeasance in the conduct of such Person's duties or responsibilities to be performed at Plant or if, in the opinion of the Owner, the presence of such Person poses a threat towards safety & security of the Plant or Services or creates an environment detrimental to the interest of the Owner. In such a case the Owner may give written notice to the Contractor identifying the Person(s) concerned and describing the complaint in detail. Upon receipt of such complaint, the Contractor shall immediately remove the relevant Person(s) from the performance of the services and replace him with appropriate personnel.

7.0 **CONTRACT PRICE AND PRICE BASIS**

7.1 **Contract Price**

7.1.1 The Owner shall, in consideration for the supply, installation, commissioning, Training etc. obligations of the Contractor under this Contract, pay to the Contractor, the contract price of **Rs. 1,42,78,000/- (Rupees One Crore Forty-Two Lakhs Seventy-Eight Thousand Only) including GST@18%** comprising of the amounts specified in Annexure 1 (Contract Price), subject to the terms of this Clause 7.0 and Clause 8.0 (Payment Terms) below ("**Contract Price**").

7.1.2 The Contract Price is full compensation to Contractor for implementation of complete online monitoring system for ICT-2, LR-1 & 2 and satisfactory performance of all its obligations under this Contract in compliance with all terms and conditions of this

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Contract. The Contract Price as payable hereunder shall cover all costs, expenses, overheads, etc., to be incurred by the Contractor and profit margin for the performance of all its obligations under this Contract including but not limited to costs and expenses of supplying Materials. No additional claim or payment would be admissible in this regard. Contract Price shall be regulated and paid in the manner described in this Clause 7.0 and Clause 8.0 (Payment Terms and Performance Bank Guarantee) below.

7.2 **Price Basis**

7.2.1 Contract Price, unit prices, pricing for change, and all other prices and rates set forth in the Contract shall remain fixed and firm and shall not be subject to any change whatsoever during the Term.

7.2.2 Contract Price includes all costs, expenses, overheads, etc., to be incurred by the Contractor and profit margin for the supply of materials and performance of all the Works and Services and obligations under this Contract including but not limited to the following and no additional claim or payment would be admissible therefore:

7.2.2.1 Cost of providing construction materials, tools & plants, scaffoldings;

7.2.2.2 Cost of dismantling, transportation, insurance, unloading, handling, storage, installation, testing, commissioning, and housekeeping;

7.2.2.3 Salaries and wages, including benefits, general and administrative overheads, and all miscellaneous expenses for the Contractor Staff;

7.2.2.4 Out-of-pocket costs paid or reimbursed for travel and subsistence during said periods of travel of the Contractor Staff;

7.2.2.5 Cost of evaluation, selection, employment, relocation, and training of Contractor's Staff;

7.2.2.6 All office and administrative expenses (including stationery, telephone, fax, printer, scanner, photocopier, etc.);

7.2.2.7 Cost of uniform, personal safety equipment, etc. for Contractor's Staff;

7.2.2.8 Premium of insurance policies and deductible amounts for all insurance policies provided by the Contractor, as per Clause 11.0 (Insurance);

7.2.2.9 All costs and expenses associated with records management, including but not limited to preparation of materials, equipments, reproduction and storage expenses;

7.2.2.10 Cost of transporting the systems, equipments, construction materials, tools & plants, etc to the Site;

7.2.2.11 Cost of legal, payroll and accounting services with respect to the Contractor Staff, and accounting and legal matters related to the administration of this Contract;

7.2.2.12 Any and all other costs and expenses for performing services, not specifically set forth herein but incurred by the Contractor for fulfillment of its overall obligation covered under this Contract;

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7.2.3 Contract Price shall be inclusive of all applicable Indirect Taxes, as specified in Annexure 1 (Contract Price). Tax payable on income or profession of the Contractor, its employees and its Subcontractor shall be the sole responsibility of the Contractor, its employees and its Subcontractor and the Owner shall have no obligation regarding the same.

7.2.4 All payments to be made to the Contractor under this Contract shall be made net of any withholding or deduction, if applicable under any Applicable Law in force at the relevant time, including Income Tax Act, 1961. In case of such deduction made by the Owner from the amount payable to the Contractor, the Owner shall provide the Contractor with appropriate tax deduction certificates.

7.2.5 For the avoidance of doubt, it is clarified that the Contract Price includes any and all direct, indirect and ancillary charges, cess, costs and expenses of whatsoever nature, taxes on the Contractor, applicable indirect taxes on supplies under this Contract, all profit, license, royalty and fees, accessories, Consumables, Commissioning Spares, Mandatory Spares, Maintenance Tools & Tackles, and intellectual property licenses to be provided under this Contract, packaging and loading of the Materials, delivery at the Loading Point, unloading at site, insurance, installation, commissioning and training of OTPC staff.

7.2.6 Failure by Contractor to fully assess the scope of the implementation of the Complete Online monitoring system for ICT-2, LR-1 & 2, as specified in this Contract shall not be considered as a basis for variations to the Contract Price or any part thereof such as pricing of individual items (unit prices) and time and material rates for changes.

7.2.7 The Contract Price shall include mobilization, demobilization and site establishment charge which shall not be subject to adjustment based upon any additions or deletions to the Contract Price.

7.2.8 The Contract Price (including the break-up) specified under Annexure 1 (Contract Price), shall apply regardless of when the Services are performed, during day or night or a holiday.

7.2.9 Contract Price shall include all costs associated with and relating to, performing Services in accordance with all Applicable Laws as well as Owner's HES Policy and security regulations.

7.2.10 Failure by Contractor to assess fully the scope of Services, as required and described in this Contract shall not be accepted as a basis for variations to the Contract Price or any part thereof such as pricing of individual items and time and material rates for changes.

7.2.11 Contract Price shall be inclusive of all applicable Indirect Taxes as specified in Annexure 1 (Contract Price). Taxes and duties applicable on any imported services relevant to Contractor's scope of Services are also included in Contract Price. Tax payable on income or profession of the Contractor shall be the sole responsibility of the Contractor and the Owner shall have no obligation regarding the same.

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7.2.12 All payments to be made to the Contractor under this Contract shall be made net of any withholding or deduction as may be required under any Applicable Law in force at the relevant time including Income Tax Act, 1961. In case of such deduction made by the Owner from the amount payable to the Contractor, the Owner shall provide the Contractor with appropriate tax deduction certificates.

8.0 **PAYMENT TERMS**

8.1 The payment to the Contractor for the supply of the Materials, installation and commissioning of the entire system and the performance of its obligations under this Contract shall be made by the Owner as per the guidelines and conditions specified herein. All payments made during the Contract shall be on-account payment only. The final payment shall be made on Final Acceptance of the Facility and on fulfillment by the Contractor of all its liabilities under the Contract including those in respect of warranties etc. Payments to be made hereunder are subject to any adjustment/deductions as per the provisions of this Contract.

8.2 The Contract Price will be paid in Indian Rupees only.

8.3 **Payment Term:**

8.3.1 Ten percent (10%) of the Contract Price shall be released as initial advance within thirty (30) days of receipt of Invoice by Owner on fulfillment of the following conditions:

8.3.1.1 Unconditional and unequivocal acceptance of Work Order;

8.3.1.2 Submission of Performance Bank Guarantee as provided in Clause 12.0;

8.3.1.3 Submission of detailed PERT Network as specified in Clause 10.3;

8.3.1.4 Submission of an unconditional Bank Guarantee covering the advance amount which shall be initially kept valid till ninety (90) days after the Time for Completion. Format of Bank Guarantee (ABG) is attached as Annexure-4.

8.3.2 Sixty percent (60%) of the Contract Price shall be released as per billing break-up (BBU) approved by Owner on pro-rata basis against progressive receipt of Materials in good condition at Site within thirty (30) days of receipt of following documents by Owner in 1 (one) original + 2 (two) copies:

8.3.2.1 Invoice;

8.3.2.2 Copy of Consignment Note / Lorry Receipt having material receipt endorsed by Owner;

8.3.2.3 Copy of Way Bill / Road Permit used for transportation of Materials; and

8.3.2.4 Material Receipt Certificate issued by Owner;

8.3.3 Twenty percent (20%) of the Contract Price shall be released on pro-rata basis as per billing break-up (BBU) approved by Owner against progressive completion of Services duly certified by Project Manager within thirty (30) days of receipt of following documents by Owner in 1 (one) original + 2 (two) copies:

8.3.3.1 Work completion & measurement certificate duly certified by Project Manager;

8.3.3.2 Protocols required to be filled-in after completion of work as per approved Field Quality Plan duly signed by quality control engineer of Owner;

8.3.3.3 Running Account Bill (to be submitted on monthly basis) duly certified by Project Manager; and

8.3.3.4 Documentary evidence of payment of taxes, duties & levies.

8.3.4 Ten percent (10%) of the Contract Price shall be released by the Owner after Final Acceptance of Facility evidenced by final acceptance certificate issued by Owner and submission of as-built drawings, documents, test reports & certificates and Operation & Maintenance Manuals within 30 days of submission of Invoice and supporting documents.

8.4 **Mode of Payment**

8.4.1 Payment shall be made either by cheque or in such other manner as the Parties may mutually agree in writing. All bank charges shall be to the account of Contractor.

8.4.2 Applicable income tax/withholding tax/TDS shall be deducted while making payment and necessary certificate as per Applicable Law shall be issued in due course of time.

8.4.3 If the Owner disputes any item of an invoice, the Owner shall make payment for the undisputed portion of such invoice when such payment becomes due under this Contract. The Owner shall make the balance payment within 30 (thirty) days after resolution of the dispute in accordance with Clause 34.0 (Settlement of Disputes).

9.0 **TAXES, DUTIES & LEVIES**

9.1 The Contractor shall bear and pay all personal, property and corporate taxes (including withholding tax, if applicable), duties, levies and its related charges assessed on the Contractor (including surcharge on income tax), its Subcontractors (or their contractors) or their employees by a Government Agency in connection with the supply of Materials and performance of its obligations under this Contract ("**Direct Tax**"). For the avoidance of any doubt, it is clarified that all Direct Taxes by whatever name called, arising on the income of the Contractor, its Subcontractors (or their contractors) or their employees, shall be borne by the Contractor. The Contractor shall provide the requisite information/documents to the Owner (including its permanent account number), so as to enable the Owner in complying with its obligations as per Applicable Law.

9.2 The Contract Price is inclusive of all indirect taxes, duties and levies as applicable on the Effective Date, the description and rates of which and the corresponding amounts included in the Contract Price are specified in Annexure 1 (Contract Price) ("**Indirect Taxes**"). Only such Indirect Taxes shall be paid/reimbursed by Owner to Contractor as part of the Contract Price against documentary evidence of payment by Contractor thereof.

9.3 The Contractor acknowledges and agrees that the description, rates and corresponding amounts of Indirect Tax included in the Contract Price, as specified in Annexure 1 (Contract Price), has been provided by the Contractor on the Effective Date. The Owner's liability to reimburse/pay the Contractor in respect of any Indirect Tax is restricted to the extent such Indirect Tax is indicated in Annexure 1 (Contract Price). In the event this information is subsequently found to be incomplete, incorrect or misleading, the Owner shall have no liability to reimburse/pay the Contractor the excess amounts with respect to any Indirect Tax, if such amounts are finally levied / imposed / recovered by any Government Agency on / from the Contractor.

9.4 Any statutory variation (upward or downward) in Indirect Taxes, as specified in Annexure 1 (Contract Price) within Time for Completion shall be to the account of the Owner. The Contractor shall submit documentary evidence of above variation along with his invoice.

9.5 Imposition of new Indirect Taxes by the Central or State government within the Time for Completion shall be to the Owner's account. However, any increase in the rates of Indirect Taxes or imposition of new Indirect Taxes, beyond the Time for Completion shall be to the Contractor's account and any benefit of statutory downward revision in Indirect Taxes beyond the Time for Completion shall be passed on by the contractor to the Owner.

9.6 In the event that the Owner is required to pay the income tax/withholding tax applicable on supply of Materials and the performance of obligations under this Contract whether outside India or within India, the Owner shall deduct such taxes from the gross value of the Contractor's invoice and remit the net amount taking into account such deductions. However, the Owner shall furnish a TDS certificate to this effect in favour of the Contractor so as to enable it to take the tax credit.

9.7 All taxes, duties and levies applicable outside India on the performance of obligation under this Contract whether outside India or within India shall be included in the Contract Price. The Owner shall have no liability whatsoever in this regard.

10.0 TIME FOR COMPLETION

10.1 The Contractor agrees to complete the implementation of Complete Online monitoring system for ICT-2, LR-1 & 2 in a timely manner in accordance with the terms of this Contract. The Contractor admits and acknowledges that time is the essence of this Contract for the supply of the Materials and installation of the system.

10.2 The time for Completion of Implementation of Online Monitoring System for ICT-2, LR-1 & 2 along with associated systems shall be 3 (Three) months from the Effective Date (**"Time for Completion"**).

10.3 Contractor shall submit to Owner for his approval, within fifteen (15) days from the Effective Date, a detailed PERT Network, consisting of adequate number of activities covering various key phases of the implementation of the complete online monitoring system for ICT-2, LR-1 & 2 such as design, engineering, procurement, manufacturing, inspection, testing, packing, loading of materials at the Loading Point, Insurance, Unloading at site, Installation, Commissioning, training of OTPC staff and final handling over. The PERT Network shall be based on Time for

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Completion specified in Clause 10.2 above. Approved PERT Network shall form integral part of the Contract. As provided elsewhere in this Section, finalization of the PERT Network will be a precondition for release of any initial advance to the Contractor.

10.4 The Contractor shall promptly notify the Owner of any event or conditions which might delay the completion of intended system within Time for Completion and the steps being taken to remedy or mitigate such situation, including on its own initiative and at its own expense, increasing or supplementing the supervision, procurement and manufacturing to such an extent so as to restore the lost sequence or progress and provide assurance of compliance with the Time for Completion under this Contract. In the event the steps taken by the Contractor to remedy or mitigate such situation causes the Owner to incur additional costs, the Contractor shall reimburse such costs to the Owner. If the Contractor fails to take necessary steps to remedy or mitigate a delay, then the Owner may take such steps as it may deem necessary, in its sole discretion (including but not limited to engaging other contractor's to perform the obligations under this Contract and deduct the cost of the same from the Contract Price).

11.0 LIQUIDATED DAMAGES AND INSURANCE

11.1 Liquidated Damages for Delay in Completion

11.1.1 In case of failure of Contractor to complete the implementation of the online monitoring system for ICT-2, LR-1 & 2 within Time for Completion specified in Clause 10.2, the Contractor shall pay to the Owner liquidated damages as follows:

For every 1 (one) week (or part thereof) delay in completion of system for reasons not attributable to the Owner, the Contractor shall pay to the Owner a sum equivalent to half percent (0.5%) of the Contract Price.

11.1.2 The total amount of liquidated damages payable by the Contractor on account of delay in completion of system under Clause 11.1 shall be limited to 10% (ten percent) of the Contract Price.

11.2 Liquidated Damages for Shortfall in Guaranteed Performance during Warranty Period

11.2.1 In case of failure of Contractor to achieve the guaranteed performance for the Online monitoring system for ICT-2, LR-1 & 2 during Warranty Period specified in Clause 43.2, the Contractor shall pay to the Owner liquidated damages as follows:

For every 0.1% (zero decimal one percent) (or part thereof) decrease in guaranteed availability of the Online monitoring system for ICT-2, LR-1 & 2 , 0.5% (zero decimal five percent) of Contract Price shall be paid as liquidated damage by the Contractor to the Owner on a *pro rata* basis.

11.2.2 The total amount of liquidated damages payable by the Contractor on account of shortfall in guaranteed performance under Clause 11.2 shall be limited to 10% (ten percent) of the Contract Price.

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11.3 Payment or deduction of liquidated damages shall in no way relieve the Contractor from discharging its other obligations under this Contract.

11.4 Owner may recover the liquidated damages payable by the Contractor from any amounts due to it or which may subsequently become due to it under this Contract or any other contract.

11.5 For the avoidance of doubt it is clarified, that the Owner's right to receive liquidated damages in accordance with this Clause 11.0 is without prejudice to any other rights the Owner may have under Applicable Law or otherwise in connection with the breach of any other obligations hereunder by the Contractor.

11.6 The total amount of liquidated damages payable by the Contractor under Clause 11.1 and Clause 11.2 shall be limited to 15% (fifteen percent) of the Contract Price.

11.7 **INSURANCE**

11.7.1 Without prejudice to its obligations under this Contract or otherwise under Applicable Law, the Contractor, at its cost, shall arrange, secure and maintain all such insurance as may be required in connection with the performance of the Services and obligatory in terms of Applicable Law, to protect its interest and interest.

11.7.2 It shall be responsibility of the Contractor to maintain all necessary insurance coverage (including those for professional liability) to the extent both in time and amount to take care of all its liabilities either direct or indirect, in pursuance of the Contract.

11.7.3 All Insurer's right of subrogation against Owner for losses or claims arising out of the performance of the Contract shall be waived under such policies.

11.7.4 Neither failure to comply nor full compliance with the insurance provisions of this Contract shall limit or relieve the Contractor of its liabilities and obligations under this Contract.

12.0 **PERFORMANCE BANK GUARANTEE**

12.1 The Contractor shall, within 15 (fifteen) days of the Effective Date, provide to the Owner an unconditional and irrevocable performance bank guarantee of an amount equivalent to 10% (ten percent) of the Contract Price for implementation of Total Online monitoring system for ICT-2, LR-1 & 2 and due performance of its obligations under this Contract, with an initial validity of up to 90 (ninety) days beyond the Warranty Period, a format of which is attached as Annexure 3 (Format of Performance Bank Guarantee) ("**Performance Bank Guarantee**").

12.2 If, at the time of discharge of Performance Bank Guarantee, the Warranty Period has been extended pursuant to Clause 27.5 or if a dispute has been referred for resolution pursuant to Clause 34.0 (Settlement of Disputes), the Contractor shall, on or before 21 (twenty one) days before the expiry of the Performance Bank Guarantee, issue an extension of the existing Performance Bank Guarantee or issue a separate security in the form of an unconditional and irrevocable bank guarantee for an amount proportionate to the Contract Price for such part, valid till the

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extended Warranty Period or until final resolution of the dispute and payment of any amount due as a result thereof, as the case may be.

12.3 The Performance Bank Guarantee to be submitted by Contractor shall be from an Acceptable Bank and in the form acceptable to the Owner and as prescribed under Annexure 3 (Format of Performance Bank Guarantee).

12.4 The Contractor acknowledges and agrees that the Performance Bank Guarantee shall be held by the Owner as security for the satisfactory completion of the obligations of the Contractor, in accordance with this Contract, including recovery of any amounts due to the Owner from the Contractor .The Owner shall have the unconditional option under the Performance Bank Guarantee to invoke and encash the same and shall be entitled to recover from such Performance Bank Guarantee, any amounts which may become due to the Owner from the Contractor.

12.5 In the event the credit rating of the Acceptable Bank which has provided the Performance Bank Guarantee falls below AA+ by Credit Rating and Information Services India Limited or below AA by ICRA Limited or below AA+ by Credit Analysis and Research Limited or below BBB Fitch Ratings, then the Contractor shall provide a fresh Performance Bank Guarantee from an Acceptable Bank which has a credit rating equal to or higher than the credit ratings mentioned in this Clause 12.5.

13.0 ENGINEERING DOCUMENTS, MANUALS AND TESTS CERTIFICATES

13.1 Engineering Drawings & Documents

13.1.1 The furnishing of engineering data by the Contractor shall be in accordance with the Technical Specifications. The review of these data by the Owner shall normally cover only general conformance of the data to the provisions of the Contract including Technical Specifications and interfaces, external connections and dimensions which might affect Plant layout. Such review by the Owner may not be a detailed review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and or/approval by the Owner shall not be construed by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements specified under the Contract including Technical Specifications.

13.1.2 Each drawing submitted by the Contractor shall be clearly marked with the name of the Owner, the Project title, the Contract No., the title of drawing, scale, date of drawing, the Contractor's drawing No., space for Owner' drawing No etc. In addition to the above information provided on drawings, each drawing shall carry a revision number, date of revision and brief details of revision carried out. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions shall be in metric units.

13.1.3 Within two (2) weeks from the Effective Date, the Contractor shall submit to Owner for his approval a list of all the drawings, documents, design calculations, material specifications, data-sheets etc proposed to be submitted by Contractor to the Owner for approval / reference identifying each by a serial number and descriptive title and giving the expected date of submission.

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13.1.4 The Contractor shall satisfy the Owner about the validity of the design with reference to the requirements of Technical Specifications, engineering codes, Good Engineering & Manufacturing Practices and Applicable Laws.

13.1.5 Drawings submitted for approval / reference shall be signed by responsible representative of the Contractor and shall be of any of the following sizes in accordance with the Indian Standard: A0, A1, A2, A3 or A4.

13.1.6 The drawings and documents submitted by the Contractor shall be reviewed by the Owner as far as practicable within Two (2) weeks and shall be modified by the Contractor if any modifications and / or corrections are required by the Owner. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings and documents for approval within two (2) weeks from the date of receipt of commented drawings and documents from the Owner. Any delays arising out of failure by the Contractor to submit the revised drawings and documents within the time for resubmission specified above shall be to the Contractor's account. While resubmitting the drawings and documents Contractor shall incorporate Owner's drawing and document number in the respective drawings and documents. The Owner's drawing and document number shall be used thereafter for all purpose of reference.

13.1.7 Three (3) hard copies and one (1) soft copy of the drawings and documents shall be submitted by the Contractor to the Owner for approval/reference. One copy of such drawings and documents shall be returned to the Contractor by the Owner marked 'Approved / Approved with comments as noted / Marked with comments / Retained for information'. The Contractor shall thereupon furnish to the Owner, the revised drawings and documents after incorporating all corrections for final approval.

13.1.8 Supply of equipments/materials shall be in strict accordance with approved drawings and documents and no deviation shall be permitted without the written approval of the Owner, if so required.

13.1.9 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings (Approved / Approved with Comments as noted) shall be at the risk and cost of Contractor. Subject to approval by the Owner, the Contractor may make necessary changes in the drawings and documents which are necessary to make the equipment conform to the provisions and intent of the Contract including Technical Specifications. Approval of Contractor's drawings by the Owner shall not relieve the Contractor of any of his responsibilities and liabilities under the Contract.

13.1.10 Any expenses resulting from an error or omission in or from the delay in delivery of the drawings and documents mentioned in the Technical Specification shall be borne by the Contractor.

13.1.11 Drawings shall include all installation and detailed cabling drawings wherever applicable. All drawings shall be fully corrected to agree with actual 'as built' construction.

13.1.12 Upon completion of installation, the Contractor shall submit 'As built Drawings' and 'As built Documents' including As built datasheet in required No. of copies as specified in Technical Specifications.

13.1.13 If at any time before Final Acceptance of the system, changes are made necessitating revision of the approved drawings and documents, the Contractor shall make such revisions and obtain approval of Owner as specified in Clause No. 13.1.5 and 13.1.6.

13.2 **Manuals and Test Certificates**

13.2.1 The Contractor shall submit to the Owner for his review and approval, draft installation, operation & maintenance manuals for all the equipments covered under the Contract, within the time agreed upon between the Owner and the Contractor. The final installation, operations & maintenance manuals, complete in all respects shall be submitted by the Contractor within 10 days of the commissioning of the system.

13.2.2 The Contractor shall furnish to the Owner spare parts catalogue.

13.2.3 The Contractor shall submit the following documents in line with Clause 13.1 and 13.2:

13.2.3.1	Printed Pamphlets / Catalogues	6 hard copies + 1 soft copy
13.2.3.2	Manuals (Preliminary)	6 hard copies + 1 soft copy
13.2.3.3	Manuals (Final)	6 hard copies + 1 soft copy
13.2.3.4	Manuals (Updated), if required	6 hard copies + 1 soft copy
13.2.3.5	Any other relevant information	6 hard copies + 1 soft copy
13.2.3.6	All Test Certificate in bound volumes	6 hard copies + 1 soft copy

14.0 **CONTRACTOR's OBLIGATIONS**

14.1 **General**

14.1.1 In addition to other specific obligations set out elsewhere in this Contract, the Contractor shall have the obligations set out in this Clause 14.0.

14.1.2 It shall be the responsibility of the Contractor to supply Equipment/Materials which shall be new and in good condition. Contractor shall supply the Materials which shall meet all the requirements provided under the Technical Specifications. Equipment selected shall be sufficient to meet the requirements of the system as mentioned in the Technical specifications.

14.1.3 The Contractor shall be fully responsible for preparing, packaging and loading the Materials on to the mode of transportation at the Loading Point, including for the payment of all packaging, loading and handling costs and expenses. Unloading of the materials at site, installation and commissioning of the system is also under the scope of contractor.

14.2 **Industrial Practice**

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14.2.1 The Contractor shall be responsible for performing its obligations under this Contract, including for associated purchases and/or subcontracting with due care and diligence and in accordance with Good Engineering & Manufacturing Practices, using sound supervisory procedures, and in a professional and workmanlike manner, in accordance with Applicable Law and the Technical Specifications and within the Time for Completion. The Contractor shall supply all Materials as per the specifications provided under the Technical Specifications. The Contractor shall ensure that the Materials shall be fit for the purpose for which each of them is intended as per the provisions of this Contract.

14.3 **Means and Methods**

14.3.1 The Contractor shall, at all times, be responsible for the efficiency and adequacy of its planning, co-ordination with its Subcontractors, design, securing of approvals, means and methods of performance, materials and equipment, irrespective of whether the Contractor acts as a result of any advice or reviews of the Owner.

14.3.2 The Contractor shall, whenever required by the Owner, submit details of the arrangements and methods which the Contractor proposes to adopt for performance of its obligations under this Contract. No significant alteration to these arrangements and methods shall be made without the same being previously notified to the Owner.

14.4 **Compliance with Laws**

14.4.1 The Contractor shall at all times be in compliance with all Applicable Laws, in the performance of its obligations under this Contract. The Contractor shall also ensure such compliance by its Subcontractors.

14.4.2 The Contractor shall at its cost, in a timely manner so as not to delay the progress of its obligations hereunder and in any event before the time required by Applicable Law, obtain all applicable Permits required for the completion of its obligations under this Contract.

14.4.3 The Contractor shall not, under any circumstances, cause or permit, in connection with the obligations to be performed hereunder, the discharge, emission or release of any hazardous substance and/or waste, pollutant, contaminant or other substance in violation of any Applicable Laws.

14.5 **Packaging**

14.5.1 **General**

14.5.1.1 All Materials shall be protected and securely packed and loaded in a manner commensurate with the transportation stresses and hazards encountered in such supply in accordance with internationally accepted transportation principles. The Contractor shall ensure that the packing provides adequate protection to the Materials from the rigors of multiple handlings, loadings and unloading. If any of the Materials are damaged, lost, stolen, destroyed or otherwise impaired prior to the completion of loading at the Loading Point, the Contractor shall, at its own cost and expense, restore or replace such affected Materials. The provisions of this Clause are designed to facilitate preservation, safe arrival, and expeditious movement of the

Materials to the Site and provide the general requirements for packaging of the Materials. The provisions of this Clause are neither a packing manual, nor a substitute for internationally recognized packing practices and the Contractor shall be fully responsible for the quality of packaging.

14.5.2 **Packing Procedure**

14.5.2.1 The Materials shall be packed in accordance with standard practices of the industry and of the mode(s) of transportation to be utilized or expected to be utilized for transportation and as specifically notified by the Owner from time to time.

14.5.2.2 The Contractor shall provide packing and packaging to protect the Materials while in storage for up to 6 (six) months.

14.5.2.3 The Contractor will use its knowledge of the Materials to provide supplementary packaging when customary and usual packaging may not provide sufficient protection. The packaging shall be in a manner such that the Materials are protected against mechanical damage (shocks, rupture, breakage, loss, etc.) and corrosion (rain, salty atmosphere, sand, wind, etc.).

14.5.2.4 Additional appropriate packing shall be considered when the Materials, or any component thereof is required to be stored outside.

14.5.2.5 The Materials shall be clean and free from metallic filings, machining debris and cleaning media such as blasting grit, if applicable.

14.5.2.6 Contractor shall adhere to the requirements of Applicable Law governing treatment to prevent infestation and mold in wood used in pallets, skids, crates, boxes or any other items used as packing material.

14.5.2.7 Contractor shall ensure adequate additional boxing or crating for consolidated small packaged and/or loose items.

14.5.2.8 Each item in each package shall be labelled or marked so that it can easily be identified by the packing list. 1 (one) copy each of the final detailed packing list shall be affixed in water tight containment on the outside of each package, container or crate secured under a metal sheet, and one copy shall be placed inside the package, container or crate. The Contractor shall also apply standard symbols indicating care and precaution to be used in handling and storing of each package. For out-of gauge consignments, either heavy or over dimensional, the center of the package shall be marked and clearly indicate the lifting points.

14.5.2.9 All means, methods and techniques of packing utilized, shall be appropriate for the conditions and materials involved and in accordance with the current state of the art and keeping with delivery schedule.

14.5.3 **Protection Against Damage in Transit**

14.5.3.1 The Contractor shall prepare all Materials for delivery in such manner so as to ensure that the packing is adequate, is of minimum size and to protect such Materials from damage in transit. Further, the packing shall be such that the Materials shall withstand rough handling, storage in hot and humid climate

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prevailing at the Site and shall be in compliance with any size, weight or handling limitations that are applicable. The Contractor shall pack the Materials in such a manner so as to ensure that no damage is caused to the same while in transit or during storage.

14.5.4 **Hazardous Materials**

14.5.4.1 Hazardous Materials shall be packed only in certified containers or only with certified packaging material in accordance with Applicable Law, including BARC and DAE Rules. The Contractor shall clearly mark all packages containing Hazardous Materials with the appropriate symbols and placards.

14.5.4.2 The Contractor hereby fully indemnifies the Owner with respect to any liability arising on account of any escape of Hazardous Material.

14.6 **Corrupt/Fraudulent Practices**

14.6.1 The Contractor shall not, directly or indirectly, engage in any Corrupt Practice, Fraudulent Practice, Coercive Practice or Obstructive Practice during the negotiation of this Contract or at any time during the Term.

15.0 **TRANSFER OF TITLE**

15.1 **Title**

15.1.1 The title to the Materials manufactured in India and supplied directly by the Contractor shall be transferred to the Owner at the Loading Point upon completion of loading of the materials on to the mode of transportation.

15.1.2 The title to the materials manufactured in India and supplied directly by the Sub-contractor to the Owner, shall be transferred to the Owner during the transit by way of transfer of document of title to materials by the Contractor after loading of the materials at the Loading Point and delivery to the transporter for transportation.

15.1.3 The title to the materials manufactured outside India and supplied directly by the Contractor shall be transferred to the Owner at the Loading Point upon completion of loading of the materials on to the mode of transportation used for transporting it to India.

15.1.4 The title to the materials manufactured outside India and supplied directly by the Sub-contractor to the Owner, shall be transferred to the Owner during the transit by way of transfer of document of title to materials by the Contractor after completion of loading of the materials at the Loading Point on to the mode of transportation used for transporting it to India.

15.1.5 Ownership of Materials in excess of the requirement for successful completion of erection and commissioning of Facility shall revert to the Contractor after successful Completion of Supply of Materials and Taking-Over of Materials.

15.2 **Responsibilities of Contractor**

15.2.1 The Contractor shall continue to be responsible for the risk of loss or damage to the Materials up to the completion of loading of the Materials on to the mode of

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transportation and for the quality and performance of the Materials till the end of the Warranty Period.

16.0 **QUALITY ASSURANCE PROGRAM**

16.1 **Inspection**

16.1.1 To ensure the conformance of the Materials, whether manufactured by Contractor or by its Subcontractors, with the provisions of this Contract, Contractor shall adopt, as well as ensure adoption by its Subcontractor, suitable Quality Assurance Program. The Owner or its representative(s) shall have the right to inspect and/or to test the Materials to check their conformity with the provisions of this Contract.

16.1.2 The Quality Assurance Program, proposed for adoption by the Contractor, shall be submitted for review and approval of the Owner, within 20 (twenty) days of the Effective Date. It shall *inter alia* specify required inspections and tests to be carried out by Contractor as per Contract and applicable codes for all phases of manufacturing and supply, the procedures involved, the place where such inspections and tests shall be conducted, acceptance basis, acceptance criteria and the customer hold points (CHPs) beyond which manufacturing shall not proceed without specific clearance from Owner. The approved Quality Assurance Program shall form part of this Contract and shall be strictly adhered to.

16.1.3 In case of customer hold points / stage inspection, Contractor shall proceed from one stage to another only after the Materials have been inspected and tested by the Owner and / or their representative and permission has been given to proceed further. The procedure shall be adopted for any rectification / repairs suggested by Owner or their representative.

16.1.4 The Contractor shall give not less than 15 (fifteen) day's prior notice as to the time and place of any scheduled inspection. Contractor shall submit following documents along with inspection call notice:

16.1.4.1 All Non-destructive examination procedures, stress relief and weld repair procedure actually used during fabrication

16.1.4.2 Welder and welding operator qualification certificates

16.1.4.3 Welder identification list, welder' and welding operator' qualification procedure and welding identification symbols.

16.1.4.4 Material mill test reports on components as specified by the specification.

16.1.4.5 The inspection plan with verification, inspection plan check points, verification sketches, if used, and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.

16.1.4.6 Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

16.1.4.7 All Non-destructive examination result reports including radiography interpretation reports.

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16.1.4.8 Stress relief time temperature charts.

16.1.4.9 Factory test results for testing required as per applicable codes and standard referred in the specifications.

16.1.5 In the event the Contractor fails to provide the Owner and/or their representative(s) at least 15 (fifteen) days prior notice of scheduled inspections, the Contractor shall pay for any costs incurred by the Owner and / or their representative in conducting the inspection which are greater than the costs which would have been incurred with proper notice. Provided, all costs of the Owner or their representative shall be borne by Owner if 15 (fifteen) day's prior notice is provided by the Contractor.

16.1.6 Contractor shall provide at his own cost all facilities including labour, materials, electricity, fuel, water, stores, apparatus, instruments etc reasonably required by Owner and/or their representative for effectively carrying out such inspection and tests of the Materials in accordance with the Contract and applicable codes.

16.1.7 Owner may ask Contractor to perform any such inspection and tests which are not specified in Contract and Quality Assurance Program. Contractor shall perform such inspection and tests and Owner shall pay to the Contractor reasonable cost incurred in carrying out such inspection and tests.

16.1.8 Inspection and acceptance of the Materials by the Owner and / or their representative shall not limit the liabilities and responsibilities of the Contractor in any manner and shall not prejudice the right of the Owner to reject the Materials if it is found to be defective during inspection after receipt at Site or if it fails to achieve guaranteed performance specified in the Contract.

16.1.9 Materials shall be dispatched only after inspection at Contractor's / Subcontractor's works is carried out and Materials are found to be acceptable. However, Owner reserves the right to waive-off inspection by Owner and / or their representative and allow dispatch of Materials to Site without inspection.

16.1.10 Contractor shall be responsible for monitoring each Subcontractor's compliance with the approved Quality Assurance Program. The Owner shall have right to conduct audits of the Contractor's Quality Assurance Program. Contractor shall cooperate with and extend all support to Owner in carrying out such audits.

16.2 **Material Tests**

16.2.1 The Contractor shall provide, at his own cost, test pieces as required by the Owner to enable him to determine the quality of material supplied under this Contract. If any test piece fails to comply with the requirements, the Owner may reject the whole material represented by the test piece.

16.2.2 Plates, sheets and bar stock materials meant for components of vessels shall be subjected to ultrasonic testing in accordance with codes specified or approved equal.

16.2.3 All high pressure pumps, valves and other high pressure casting shall be subjected to radiographic testing in accordance with codes specified or approved equal

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16.2.4 All forgings shall be subjected to ultrasonic and magnetic particle testing in accordance with codes specified or approved equal

16.2.5 All ferrous and non-ferrous pipes and tubes of 65mm size and under shall be subject to eddy current testing in accordance with codes specified or approved equal

16.2.6 All U-bent tubes made of copper alloy shall be stress relieved.

16.2.7 All materials used in manufacturing of Materials covered by the Contract shall also be subjected to one or more of the following non-destructive tests (NDT) – visual, dye penetration, magnetic particles, ultrasonic or radiographic. Salvaging of material due to unacceptable defect is to be attempted by the Contractor only after getting specific concurrence from the Owner and according to the approved procedures.

16.2.8 Unless otherwise specified, NDT tests shall be witnessed by the Owner.

16.3 **Welding**

16.3.1 All welding involved in the manufacturing of Materials shall be carried out in accordance with applicable codes or approved equal.

16.3.2 Welding Procedure and welder's qualifications shall be approved by the Owner, where applicable. Welders shall be tested as detailed in codes specified for pipe welding, vessel welding and structural welding and appropriate to the corresponding weld position using test pieces of appropriate parent metal to be used on the job. The Owner shall have the right to have any welder retested at any time during this Contract.

16.3.3 Approved methods of radiographic, ultrasonic or other non-destructive testing shall be carried out for the welding of seams in pipes and vessels. Recommendations of codes specified shall be followed where applicable

16.3.4 Weld coupon plates shall be tested subsequent to heat treatment.

16.3.5 Copies of all welding procedures, preheating, post-heating and stress relieving records, NDT records and other test results shall be made available upon request to the Owner.

16.3.6 Fabrication/inspection procedures for vessels, heat exchangers, pipes, tubes, valves, etc. shall be in accordance with codes specified or any other approved equal.

16.3.7 If the Contractor has special requirements relating to the welding procedures for welds at the terminals of the equipment to be procured by the Owner under separate specifications, the requirements shall be submitted to the Owner well in time.

16.4 Price for all inspection and tests to be carried out till Final Acceptance of Facility and during Warranty Period are included in Contract Price.

16.5 Nothing in this Clause 14.0 shall, in any way, release the Contractor from any of its Warranty or other obligations under this Contract.

17.0 **DELETED**

18.0 **INDEMNIFICATION**

18.1 **Indemnification by Contractor**

18.1.1 Contractor agrees to defend, indemnify and hold harmless the Owner, its Affiliates, and all of their directors, officers, employees, agents and representatives ("**Owner Indemnified Parties**"), from and against any and all Losses arising:

18.1.1.1 By reason of Contractor's actual or asserted failure to comply with any Applicable Law or any provision of this Contract. If the Contractor fails to comply with the requirements mentioned above and as a result fines, penalties or other assessments are imposed upon either the Contractor or the Owner by any Government Agency under any Applicable Law, then the Contractor shall be liable to pay all such fines, penalties or other assessments;

18.1.1.2 From actual or asserted violation or infringement of rights in any patent, copyright, proprietary information, trade secret or other property right caused or alleged to be caused by the use of materials, equipment, methods, processes, designs or information supplied by Contractor or its Subcontractors in performance of its obligations under this Contract. Should any Materials supplied by Contractor become, or appear likely to become, the subject of a claim of infringement of a patent, copyright or other property right, Contractor shall, at the Owner's option, either procure for the Owner the right to continue using such Materials or replace same with equivalent, non-infringing Materials, provided that any such replacement is of equal quality as the infringing Materials;

18.1.1.3 From injury to or death of any Person (including employees of the Owner, Contractor and Contractor's Subcontractors or any third party) or from damage to or loss of property (including the property of the Owner or a third party) arising directly or indirectly out of this Contract or out of any acts of omission or commissions of Contractor or its Subcontractors. Contractor's indemnity obligations hereunder include claims and damages arising from non-delegable duties of the Owner or arising from use by Contractor of facilities furnished to Contractor by the Owner; or

18.1.1.4 From present or future Environmental Claims directly or indirectly related to or arising out of the actual or alleged existence, generation, use, delivery, collection, treatment, storage, transportation, recovery, removal, discharge or disposal of Hazardous Material at the Plant and/or adjacent areas solely to the extent arising out of the gross negligence or Willful Misconduct of the Contractor, its Subcontractors in the performance of its obligations under this Contract.

18.1.2 Contractor's indemnity obligations shall apply regardless of whether the Owner Indemnified Party was concurrently negligent, whether actively or passively, excepting only where the Losses are caused solely by the negligence or Willful Misconduct of, or by defects in design furnished by the Owner Indemnified Party. Contractor's defense and indemnity obligations shall include the duty to reimburse any attorneys' fees and expenses incurred by the Owner Indemnified Party for legal action to enforce Contractor's indemnity obligations.

18.1.3 With respect to claims by employees of Contractor or its Subcontractors on the Owner Indemnified Party, the indemnity obligations created under this Clause 18.1 shall not be limited by the fact of, amount, or type of benefits or compensation payable by or for Contractor, its Subcontractors under any workers' compensation, disability benefits, or other employee benefits acts or regulations, and Contractor waives any limitation of liability or immunity arising from workers' compensation or such other acts or regulations.

18.1.4 The Owner shall be entitled to retain from payments otherwise due to Contractor such amounts as shall reasonably be considered necessary to satisfy any claims, suits or liens for damages that fall within Contractor's indemnity obligations under this Clause 18.1, until such claims, suits or liens have been settled and satisfactory evidence to that effect has been furnished to the Owner.

18.1.5 Contractor acknowledges that specific payment has been incorporated into the Contract price as legal consideration for Contractor's indemnity obligations as provided in this Contract.

18.2 **Indemnification by Owner**

18.2.1 Owner agrees to defend, indemnify and hold harmless the Contractor, its Affiliates, and all of their directors, officers, employees, agents and representatives (**"Contractor Indemnified Parties"**) from and against any and all Losses arising out of or resulting from claims of third parties for any damage to or destruction of property of, or death of or bodily injury to, any Person due to any gross negligence or Willful Misconduct of the Owner in the course of performance of its obligations under this Contract; provided that the foregoing obligations shall not apply to the extent the Contractor Indemnified Parties are negligent or to the extent such Losses are caused by the acts of omission or commissions of the Contractor Indemnified Parties.

18.3 **Defense of Claims**

18.3.1 The indemnifying Party shall be entitled, at its option, and expense and with counsel of its selection, to assume and control the defense of any claim, action, suit or proceeding in respect of, resulting from, relating to or arising out of any matter for which it is obligated to indemnify the other Party hereunder, provided it gives prompt notice of its intention to do so to the indemnified Party and reimburses the indemnified Party for the reasonable costs and expenses incurred by the indemnified Party in connection with the defense of such claim, action, suit or proceeding, prior to the assumption by the indemnifying Party of such defense.

18.3.2 Notwithstanding the provisions of Clause 18.3.1, unless and until the indemnifying Party acknowledges in writing its obligation to indemnify the indemnified Party and assumes control of the defense of a claim, suit, action or proceeding in accordance with Clause 18.3.1, the indemnified Party shall have the right, but not the obligation, to contest, defend and litigate, with counsel of its own selection, any claim, action, suit or proceeding by any third party alleged or asserted against such Party in respect of, resulting from, related to or arising out of any matter for which it is entitled to be indemnified hereunder, and the reasonable costs and expenses thereof shall be subject to the indemnification obligations of the indemnifying Party hereunder.

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18.3.3 Neither Party shall be entitled to settle or compromise any such claim, action, suit or proceeding without the prior written consent of the other Party; provided, however, that after agreeing in writing to indemnify the indemnified Party, the indemnifying Party may settle or compromise any claim without the approval of the indemnified Party. Except where such consent is unreasonably withheld, if an indemnified Party settles or compromises any claim, action, suit or proceeding in respect of which it would otherwise be entitled to be indemnified by the other indemnifying Party without the prior written consent of the other indemnifying Party, the other indemnifying Party shall be excused from any obligation to indemnify the indemnified Party making such settlement or compromise in respect of such settlement or compromise.

18.3.4 Following the acknowledgment of the indemnification and the assumption of the defense by the indemnifying Party, the indemnified Party shall have the right to employ its own counsel and such counsel may participate in such action, but the fees and expenses of such counsel shall be at the expense of such indemnified Party.

18.4 In the event that the indemnity provisions in this Contract are contrary to the laws of India, then the indemnity obligations applicable hereunder shall be construed to be to the fullest extent allowed by Applicable Law.

18.5 Provision of this Clause 18.0 shall survive termination or expiry of this Contract.

19.0 **LIMITATION OF LIABILITY**

19.1 Both Owner and Contractor understand and agree that there shall be absolutely no personal liability on the part of any of the members, shareholders, officers, employees, directors, agents, authorized representatives or Affiliates of the Owner or Contractor for the payment of any amounts due hereunder, or performance of any obligations hereunder.

19.2 With the exception of those provision of this Contract providing for the payment of liquidated damages, neither the Contractor nor the Owner shall be liable to the other as a result of any action or inaction under this Contract or otherwise for any special, indirect, incidental or consequential losses such as but not limited to loss of profit, loss of revenue, loss of power, loss of opportunity, loss of goodwill, loss of contracts or cost of capital. It is hereby agreed that this limitation of liability shall not apply in respect of claims for which either Party is indemnified under Clause 18.0 (Indemnification). Nothing in this Clause 19.0 shall reduce the Contractor's liability for liquidated damages in accordance with the provisions of this Contract.

19.3 The aggregate liability of the Contractor with respect to all claims arising out of or in connection with performance or non-performance of this Contract whether in contract, warranty, tort or otherwise shall not exceed the Contract Price, provided that this limitation shall not apply in case of negligence, Willful Misconduct or liabilities arising out of indemnity provisions in this Contract.

19.4 The provisions of this Contract constitute Contractor's and Owner's exclusive liability, respectively, to each other, and Contractor's and Owner's exclusive remedy, respectively, to each other, with respect to the obligations under this Contract.

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20.0 **SUSPENSION**

20.1 Owner reserves the right, at its convenience, to suspend and reinstate performance of the whole or any part of this Contract without invalidating the provisions of this Contract. Orders for suspension or reinstatement of the performance of this Contract shall be issued to the Contractor in writing.

20.2 Upon receiving any such notice of suspension, Contractor shall promptly suspend further performance of this Contract to the extent specified, and during the period of such suspension shall take proper care of and protect all supplies Contractor has with it for performance of its obligations under this Contract. Upon the request of the Owner, the Contractor shall promptly deliver to the Owner copies of outstanding Subcontracts of Contractor and shall take such action with respect to such Subcontracts as may be directed by the Owner. Contractor shall use its best efforts to mitigate costs associated with suspension. Owner may, at any time, withdraw the suspension of performance of the Contract as to all or part of the suspended obligations by written notice to the Contractor specifying the effective date and scope of withdrawal, and Contractor shall resume diligent performance of its obligations for which the suspension is withdrawn on the specified effective date of withdrawal.

20.3 The Time for Completion shall be extended for a period equal to the duration of the suspension provided the suspension is not due to some default on the part of Contractor.

20.4 If such suspension continues for a continuous period of 180 (one hundred and eighty) days, at the end of such period, Contractor or Owner may, by a further 30 (thirty) days prior written notice, terminate the Contract and in such case Owner shall pay to the Contractor costs in accordance with Clause 32.6 of this Contract as if such termination was a termination under Clause 32.4 of this Contract.

21.0 **CHANGE IN CONTROL**

21.1 The current shareholding of the Contractor is provided in Annexure 6 (Current Shareholding of the Contractor). From the Effective Date no change in Control of the Contractor shall be permitted without the prior written consent of the Owner.

22.0 **PROGRESS REPORT AND APPLICABLE LABOR LAWS**

22.1 The Contractor shall submit formal written and quantitative reports to the Owner on the progress of the manufacturing and supply of Materials in a format approved by the Owner and in sufficient detail to permit the Owner to assess performance. Within 10 (ten) days of the submission of each such report and at such other times as the Owner may reasonably request, the Contractor and the Owner shall meet to discuss progress. Each monthly progress report shall be submitted no later than the 5th day of the month following that in respect of which it is made, but may report on actual progress only up to the 25th day of the month and anticipated progress thereafter. Monthly progress reports shall include the followings:

22.1.1 executive summary;

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22.1.2 description of the design, engineering, procurement, manufacturing, inspection, testing and supply activities performed during the preceding month;

22.1.3 updated Project Schedule showing progress up to the end of the month (as percentages completion of the activities broken down into significant elements of the supply of Materials), current schedule of activities and targets for the next month;

22.1.4 design & engineering, procurement, raw material & components availability, manufacturing and inspection status for the previous month and current months showing planned vs. actual, monthly and cumulative.

22.1.5 updated billing schedule showing the billing and payment status and cash flow forecast;

22.1.6 areas of concern;

22.1.7 Corrective Action Plan;

22.1.8 such other information and supporting documentation as the Owner may reasonably request;

22.2 Contractor shall submit six (6) hard copies and one soft copy of the progress report.

22.3 All progress review meeting shall be held at Palatana or New Delhi as advised by Owner.

22.4 In the event performance of the Contract is not in compliance with the schedule established for such performance, Owner may, in writing, require the Contractor to submit its plan for schedule recovery, or specify in writing the steps to be taken to achieve compliance with such schedule, and/or exercise any other remedies under this Contract. Contractor shall thereupon take such steps as may be directed by Owner or otherwise necessary to improve its progress without additional cost to Owner.

22.5 **APPLICABLE LABOUR LAWS**

22.5.1 The Contractor shall comply with all the rules and regulations under the Applicable Law during the performance of the Services under this Contract.

22.5.2 The Contractor shall comply with all Applicable Laws with respect to employment of labour (issued by the Central Government or the State Government as the case may be).

22.5.3 The Contractor shall *inter alia* comply with the provision of the Payment of Wages Act, 1936, Minimum Wages Act, 1948, Employees Liability Act, 1938, Workmen's Compensation Act, 1923, Industrial Disputes Act, 1947, Maternity Benefits Act, 1961, Employees' Provident Funds and Miscellaneous Provisions Act, 1952, Contract Labour (Regulation and Abolition) Act, 1970, Inter State Migrant Labour Act, 1979 and Employees State Insurance Act, 1948 or any modification thereof or any other law relating thereto and rules made there under from time to time.

22.5.4 The Contractor shall obtain all Permits required under Applicable Law in connection with the Contractor Staff employed by it for performing the Services including but not limited to licenses required under Contract Labour (Regulation and Abolition) Act, 1970 and rules made there under; the registration under the Employees' Provident Funds and Miscellaneous Provisions Act, 1952 and obtaining the Employee Provident Fund (EPF) Code. All registration and statutory inspection costs and expenses (including payment of fees), if any, in respect of the performance of the Services pursuant to this Contract shall be to the account of the Contractor.

22.5.5 The Contractor shall pay to the labour, employed by it, either directly or through Subcontractors, wages in accordance with the provisions of the Minimum Wages Act, 1948 and the Contract Labour (Regulation and Abolition) Act, 1970 as prevalent in Tripura.

22.5.6 The Contractor shall cover contract labourers to be engaged by them during the Term for the purpose of provident fund benefits as per rules under the Contract Labour (Regulation and Abolition) Act, 1970 and the Employees' Provident Funds and Miscellaneous Provisions Act, 1952.

22.5.7 The Contractor shall submit to the Owner on the 10th (tenth) day of every month a return on the prescribed form for the payment of wages under the provisions of the Minimum Wages Act, 1948 and the Contract Labour (Regulation and Abolition) Act, 1970 as prevalent in Tripura. Failure of the Contractor to submit such a form shall be considered as breach of this Contract.

22.5.8 If Owner as "Principal Employer" is held liable to pay contribution, etc. under any Applicable Law or court decision in respect of any Contractor Staff, then Contractor would reimburse the amount of contribution so paid by the Owner and in addition the Contractor shall keep the Owner fully indemnified in this regard.

22.5.9 In the event of the Contractor committing a default or breach of any of the provisions of the Applicable Law as mentioned in this Clause 22.5, as amended from time to time, or in furnishing any information or submitting or filling any form, register/slip under the provisions of such Applicable Law, the Owner shall be at liberty to take recourse to any action it may deem fit, under the circumstances, to protect its own interest. Further, all amounts as may become due for payment to the concerned authorities/agencies on account of such defaults or breach shall be settled by the Owner after recovering the same from the Contractor. The Owner shall be entitled to deduct such amounts from the Contract Price payable to the Contractor under this Contract

23.0 SUBCONTRACTING & LIST OF COUNTRIES

23.1 Contractor shall not subcontract any portion of the Contract.

23.2 Contractor shall ensure that supply of materials including repaired and replacement material are manufactured and shipped from the countries listed below in clause 23.4 (**"List of countries"**)

23.3 Contractor shall also ensure that any Firmware Upgrades, Patches, Hot Fixes etc. shall have been developed and tested in the countries listed under clause 23.4.

23.4 List of Countries

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23.4.1 United States of America

23.4.2 Europe

23.4.3 Australia

23.4.4 India

23.4.5 Singapore

23.4.6 Malaysia

23.4.7 Thailand

23.4.8 Japan

23.4.9 Mexico

23.4.10 South Korea

23.5 Contractor shall furnish Owner original documents showing manufacturing and shipment details of the material. Any material manufactured and shipped other than the countries mentioned under clause 23.4 shall not be accepted. Contractor shall submit original Manufacturer's Authorization Form (MAF) as per format attached as Annexure-8.

24.0 **LIEN**

24.1 To the full extent permitted by Applicable Law, Contractor hereby waives and releases any and all rights of unpaid seller's lien and similar rights for payment for goods, equipment, or materials furnished by the Contractor in performance of the obligations hereunder and granted by Applicable Law to Persons supplying materials, equipment, goods and other things, which Contractor may have against the goods supplied under this Contract to the Owner.

24.2 Contractor shall at all times promptly pay for all services, materials, equipment and labor used or furnished by Contractor in the performance of the obligations under this Contract and supply of the Materials and shall, to the fullest extent allowed by Applicable Law, at its expense keep all properties belonging to the Owner, including the Materials after the title has been transferred to the Owner, free and clear of any and all of the above mentioned liens and rights of lien arising out of goods, equipment or materials furnished by Contractor or its employees, contractors or Subcontractors in the performance of the obligations under this Contract. If Contractor fails to release and discharge any lien or threatened lien against the property of the Owner arising out of performance of the obligations under this Contract within seven (7) days after receipt of written notice from the Owner to remove such claim of lien, the Owner may, at its option, discharge or release the claim of lien or otherwise deal with the lien claimant, and Contractor shall pay the Owner any and all costs and expenses of the Owner in so doing, including reasonable attorneys' fees incurred by the Owner.

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25.0 **FORCE MAJEURE**

25.1 Force majeure is herein defined as any cause which is beyond the reasonable control of the Contractor or the Owner, as the case may be, which the affected Party could not foresee or with a reasonable amount of due diligence could not have foreseen, which could not have been prevented or overcome by the affected Party through the exercise of reasonable skill or care, which does not result from the affected Party's negligence or the negligence of its agents, employees or Subcontractors (as the case may be), and which substantially affects the performance of the obligations under this Contract ("**Force Majeure**"), such as:

25.1.1 Natural phenomena, including but not limited to floods, droughts, earthquakes, pandemics, epidemics, cyclone, lightning, storm, plague;

25.1.2 Lawful strikes and lawful lockouts and other generalized labour action occurring within India (excluding such events which are attributable to Contractor);

25.1.3 Act of terrorism or sabotage, act of any Government Agency, including but not limited to war (whether declared or undeclared), invasion or armed conflict, revolution, riot, civil commotion, quarantines, embargoes, in each case occurring inside India or directly involving India;

25.1.4 Radioactive contamination or ionising radiation or chemical contamination originating from a source in India or resulting from another Force Majeure event;

25.1.5 Fire or explosion, except as may be attributable to the Contractor;

25.1.6 An act of God;

25.1.7 Any act, failure to act, restraint or regulation, of any Government Agency (excluding actions that constitute remedies or sanctions lawfully exercised as a result of breach by the affected Party of any Applicable Law which is not discriminatory in nature); or

provided either Party shall within 7 (seven) days from the occurrence of any such cause notify the other Party in writing.

25.2 For avoidance of doubt, it is clarified that lack of funds shall not be construed as an event of Force Majeure.

25.3 Contractor shall not be entitled to, and hereby expressly waives recovery of, any damages suffered by reason of delays of any nature and extension of time shall constitute the sole remedy of the Contractor for delays under this Clause.

25.4 Neither Party shall be considered to have defaulted in the performance of any of its obligations under this Contract, when and to the extent such failure of performance shall be due to a Force Majeure event.

25.5 **Obligation to cure Force Majeure Diligently**

25.5.1 If either Party claims an event of Force Majeure, then the Party claiming the event shall:

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25.5.1.1 Provide prompt notice and in any event within 7 (seven) days from the occurrence of such Force Majeure event, to the other Party of the occurrence of Force Majeure event, stating whether it claims relief under this Clause 25.0 by giving reasons of such event, expected duration of such event and probable impact of such event on the performance of its obligations hereunder;

25.5.1.2 Exercise all reasonable efforts to continue to perform its obligations hereunder;

25.5.1.3 Consult with the other Party, agree upon the action to be taken and expeditiously take action to correct or cure the event or condition excusing performance;

25.5.1.4 Exercise all reasonable efforts to mitigate or limit damages to the other Party to the extent such action will not adversely affect its own interests;

25.5.1.5 Furnish weekly reports with respect to its progress in overcoming the adverse affects of such event or circumstances; and

25.5.1.6 Provide prompt notice to the other Party of the cessation of the event or condition giving rise to its excuse from performance.

25.5.2 The affected Party shall not be obliged, when complying with its obligations under this Clause 25.5, to take any steps which would be beyond its reasonable control. The suspension of the obligations hereunder of the affected Party shall be of no greater scope and no longer duration than is reasonably necessitated by the Force Majeure event.

25.6 So long as the affected Party has at all times since the occurrence of the Force Majeure event complied with the obligations of Clause 25.5 and continues to so comply then, the affected Party shall not be liable for any failure or delay in performing its obligations under or pursuant to this Contract during the existence of a Force Majeure event; provided, however, that no relief shall be granted to the affected Party pursuant to this Clause 25.6 to the extent that such failure or delay would have nevertheless been experienced by the affected Party had the Force Majeure event not occurred.

25.7 If the performance of this Contract is prevented, hindered or delayed for a continuous period of 180 (one hundred eighty) days from the beginning of a Force Majeure event or for an aggregate period of more than 270 (two hundred seventy) days during the Term, due to a Force Majeure event, then the Parties shall mutually decide further course of action. If mutual settlement cannot be arrived at within 30 (thirty) days, either Party shall have the right to terminate this Contract in accordance with Clause 32.3.2.

26.0 REPRESENTATIONS AND WARRANTIES

26.1 The Contractor represents and warrant that:

26.1.1 The Contractor is a company duly organized, validly existing and in good standing under the jurisdiction of its incorporation. The Contractor has full power, authority and legal right to execute and deliver and perform its obligations under this Contract. This Contract has been duly executed by its legal representative and constitutes a legal, valid and binding obligation of the Contractor, enforceable in

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accordance with its terms except to the extent that such enforcement may be limited by any Bankruptcy Event, agreement of creditors, insolvency, moratorium or similar laws affecting generally the enforcement of lenders rights;

26.1.2 The execution and delivery of, and performance by, the Contractor of its obligations under this Contract are not in violation of, or in conflict with, any provision of the Contractor's organizational or authorizing documents, and do not constitute a default under any contracts, agreements or other instruments to which the Contractor is a party or by which it is bound, and are not in violation of, or in conflict with, any term or provision of any law applicable to it;

26.1.3 The Contractor is not in default under any loan agreement, mortgage, deed of trust, indenture executed by it or any other agreement evidencing indebtedness to which it is a party or by which it or its property is bound or affected to the lenders;

26.1.4 There is no legal action, suit, proceeding, inquiry or investigation against the Contractor before or by any Government Agency or such other relevant authority as per laws applicable to it, of which the Contractor has received legal notice or of which it has otherwise become aware, that could adversely affect its ability to comply with its obligations under this Contract;

26.1.5 The Contractor has reviewed or examined and has the requisite knowledge and understanding with respect to the Site, the Technical Specifications, and all other factors and conditions affecting the performance of the Contractor's obligations under this Contract and accepts the same and agrees that the Site, the battery limits and such specifications, information, requirements, obligations, rules and procedures are satisfactory and will not prevent or impair or have any adverse effect on the performance by the Contractor of its obligations under this Contract;

26.1.6 It is fully experienced and properly qualified to supply the Materials and perform its obligations hereunder, and that it is properly equipped, organized and financed to fulfill its obligations and responsibilities under this Contract; and

26.1.7 It is properly licensed and qualified to do business in all governmental jurisdictions in which the Materials are to be delivered. Upon written request by Owner, Contractor shall furnish to them such evidence as Owner may require relating to the Contractor's ability to fully perform the obligations under this Contract.

26.2 The Owner represents and warrant that:

26.2.1 The Owner is a company duly organized, validly existing under Applicable Laws. The Owner has full power, authority and legal right to execute and deliver and perform its obligations under this Contract. This Contract has been duly executed by its legal representative and constitutes a legal, valid and binding obligation of the Owner, enforceable in accordance with its terms except to the extent that such enforcement may be limited by any Bankruptcy Event, agreement of creditors, insolvency, moratorium or similar laws affecting generally the enforcement of Lender's rights;

26.2.2 The execution and delivery of, and performance by the Owner of its obligations under this Contract are not in violation of, or in conflict with, any provision of the Owner's organizational or authorizing documents, and do not constitute a default

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under any contracts, agreements or other instruments to which the Owner is a party or by which it is bound, and are not in violation of, or in conflict with, any term or provision of any Applicable Law;

26.2.3 The Owner is not in default under any Loan Agreement, mortgage, deed of trust, indenture executed in relation to any Loan Agreement or any other agreement evidencing indebtedness to which it is a party or by which it or its property is bound or affected to the Lenders;

26.2.4 There is no legal action, suit, proceeding, inquiry or investigation against the Owner before or by any Government Agency of which the Owner has received legal notice and which adversely affects its ability to comply with its obligations under this Contract.

27.0 **WARRANTY AND WARRANTY PERIOD**

27.1 The Contractor hereby warrants to the Owner that the Materials supplied under this Contract shall (the "**Warranty**"):

27.1.1 comply strictly with the terms of this Contract, all specifications, drawings and standards referred to in the Technical Specifications or this Contract or furnished by the Owner hereafter, in accordance with Good Engineering & Manufacturing Practices and Applicable Law;

27.1.2 be first-class in every particular and free from defects and deficiencies in design, engineering, material and workmanship; and

27.1.3 shall be new, merchantable, of the most suitable grade and fit for their intended purposes.

27.1.4 shall not become obsolete or shall not be proclaimed as 'End of Life' by the Original Equipment Manufacturer (OEM) during Warranty Period.

27.1.5 shall not be proclaimed as 'End of Sale' by the OEM within 60 (sixty) months from the date of Final Acceptance of Material.

27.1.6 shall ensure availability of spares for a minimum of 15 (fifteen) years from the date of Final Acceptance of Material.

27.2 Contractor shall be liable for any defects in the Materials supplied and workmanship of the Services provided by it for a period of 60 (Sixty) months after the date of Completion of Supply of Materials and Taking-Over of Materials by the Owner (the "**Warranty Period**").

27.3 Without limitation of any other rights or remedies of the Owner, if any defect in the Materials supplied and Services provided under this Contract in violation of the foregoing warranties arises within the Warranty Period, Contractor shall, upon receipt of written notice of such defect, at no cost to the Owner, promptly furnish replacement Materials or parts thereof necessary to correct such defect or repair/modify the defective Materials, so as to meet the specifications.

27.4 If any replacement, repair or modification is of such a character which may affect the subsequent performance of the Facility or any part thereof in accordance with

the Technical Specifications, Owner may within 30 (thirty) days after such replacement, repair or modification give to the Contractor notice requiring the Contractor to demonstrate the adequacy and efficacy of the replacement, repair or modification.

27.5 In the event Contractor shall have been notified of any defects in the Materials in violation of Contractor's foregoing warranties and its has failed to promptly and adequately correct such defects, Owner shall have the right to correct or to have such defects corrected for the account of Contractor, and Contractor shall promptly pay to the Owner the costs incurred in correcting such defects. In the event the Contractor replaces the defected Materials, then such replaced Materials, as the case may be, shall be warranted by the Contractor in accordance with the warranties set forth in Clause 27.1 for a period of 60 (sixty) months from the date of replacement of such Materials, as the case may be.

27.6 Contractor shall include, as a minimum, the foregoing warrantee requirements in any Subcontract that it executes.

27.7 The acceptance of the Materials, as the case may be, by the Owner shall in no way relieve the Contractor of its obligation under this Clause.

27.8 In respect of goods supplied by the Subcontractors to the Contractor where a longer warranty (more than 60 (sixty) months) is provided by Subcontractors, the Owner shall be entitled to the benefit of such longer warranty period.

27.9 At the end of Warranty Period set forth in clause 27.2 above, Contractor's liability ceases except for the Latent Defects. The Contractor's liability for Latent Defects shall be limited to a period of ten (10) years from the date of Final Acceptance of Materials.

27.10 Contractor shall take back to back support / agreement from OEM to meet the Service Level Agreements (SLA) as defined in Technical Specification. Contractor shall furnish evidence of such support Contract with OEM with respect to this Contract.

27.11 Contractor shall furnish Warranty / support certificates from OEMs for all equipments, software etc.

27.12 The Contractor shall be responsible for payment of all costs, taxes (including all indirect taxes) and duties incurred in the course of performance of its obligations under this Clause 27.0.

28.0 **CONTRACTOR TO INFORM ITSELF FULLY**

28.1 Contractor shall be deemed to have carefully examined the Technical Specifications, the Site location and the Plant and fully acquainted itself with Site conditions and all other conditions relevant to the performance of this Contract. Contractor shall be deemed to have assumed the risk of such conditions and will, regardless of such conditions or negligence of the Owner, if any, fully complete the supply of Materials for the Contract Price without further recourse to the Owner. Information on the Site and local conditions at such Site, furnished by the Owner in specifications or otherwise is not guaranteed by the Owner and is furnished only for the convenience of the Contractor.

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28.2 The Contractor acknowledges that the Technical Specifications provided by the Owner may not be complete in every detail. Contractor shall comply with their manifest intent and general purpose, taken as a whole, and shall not make use of any errors or omissions therein to the detriment of the Owner. In the event the Contractor, in the performance of its obligations hereunder, encounters or comes across any conflict, error, omission or discrepancy in the specifications of the Materials, or in Site conditions, the Contractor shall promptly notify Owner in writing and Owner shall issue written instructions to be followed in relation to such conflict, error, omission or discrepancy. If Contractor proceeds with the supply of Materials prior to receiving such instructions, then required corrections shall be at Contractor's expense.

29.0 **CHANGE / VARIATION ORDER**

29.1 The scope of supply of Materials shall be subject to change by additions, deletions or revisions thereto by Owner. Contractor shall be notified of such changes by providing additional and / or revised drawings, specifications, exhibits or other written notification.

29.2 Contractor shall inform Owner, within three (3) days of receipt of notification of change, about impact of notified change on Contract Price and / or Time for Completion. Within 10 days of notifying impact of change, Contractor shall submit to Owner:

29.2.1 price of performing change along with material take-off, detailed calculations of price for performing change and supporting documents, for cases requiring amendment of Contract Price; and

29.2.2 modified Time for Completion along with necessary justification, for cases requiring amendment of Time for Completion.

29.3 Contractor shall not perform changes in the scope of supply of Materials notified in accordance with Clause 29.1 until Owner has approved in writing the price for performing changes and any adjustment in the Time for Completion for performing change, except as set forth in Clause 29.4 and 29.5.

29.4 Notwithstanding Clause 29.3, Owner may expressly authorize Contractor in writing to perform the change prior to approval of price for change and / or modification of Time for Completion. Contractor shall not suspend supply of Materials during the review and negotiation of any change, except as may be directed by Owner pursuant to Clause 20.0 (Suspension of Services). In the event Owner and Contractor are unable to reach timely agreement regarding any change, Contractor shall comply with Clause 30.0 (Claims).

29.5 Contractor shall perform only such changes in the scope of supply of Materials which have been notified in writing. If any oral notice or instruction received from Owner involves change in the Contract Price, or Time for Completion, Contractor shall forthwith ask Owner to notify such instructions in writing. Any costs incurred by Contractor in performing such changes not notified in writing shall be to Contractor's account. Contractor waives any and all rights to claim compensation from Owner for

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performing such changes in scope of supply of Materials not notified in writing by Owner.

30.0 **CLAIM**

30.1 If, for any reason, Contractor considers that an event has occurred pursuant to which it has a right to claim compensation from Owner or an extension of Time for Completion, Contractor shall notify Owner in writing of the existence of such claim (the **"Claim"**) within three (3) days of occurrence of such event and within ten (10) days of notifying Claim, Contractor shall submit to Owner details of Claim as per provisions of Clause 30.2. Contractor shall substantiate its Claim with payroll documents, paid invoices, receipts, records of performance and other documents satisfactory to Owner and subject to its verification. Owner shall not be liable for, and Contractor hereby waives, any claim or potential claim which have not been notified by Contractor in accordance with provisions of this Clause 30.1.

30.2 After examining Claim submitted by Contractor, Owner shall determine admissibility of the Claim and the extent, if any, to which the Contract Price and Time for Completion is to be changed and outcome shall be informed to Contractor. If Contractor disputes Owner's decision and notifies Owner within five (5) working days of receiving Owner's Decision, Contractor may seek to resolve the dispute in accordance with Clause 34.0 (Settlement of Disputes). If Contractor decides to proceed pursuant to Clause 34.0 (Settlement of Disputes), Contractor agrees to limit its claim to the amount claimed by it in accordance with Clause 30.1. In no event shall any supply be halted, whether or not the claim can be resolved to Contractor's satisfaction, and Contractor shall be bound by the terms and conditions of this Contract to supply the Materials without delay till its successful completion.

30.3 The following shall not constitute changes and Contractor has no right to make any claim in relation thereto:

30.3.1 Instructions, interpretations, decisions or acts by Owner which are:

30.3.1.1 to achieve compliance with the Contract by Contractor; or

30.3.1.2 to correct errors, omissions, poor engineering, defective materials and workmanship or other failure of the Contractor to comply with the Contract;

30.3.2 Delay in the completing supply of Materials or any additional work caused by Contractor.

30.3.3 Any materials supplied by Contractor arising out of Owner's comments on Contractor's submittals to the extent that such comments are consistent with the Contract.

30.4 If Contractor fails to follow the requirements of Clause 30.1, it shall have waived any right to make any claim in respect of the events referred to in Clause 30.1. Contractor's sole remedy in respect of any claim will be as provided in Clause 30.2. No claim by Contractor in relation to events referred to in Clause 30.1 shall be allowed after final payment is made.

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30.5 Owner shall not be bound to any adjustments in the Contract Price or scheduled time unless expressly agreed to by Owner in writing.

31.0 **BACKCHARGE**

31.1 A backcharge is a cost sustained by Owner and chargeable to Contractor for the Owner's performance of obligations that is the responsibility of Contractor.

31.2 Without limitation and by way of example only, backcharge may result from:

31.2.1 Obligations performed by the Owner, at Contractor's request, which are within Contractor's scope of supply of Materials under this Contract;

31.2.2 Costs sustained by the Owner as a result of Contractor's non-compliance with the provisions of this Contract or Contractor's act of omission or negligence; or

31.2.3 Costs incurred by the Owner to fix all defects, deficiencies or errors that may appear in the Materials during the Warranty Period.

31.3 Upon identification by the Owner of an actual or anticipated backcharge, the Owner will issue a backcharge notice to Contractor. This notice shall describe the backcharge work to be performed, the schedule period for performance, the cost to be charged by the Owner to Contractor for the backcharge and other terms.

31.4 A backcharge shall consist of:

31.4.1 Labor: at actual cost plus 25% (twenty five percent) to cover payroll additives;

31.4.2 Materials: at actual contractor and freight invoice cost delivered to jobsite;

31.4.3 Equipment: at actual third party rental cost or at Owner's equipment rental rates, whichever may be applicable;

31.4.4 Subcontracts: At actual cost;

31.4.5 All taxes, levies, duties and assessments attributable to the backcharge work; and

31.4.6 25% (twenty-five percent) shall be added to the foregoing for indirect costs, overhead, supervision and administration.

31.5 Within 24 (twenty-four) hours after receipt of the backcharge notice, Contractor shall fax back to the Owner a signed copy of the backcharge notice, indicating either acceptance of the backcharge or agreement to perform the described backcharge work within the indicated schedule period for performance, utilizing Contractor's supplied labor, material and equipment, as applicable.

31.6 Contractor will be required to sign the backcharge notice before commencement of the backcharge work by the Owner or others. In the event Contractor refuses to sign, Owner shall, at its option, proceed with the backcharge work and charge the backcharge cost to Contractor's account. 30 (thirty) days after commencement of the backcharge work or on completion of the backcharge work, whichever occurs

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earlier, Owner will invoice Contractor for the incurred backcharge cost and the Contractor shall forthwith pay the same.

32.0 **TERMINATION**

32.1 **Termination by Owner for Contractor's Event of Default**

32.1.1 Each of the following events, unless occurring solely as a result of breach by the Owner of its obligations under this Contract or a Force Majeure event, shall constitute an event of default and the Owner may terminate this Contract by giving 30 (thirty) days written notice of termination to the Contractor other than in case of Clauses 32.1.1.5 where the Owner may terminate this Contract by giving 7 (seven) days written notice ("**Contractor's Event of Default**"):

32.1.1.1 Contractor refuses or neglects to comply with any reasonable order given to it in writing by the Owner in connection with the obligations of the Contractor under this Contract;

32.1.1.2 Failure of the Contractor to perform its obligations under this Contract and supply Materials in a manner so as to achieve Completion of Supply of Materials as per the Time for Completion specified in Clause 10.2 and such failure continues after written notice is provided to the Contractor by the Owner and the Contractor has not cured such default within 30 (thirty) days from the date of such notice.

32.1.1.3 Failure of the Contractor to comply with or fulfill its Warranty obligations under Clause 27.0 (Warranty and Warranty Period);

32.1.1.4 Abandonment of its obligations under the Contract by the Contractor;

32.1.1.5 Contractor indulging in Corrupt Practices or Coercive Practices or Fraudulent Practices or Obstructive Practices during the signing of this Contract or during the Term in the opinion of the Owner;

32.1.1.6 Any Bankruptcy Event or insolvency of the Contractor; provided, that in the case of involuntary bankruptcy proceedings, the Contractor shall have 60 (sixty) days cure period after the commencement of such proceedings to stay or lift such proceedings;

32.1.1.7 Transfer or charge by the Contractor of any of its rights or obligations under this Contract without prior written consent of the Owner;

32.1.1.8 Any change in the Control of the Contractor which is not in accordance with Clause 21.0 (Change in Control);

32.1.1.9 Any act or omission by the Contractor such that the Owner is or is likely to be or become in breach of any of its obligations under this Contract or constitutes or is likely to give rise to a Owner's event of default as mentioned under Clause 32.2;

32.1.1.10 Contractor ceases to carry on its business;

32.1.1.11 Failure of the Contractor to comply with an Arbitral Award within 30 (thirty) days of the Arbitral Award or within such time as prescribed under such award, whichever is earlier;

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32.1.1.12 Contractor has incurred or is liable for liquidated damages in excess of the amount set out in Clause 11.6;

32.1.1.13 A breach by the Contractor of any of the terms of the contracts for providing civil construction works and installation services dated on or about the date of this Contract;

32.1.1.14 Failure by the Contractor to perform any obligation under this Contract with due diligence and expedition including any breach of Applicable Laws and such failure continues after written notice is provided to the Contractor by the Owner; provided, that the Contractor shall have up to 30 (thirty) days after such notice is given to cure such default or to diligently commence and continue in good faith to cure such default prior to any such termination (provided that in no event shall such cure period exceed 120 (one hundred and twenty) days including the 30 (thirty) days of notice period); or

32.1.1.15 If any of the representations and warranties provided by the Contractor under Clause 26.1 or during the negotiation of this Contract is incorrect, false or misleading.

32.2 **Termination by Contractor for Owner's Event of Default**

32.2.1 Each of the following events, unless occurring as a result of a breach by the Contractor of its obligations under this Contract or a Force Majeure event, and subject to the conditions defined elsewhere in this Contract shall constitute an event of default and the Contractor may terminate this Contract by giving 30 (thirty) days written notice of termination to the Owner ("**Owner's Event of Default**"):

32.2.1.1 Failure by the Owner to pay to the Contractor any undisputed amount due and payable under this Contract, which is not less than 25% (twenty-five percent) of the Contract Price and that remains unpaid for a period of 90 (ninety) days or more from the due date for such payment;

32.2.1.2 Any willful and persistent material breach of this Contract by the Owner and such breach continues for 60 (sixty) days after written notice is provided to the Owner by the Contractor; provided, that the Owner shall have further 30 (thirty) days after such expiry of above period to cure such breach or to diligently commence and continue in good faith to cure such breach prior to any such termination; or

32.2.1.3 Any Bankruptcy Event or insolvency of the Owner; provided, that in the case of involuntary bankruptcy proceedings, the Owner shall have 60 (sixty) days cure period after the commencement of such proceedings to stay or lift such proceedings.

32.3 **Termination due to Force Majeure Events**

32.3.1 The Owner shall have a right to forthwith terminate this Contract if the performance of this Contract is prevented, hindered or delayed due to a Force Majeure event for a continuous period of 90 (ninety) days from the beginning of a Force Majeure event.

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32.3.2 If the performance of this Contract is prevented, hindered or delayed due to a Force Majeure event for a continuous period of 180 (one hundred eighty) days from the beginning of a Force Majeure event or for an aggregate period of more than 270 (two hundred seventy) days during the Term of this Contract, and the Parties cannot mutually decide further course of action within 30 (thirty) days thereafter, either Party shall have the right to terminate this Contract by giving the other Party a 30 (thirty) days written notice of termination.

32.4 **Termination for Convenience by Owner**

32.4.1 Owner may terminate this Contract without assigning any reason by giving thirty (30) days written notice of termination to the Contractor.

32.5 **Termination Procedure**

32.5.1 Notice of termination shall be given to the other Party specifying the termination date with effect from which this Contract shall be terminated ("**Termination Date**") except for the obligations or duties that are stated to survive termination or are to be carried out after termination or owed by a Party at the time of or as a result of such termination. Termination notice shall also specify in reasonable detail the circumstances giving rise to termination of this Contract.

32.6 **Payment on Termination**

32.6.1 Owner shall not be liable to make any further payments to the Contractor until the costs of execution and all other expenses incurred by the Owner in completing the scope of supply of Materials have been ascertained (the **"Cost of Completion"**). If the Cost of Completion when added to the total amounts already paid to Contractor as at the date of termination exceeds the total amount which would have been payable to the Contractor for supply of Materials, the Contractor shall upon demand, pay to the Owner the amount of such excess. Any such excess shall be deemed a debt due by the Contractor to the Owner and shall be recoverable accordingly. If there is no such excess the Contractor shall be entitled to be paid the difference (if any) between the Cost of Completion and the total of all payments received by the Contractor as on the date of termination.

32.6.2 In the event of termination for convenience by Owner as per Clause 32.4, the Contractor shall be paid compensation, equitable and reasonable, dictated by the circumstances prevalent at the time of termination.

32.6.3 Contractor shall not be entitled to any prospective profits or any damages.

32.7 **Obligation upon Termination**

32.7.1 Contractor shall discontinue supply of Materials from the Termination Date.

32.7.2 Contractor shall advise Owner of its outstanding Subcontracts pertaining to performance of the terminated supply of Materials and, upon request, furnish Owner with complete copies.

32.7.3 Contractor shall place no further Subcontracts except as may be necessary for completion of such portion of the scope for supply of Materials which is not terminated.

32.7.4 Contractor shall promptly make every reasonable effort to procure cancellation, upon terms satisfactory to Owner, of all Subcontracts to the extent they relate to the scope for supply of Materials terminated or, as directed by Owner, shall assign them to Owner, in form satisfactory to Owner, such of its Subcontracts as are designated by Owner or shall take such other action relative to such Subcontracts as may be directed by Owner.

33.0 **GOVERNING LAW AND JURISDICTION**

33.1 This Contract shall be governed by the laws of India.

33.2 The courts of New Delhi shall have exclusive jurisdiction in all matters arising under this Contract, including execution of arbitration awards.

33.3 The United Nations convention on contracts for the international sale of goods does not apply to this Contract.

34.0 **SETTLEMENT OF DISPUTES**

34.1 The Parties hereto agree that any dispute or difference arising out of or in connection with this Contract shall, to the extent possible, be settled promptly and amicably between the Parties. Parties further agree to provide each other with reasonable access during normal business hours to any and all non-privileged records, information and data pertaining to any such disputes.

34.2 All unsettled disputes or differences arising out of or in connection with this Contract which cannot be amicably resolved by the Parties shall in the first instance be decided by the Owner in accordance with provisions of Clause 34.3 below.

34.3 **Owner's Decision**

34.3.1 If any dispute or difference of any kind whatsoever shall arise between the Owner and the Contractor, arising out of this Contract whether during the performance of the obligations under this Contract or after its completion or whether before or after the termination, Abandonment or breach of this Contract, such dispute or difference cannot be amicably settled by the Parties in accordance with Clause 34.1, it shall, in the first place, be referred to and settled by the Managing Director of the Owner, who, within a period of 30 (thirty) days after being requested to do so, shall give written notice of its decision to the Contractor.

34.3.2 Save as hereinafter provided, such decision in respect of every matter so referred shall be final and binding upon the Parties until the Completion of Supply of Materials under this Contract and shall forthwith be given effect to by the Parties who shall comply with all such decisions, with all due diligence, whether it requires arbitration, as hereinafter provided or not.

34.3.3 If after the Owner has given written notice of its decision to the Contractor and no notice for arbitration has been communicated to it by the Contractor within 30 (thirty) days from the receipt of such notice, the said decision shall become final and binding on the Parties.

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34.3.4 The Owner's decision (or the failure of the Owner to give decision within the time specified in Clause 34.3.1) and issuance of a written notice for arbitration pursuant to Clause 34.3.3 shall be a condition precedent to the right to request arbitration. It is the intent of this Contract that there shall be no delay in the performance of obligations and the decision of the Owner, as rendered, shall be promptly observed.

34.3.5 In the event of the Owner failing to notify its decision, as aforesaid, within 30 (thirty) days after being requested, or in the event of a Party being dissatisfied with any such decision, either Party may require that the matters in dispute be referred for arbitration as provided in Clause 34.4.

34.4 **Arbitration**

34.4.1 All disputes or differences in respect of which the decision, if any, of the Owner has not become final or binding as aforesaid, shall be settled by arbitration, under and in accordance with the provisions of the Indian Arbitration and Conciliation Act, 1996 (the "**Arbitration Act**") or any statutory modification, in the manner hereinafter provided. The Place, Venue and Seat of arbitration shall be New Delhi, India.

34.4.2 The arbitration shall be conducted in accordance with the Arbitration Act by 3 (three) arbitrators, 1 (one) each to be nominated by the Contractor and the Owner and the 3rd (third) to be nominated by the 2 (two) arbitrators nominated by the Parties at the commencement of arbitration proceedings. The 3rd (third) arbitrator so appointed shall act as the presiding arbitrator.

34.4.3 If one Party fails to appoint its arbitrator within 30 (thirty) days after the other Party has named its arbitrator, the Party which has named an arbitrator may request the President of the Institution of Engineers to appoint the second arbitrator on behalf of such Party. If the 2 (two) arbitrators appointed by both Parties do not succeed in appointing a 3rd (third) arbitrator within 30 (thirty) days after the latter of the 2 (two) arbitrators has been appointed, the 3rd (third) arbitrator shall, at the request of either party, be appointed by the Chairman of OTPC.

34.4.4 The decision of the majority of the arbitrators ("**Arbitral Award**") shall be final and binding upon the Parties. The expense of the arbitration shall be paid as may be determined by the arbitrators. The arbitrators may, from time to time, with the consent of both the Parties increase the time for making the award. In the event of any of the aforesaid arbitrators dying, neglecting, resigning or being unable to act for any reason, it will be lawful for the Party concerned to nominate another arbitrator in place of the outgoing arbitrator.

34.4.5 The arbitrators shall have full powers to review and/or revise any decision, opinion, directions, certification or valuation of the Owner in consonance with this Contract, and neither party shall be limited in the proceedings before such arbitrators to the evidence or arguments put before the Owner for the purpose of obtaining the said decision.

34.4.6 No decision given by the Owner in accordance with the foregoing provisions shall disqualify it from giving evidence before the arbitrators on any matter whatsoever relevant to the dispute or difference referred to the arbitrators as aforesaid.

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34.5 During settlement of disputes including arbitration proceedings, both Parties shall be obliged to carry out their respective obligations under this Contract.

34.6 Parties agree that neither Party to this Contract shall be entitled for any interest on the amount of award.

34.7 The provisions of this Clause 34.0 shall survive termination of this Contract.

35.0 **CHANGE IN LAW**

35.1 If after the Effective Date there is a Change in Law which is expected to result in the increase or decrease in the Contract Price by an amount of Rs. 500,000 (Rupees Five Lakh Only) or more, then either Party may request the other for a revision of the Contract Price in accordance with Clause 35.2, to reflect any such increase or decrease in costs. Such additional or reduced costs shall not be separately paid or credited if the same has already been accounted for in the Contract Price.

For the avoidance of doubt, it is clarified that any revision to the Contract Price would be restricted to direct transactions between the Parties.

35.2 In case of a Change in Law affecting the Contract Price, the Contractor or the Owner, as the case may be, shall provide notice to the other, of such request, setting forth the proposed amount of, and the relevant details and calculations relating to, such increase or decrease in the Contract Price. Promptly upon, and in any event within 7 (seven) days of, the Contractor or the Owner, as the case may be, receiving such request (such date of receipt the "**Change in Law Request Date**"), the Parties shall discuss such proposed increase or decrease, in good faith and within 60 (sixty) days of the Change in Law Request Date, mutually agree upon a revised Contract Price.

36.0 **ASSIGNMENT**

36.1 Except as expressly provided in this Clause, neither Party may assign its rights or obligations hereunder directly or indirectly, whether by pledge, assignment, sale of assets or sale or merger (statutory or otherwise), without the prior written consent of the other Party.

36.2 Notwithstanding the foregoing, it is agreed that, without the consent of the Contractor:

36.2.1 The Owner may assign or create a security interest over its rights and interest under or pursuant to this Contract or any movable property of the Owner or any rights or assets of the Owner, in favour of any of the Lenders; or

36.2.2 The Owner may assign this Contract or its rights or obligations hereunder to any Subsidiary or Affiliate of the Owner.

36.3 The holder of any security interest in this Contract shall not be prevented or impeded by the Contractor from enforcing such security interest. The Contractor shall execute all consents to assignment and/or acknowledgements of any security interest as are requested by the Owner to give effect to the foregoing or to perfect any security interest, and shall provide such certificates and opinions of counsel

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addressed to the Owner and the Lenders as may be requested in connection with any financing of the Plant. The Contractor agrees that such consents and acknowledgements shall, *inter alia*, include:

36.3.1 an agreement by the Contractor to allow the holder of such security interest to cure defaults by the Owner;

36.3.2 an acknowledgement by the Contractor that the Owner is not in default under this Contract due to such assignment;

36.3.3 representations and warranties by the Contractor;

36.3.4 a prohibition against amending, assigning or terminating this Contract without the written consent of the holder of such security interest; and

36.3.5 a consent by the Contractor to allow the assignment of the Contract to the successors-in-interest of the holder of such security interest after foreclosure hereon.

36.4 The Contractor acknowledges and agrees that the Lenders and providers of insurance will review this Contract and may require changes there to as a condition for providing financing and/or insurance, and the Contractor agrees to consider any such requirements in good faith and otherwise to co-operate with the Lenders/insurers in executing such amendments to this Contract or providing such other letters of consent and comfort as may be reasonably requested by the Lenders/insurers.

37.0 **RELEASE OF INFORMATION**

37.1 The Contractor shall not communicate or use in advertising, publicity, sales releases or in any other medium, photographs or other reproduction of, or description of the Site or the Plant, dimensions, quantity, quality or other information, concerning this Contract, the Plant, the Site or the Project unless prior written permission has been obtained from the Owner.

38.0 **CONFIDENTIAL INFORMATION**

38.1 Subject to Clause 38.2, each Party shall keep all documents, data, photographs, technical information or other information provided directly or indirectly by the other Party in connection with this Contract ("**Confidential Information**") private and confidential for a period of 6 (six) years from the Effective Date and shall not, without the consent of the other Party, publish or divulge to any third party, any Confidential Information or any particulars thereof, whether such Confidential Information has been provided prior to, during or following termination of this Contract.

38.2 Each Party shall be entitled to disclose the Confidential Information without the prior written consent of the other Party, if such Confidential Information:

38.2.1 was furnished prior to this Contract without restriction;

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38.2.2 is or becomes available within the public domain (other than by breach of the foregoing obligation of confidentiality);

38.2.3 is received by either Party from a third Party without restriction and not in breach of this Contract;

38.2.4 is independently developed by either Party;

38.2.5 is required to be provided to any contractors/subcontractor, subject to inclusion of terms similar to the provision of this Clause 38.0 in the agreement with such contractor/subcontractor;

38.2.6 is required to be provided to the Lenders;

38.2.7 if and to the extent required to be provided by the rules of a relevant and recognized stock exchange or securities commission;

38.2.8 if and to the extent required to be provided under Applicable Law or pursuant to an order of any court of competent jurisdiction provided that the original disclosing Party is given notice and adequate time to seek a protective order applicable to the information, if practicable, before it is disclosed;

38.2.9 if and to the extent required to enforce any right or remedies under this Contract;

38.2.10 if required to be provided to any insurer under a policy of insurance related to this Contract;

38.2.11 if required to be provided to directors, employees and officers of such Party provided that the disclosing Party determines in good faith that the recipient has a legitimate need to see such Confidential Information; and the recipient has been made aware of and has agreed to be bound by the requirements of this Clause 38.0;

38.2.12 in case of the Owner, if required to be provided to any of its Affiliates; or

38.2.13 in case of the Owner, if required to be provided to such other parties to whom the Owner may be reasonably required to disclose such information.

38.3 **Confidentiality of Intellectual Property and Information**

38.3.1 Each Party shall:

38.3.1.1 make available to the other Party without charge such materials, documents and data as would normally be made available to the other Party in connection with the supply obligations hereunder (except any internal cost accounting or cost reporting data or any materials documents and data protected by legal privilege or which is subject to any duty of confidentiality to any third party) acquired or brought into existence in any manner whatsoever by each of them in connection with the Contract as the other may reasonably request for the purposes of exercising its rights or carrying out its duties or performing its obligations under this Contract; and

38.3.1.2 use all reasonable endeavors to make available such materials and documents and data acquired or brought into existence by third parties as the other Party may

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reasonably request for the purpose referred to in Clause 38.3.1.1 above and as would normally be made available by Persons acting in accordance with Good Engineering & Construction Practice.

38.3.2 Neither Party shall without the prior written authority of the other Party publish alone or in conjunction with any other Person any article or other material relating to any dispute arising under this Contract nor impart to any radio or television program or any other medium any information regarding any such dispute.

38.3.3 All documents, papers, computer discs, magnetic tapes or other records made or created wholly in relation to the performance by the Contractor of its obligations under this Contract containing Confidential Information shall be and remain the property of the Owner, and shall be handed over by the Contractor to the Owner during the Term on the Owner giving the Contractor 2 (two) days notice and in any event immediately on the termination or expiry of this Contract.

39.0 INTELLECTUAL PROPERTY

39.1 Ownership and License of Intellectual Property

39.1.1 If any intellectual property is developed by the Contractor and/or its employees, agents, Contractor, representatives or Subcontractors for the purpose of performing the obligations under this Contract during the Term, such intellectual property shall belong to the Owner.

39.1.2 The Owner shall, subject to any applicable third party restrictions, grant the Contractor during the Term a royalty-free, non-exclusive, personal and non-transferable license to use the intellectual property which is owned by or licensed to the Owner by third parties only to the extent necessary to enable the Contractor to perform its obligations under this Contract. Such licenses shall not carry the right to grant sublicenses.

40.0 PATENT RIGHTS AND ROYALTIES

40.1 Royalties and fees for patents covering materials, articles, apparatus, devices, equipment or processes relating to the Materials shall be deemed to have been included in the Contract Price. Contractor shall satisfy all demands that may be made at any time for such royalties or fees and it alone shall be liable for any damages or claims for patent infringements and shall keep the Owner indemnified in that regard. Contractor shall, at its own cost and expense, defend all suits or proceedings that may be instituted for alleged infringement of any patent involved in the Materials, and, in case of an award of damages, Contractor shall pay for such award. In the event of any suit or other proceedings instituted against the Owner, the same shall be defended at the cost and expenses of Contractor who shall also satisfy/comply any decree, order or award made against Owner.

40.2 Contractor hereby represents to the Owner that, as of the Effective Date, Contractor has received no notification of any rightful patent infringement claim which would prejudice the Owner's right to use the Materials.

41.0 FIELD QUALITY ASSURANCE AND INSPECTIONS

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41.1 To ensure the conformance of the Services, whether performed at the Site, by Contractor or by its Subcontractors, with the provisions of this Contract, Contractor shall adopt, as well as ensure adoption by its Subcontractor, suitable Field Quality Program. The Owner or its representative(s) shall have the right to inspect and/or to test the Services to check their conformity with the provisions of this Contract.

41.2 The Field Quality Program, proposed for adoption by the Contractor, shall be submitted for review and approval of the Owner, within 30 (thirty) days of the Effective Date. It shall *inter alia* specify required inspection and tests to be carried out by Contractor as per Contract and applicable codes for all phases of erection, testing and commissioning, the procedures involved, acceptance basis, acceptance criteria and customer hold points (CHPs) beyond which work shall not proceed, without the specific clearance of the Owner. The approved Field Quality Program shall form part of this Contract and shall be strictly adhered to.

41.3 In case of stage inspection, the Contractor shall proceed from one stage to another only after the component of the work is inspected and tested by the Owner or their representative(s) and permission given to proceed further. The procedure shall be adopted for any rectifications/repairs suggested by the Owner or their representative(s).

41.4 No part of the work shall be covered up without carrying out inspection and tests specified in the Field Quality Program. Contractor shall uncover such part of the work which have been covered up without carrying out inspection and tests specified in Field Quality Program and them up after carrying out inspection and tests specified in Field quality Program. Cost for such uncovering and covering up shall be borne by Contractor.

41.5 Contractor shall provide reasonable advance notice to Owner for witnessing inspection and tests specified in Field Quality Program.

41.6 Contractor shall provide at his own cost all facilities including labour, materials, electricity, fuel, water, stores, apparatus, instruments etc reasonably required by Owner and/or their representative for effectively carrying out such inspection and tests in accordance with the Contract and applicable codes.

41.7 Owner may ask Contractor to perform any such inspection and tests which are not specified in Contract and Field Quality Program. Contractor shall perform such inspection and tests and Owner shall pay to the Contractor reasonable cost incurred in carrying out such inspection and tests.

41.8 Contractor shall also be responsible for monitoring each Subcontractor's compliance with the Field Quality Program. The Owner shall have the right to conduct audits of the Contractor's Field Quality Program. Contractor shall cooperate with and extend all support to Owner in carrying out such audits.

41.9 Price for all inspection and tests to be carried out till Final Acceptance of Facility and during Warranty Period are included in Contract Price.

41.10 Inspection and acceptance of the Services by the Owner and / or their representative shall not limit the liabilities and responsibilities of the Contractor in any manner and shall not prejudice the right of the Owner to reject the Services if it

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is found to be defective subsequently or if Facility fails to achieve performance guarantee under the Contract. Nothing in this Clause 41.0 shall, in any way, release the Contractor from any of its Warranty or other obligations under this Contract.

42.0 **COMPLETION AND FINAL ACCEPTANCE OF FACILITY**

42.1 **Pre-commissioning Tests**

42.1.1 After successful completion of erection of Facility, Contractor shall notify the same to Owner and seek approval of Owner for proceeding with pre-commissioning tests specified in Technical Specifications (the **"Pre-commissioning Tests"**). Contractor shall proceed with Pre-commissioning Tests after receipt of approval from Owner.

42.1.2 Contractor shall submit to Owner for his approval, at least 7 (seven) days before scheduled start of Pre-commissioning Tests, procedures for Pre-commissioning Tests for each equipment and systems. Contractor shall proceed with Pre-commissioning Tests of all equipment & systems of the Facility as per approved procedure for Pre-commissioning Tests.

42.1.3 Owner shall inform Contractor about defects and deficiencies observed in equipments and systems during Pre-commissioning Tests. Contractor shall rectify such defects and deficiencies and re-perform Pre-commissioning Tests for defective equipments and systems.

42.1.4 After successful completion of Pre-commissioning Tests of each equipment and systems, test protocols shall be signed jointly by Owner and Contractor.

42.2 **Commissioning Tests**

42.2.1 After successful completion of Pre-commissioning Tests of the all the equipments and systems of the Facility and signing of test protocols, Contractor shall notify the same to Owner and seek approval of Owner for proceeding with commissioning tests. Contractor shall proceed with Commissioning Tests after receipt of approval from Owner.

42.2.2 Contractor shall submit to Owner for his approval, at least 7 (seven) days before scheduled start of Commissioning Tests, procedures for Commissioning Tests for each equipments and systems. Contractor shall proceed with Commissioning Tests of each equipments and systems of the Facility as per approved procedure for Commissioning Tests.

42.2.3 Owner shall inform Contractor about defects and deficiencies observed in equipments and systems during Commissioning Tests. Contractor shall rectify such defects and deficiencies and re-perform Commissioning Tests for defective equipments and systems.

42.2.4 After successful completion of Commissioning Tests of each equipment and systems of the Facility, test protocols shall be signed jointly by Owner and Contractor.

42.3 **Trial Operation**

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42.3.1 After successful completion of Commissioning Tests of the Facility, Contractor shall notify the same to Owner and seek approval of Owner for proceeding with trial operation of the Facility specified in Technical Specification (the **"Trial Operation"**). Contractor shall proceed with Trial Operation after receipt of approval from Owner.

42.3.2 Minimum duration of Trial Operation shall be 3 (three) days during which Facility including all associated sub-systems and auxiliaries shall be run in integrated manner at rated full load / part load as made available by the Owner.

42.3.3 During Trial Operation, Facility shall necessarily be operated uninterruptedly for at least seventy two (72) hours at its rated full load.

42.3.4 In the event of interruptions to the Trial Operation, for which Contractor is responsible, Trial Operation shall be restarted.

42.3.5 As part of Trial Operation of the Facility, following shall be demonstrated by the Contractor:

42.3.5.1 Sustained capability of the Facility;

42.3.5.2 Reliability of the equipment and auxiliaries;

42.3.5.3 Adequacy of various auxiliaries, ancillaries and systems & controls;

42.3.5.4 Capability of each equipment of the Facility to correctly perform the functions for which it is specified; and

42.3.5.5 Safety requirements.

42.3.6 Owner shall inform Contractor about defects and deficiencies in Facilities observed during Trial Operation. Contractor shall rectify minor defects and deficiencies and re-perform necessary tests to demonstrate removal of defects and deficiencies. For defects and deficiencies in Facilities which may adversely affect the performance of the Facility, various tests to be performed by Contractor after removal of defects and deficiencies shall be jointly agreed between Owner and Contractor.

42.3.7 After successful completion of Trial Operation of the Facility and removal of major defects, test protocols for Trial Operation shall be jointly signed by Contractor and Owner.

42.4 After successful completion of Trial Operation of the Facility and signing of test protocols, Contractor shall notify the Owner about completion of Facility. After satisfying itself about satisfactory completion of Facility, within seven (7) days of receipt of notification from Contractor for successful completion of Facility, Owner shall issue a provisional acceptance certificate to the Contractor (the **"Final Acceptance of Facility"** or the **"Commissioning of Facility"**).

42.5 After Final Acceptance of Facility, Owner shall take-over the Facility from Contractor. Upon taking over of the Facility, Owner shall become responsible for care, custody, operation and maintenance of Facility (the **"Taking-Over of Facility"**).

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43.0 **GUARANTEED PERFORMANCE**

43.1 The Contractor shall maintain the performance guarantees as set out in the Clause 43.2 during Warranty Period (the **"Performance Guarantee"**).

43.2 **Annual Online monitoring system for ICT-2, LR-1 & 2 Availability**

43.2.1 Annual Online monitoring system for ICT-2, LR-1 & 2 Availability (the **"Annual Online monitoring system for ICT-2, LR-1 & 2 Availability"**) shall be 99.5% (ninety-nine and half of one percent) minimum.

43.2.2 In case Annual Online monitoring system for ICT-2, LR-1 & 2 Availability is less than 99.5% (ninety-nine and half of one percent), liquidated damage shall be payable as specified in Clause 11.2

43.2.3 Annual Online monitoring system for ICT-2, LR-1 & 2 Availability shall be calculated as follows:

43.2.4 A = [TSH – (TUD – TEPD)] *100/TSH; wherein:

43.2.4.1 A = Annual Online monitoring system for ICT-2, LR-1 & 2 Availability (in %);

43.2.4.2 TSH = Total Service Hour (in hours)

43.2.4.3 TUD = Total Unscheduled Downtime (in hours);

43.2.4.4 TEPD = Total Excused Performance Downtime (in hours)

43.2.4.5 Total Service Hour in any Operating Year shall be total number of hours during the period under consideration e.g. 8760 (eight thousand seven hundred and sixty) hours for a normal year or 8784 (eight thousand seven hundred and eighty-four) hours for a leap year starting at 00:00 hrs of the first day of first month and 24:00 hrs of the last day of the last month of the relevant operating year;

43.2.4.6 Unscheduled System Downtime shall mean the time when Online monitoring system for ICT-2, LR-1 & 2 is not available fully for functional use and which is outside Scheduled Downtime;

43.2.4.7 Scheduled Downtime is the planned Online monitoring system for ICT-2, LR-1 & 2 maintenance downtime jointly agreed by the Owner and the Contractor in advance; and

43.2.4.8 Excused Performance Downtime is the time when Online monitoring system for ICT-2, LR-1 & 2 is not available fully for functional use for reasons which is excused in the Contract.

43.2.5 The Contractor shall ensure that no Scheduled Downtime occurs for a period greater than the Scheduled Downtime period agreed between the Owner and the Contractor. Any increase in the agreed Scheduled Downtime period shall be considered as Unscheduled System Downtime for calculating Annual Online monitoring system for ICT-2, LR-1 & 2 Availability

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44.0 **AMENITIES TO BE PROVIDED BY OWNER AND CONTRACTOR**

44.1 Following amenities at Site shall be provided by Owner:

44.1.1 Material storage area, as available at site, shall be provided to Contractor by Owner. However, securing the area in order to ensure safe and secure storage of materials brought to Site shall be done by Contractor.

44.2 Following amenities at Site shall be provided by Contractor:

44.2.1 The Contractor shall provide all the construction equipment, tools, tackles, scaffoldings etc required for performing Services under the Contract. It shall submit a list of all such materials to the Owner before the commencement of construction at Site. These equipments, tools, tackle, scaffoldings etc shall not be removed from the Site without written permission of the Owner.

44.2.2 The Contractor shall provide appropriate lighting and fencing for performing the Services round the clock in safe manner and protecting the Facility.

44.2.3 The Contractor shall make his own arrangement for telephone, fax and internet facilities.

44.2.4 The Contractor shall provide the necessary first-aid facilities for all Contractor Staff working at Site. Adequate number of Contractor Staff shall be trained in administering first-aid.

44.2.5 The Contractor shall keep the entire area allotted to it clean and free from rubbish, debris, etc. during the Term. The Contractor shall employ adequate number of special personnel to thoroughly clean its work area, at least once in a day. All rubbish and scrap material shall be stacked or disposed of in a place to be identified by the Owner. Materials and stores shall be so arranged as to permit easy cleaning of the area. In areas where equipment might drip oil and cause damage to the floor surface, a suitable protective cover of a flame resistant, oil proof sheet shall be provided by Contractor to protect the floor from such damage.

44.2.6 After Taking-Over of Facility by the Owner, the Contractor shall remove all rubbish and scrap material from the Site and leave the Site and the Facility clean and safe.

45.0 **WAIVER**

45.1 **No Waiver of Rights**

The failure of either Party to enforce at any time any of the provisions of this Contract or any rights in respect thereto or to exercise any option therein provided, shall in no way be construed to be a waiver of such provisions, rights or options or in any way to affect the validity of this Contract. The exercise by either Party of any of its rights herein shall not preclude or prejudice either Party from exercising the same or any other right it may have hereunder.

45.2 **Payments Not to Affect Right of the Owner and Liability of Contractor**

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No sum paid on account by the Owner shall affect or prejudice the rights of the Owner against the Contractor or relieve the Contractor of its obligations for the due performance of its obligations under this Contract, including supply of Materials or be interpreted as approval of the Materials delivered.

46.0 **VALIDITY AND SURVIVAL OF PROVISIONS**

46.1 **Validity of Provisions and Severability**

The provisions of this Contract are severable. In the event any provision or condition of this Contract shall be held to be invalid, void or otherwise unenforceable, such prohibition, invalidity or unenforceability shall not affect the validity or enforceability of any other provisions and conditions of this Contract. The Parties agree in such circumstances to negotiate an equitable amendment to the provisions of this Contract to give effect to the original intention of the Parties.

46.2 **Survival of Provisions**

The provisions of this Contract which by their nature are intended to survive the termination or expiry of this Contract shall continue as valid and enforceable obligations of the Parties notwithstanding any such termination or expiry.

47.0 **LANGUAGE AND MEASURES**

47.1 The governing language for the Contract shall be English. All documents pertaining to this Contract including specifications, schedules, notices, correspondences or any other document shall be written in English language. The metric system of measurement shall be used exclusively in this Contract.

48.0 **NOTICES**

48.1 All notices, reports, certificates or other communications to be given by one Party to the other under this Contract shall be in writing and by letter or facsimile transmission or electronic mail (save as in case of major issues relating to this Contract, such as notices of tests, arbitration, termination, etc.) and shall be deemed to be duly given when delivered (in the case of personal delivery), when dispatched (in the case of facsimile transmission or electronic mail, provided that the sender has received a receipt indicating proper transmission) or 3 (three) days after being dispatched by an internationally recognized courier (in the case of a letter) to such Party at its address or facsimile number or electronic mail address specified in Clauses 48.2 and 48.3 below, or at such other address or facsimile number as such Party may hereafter specify for such purpose to the other Party by notice in writing.

48.2 Address for Notice to Owner:

Attn: Managing Director
ONGC Tripura Power Company Limited
10th Floor, Core-4 and Central,
Scope Minar, Laxmi Nagar,
New Delhi – 110092
Fax: +91-11-22017731
Email: sanil.namboodiripad@otpcindia.in

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48.3 Address for Notice to Contractor:
Attn: Managing Director
401/Labh Complex, Atladra
Vadodara, Gujarat-390012
Fax: +91-265-2680160
Email: jitin@utilitypowertest.com

48.4 For the avoidance of doubt it is provided that in case of a facsimile transmission, a positive transmission report from the sender's machine will be conclusive evidence of receipt in the absence of evidence to the contrary.

49.0 **CONTRACTUAL RELATIONSHIP**

49.1 The Contractor shall act as an independent contractor performing this Contract. This Contract does not create any agency, partnership, joint ventures or joint relationship between the Parties. Subject to the compliance of this Contract, Contractor shall be solely responsible for the manner in which the Materials are supplied. All employees, representatives or Subcontractors engaged by the Contractor in performing this Contract shall be under the complete control of the Contractor and shall not be deemed to be employees of the Owner and nothing contained in this Contract or in any Subcontract awarded by the Contractor shall be construed to create any contractual relationship between any such employees or representative or Subcontractors and the Owner. Contractor shall be responsible for its acts, defaults or negligence and acts, defaults or negligence of its agencies, servant, employees, workmen or Subcontractors.

49.2 Nothing contained in this Contract or any Subcontract awarded by Contractor shall create any contractual relationship between any Subcontractor and Owner.

50.0 **COPIES OF CONTRACT AND COUNTERPARTS**

50.1 This Contract shall be signed in 2 (two) originals. The Contractor shall be provided with 1 (one) signed original and the other one will be retained by the Owner.

50.2 Subsequent to signing of this Contract, the Contractor, at its own cost, shall provide the Owner with at least 5 (five) photocopies of this Contract within 30 (thirty) days after the signing of this Contract.

51.0 **ENTIRE AGREEMENT**

51.1 This Contract constitutes the entire understanding between Parties hereto with respect to the subject matter hereof and supersedes all communication, negotiations and agreement (whether written or oral) of the Parties with respect hereto made prior to the date of this Contract.

51.2 There are no understandings or agreements between the Owner and the Contractor which are not fully expressed herein including the Annexures referred to in this Contract.

51.3 No modifications of this Contract shall be valid unless the same is agreed in writing between the Parties hereto and issued as an amendment in writing to this Contract.

Please acknowledge receipt and send one copy of this 'Work Order' duly signed and stamped as a token of your unconditional and unequivocal acceptance within 7 days.

Thanking you,
Yours faithfully,
for ONGC TRIPURA POWER COMPANY LIMITED

06/09/2023

Karan Bakshi
Head Engineering

ONGC-Tripura Power Co. Ltd. Palatana, Tripura

06/09/2023

Received & Accepted
For Utility Power Test
Authorized Signatory

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Enclosures:

Annexure-1 : Contract Price

Annexure-2 : Technical Specifications

Annexure-3 : Format for Performance Bank Guarantee

Annexure-4 : Format for Advance Bank Guarantee

Annexure-5: List of Acceptable Banks

Annexure-6: DELETED

Annexure-7: Guaranteed Performance

Annexure-8: DELETED

Annexure-9: Site Conditions

Annexure-10: Deleted

Annexure-1

CONTRACT PRICE

Sl. No.	Description	PRICE IN (INR)
I	**SUPPLY PRICE FOR ONLINE MONITORING SYSTEM FOR 125MVA ICT-2**	
IA	Price for supply of Equipment and Materials required for implementing complete Online Monitoring System for 125MVA ICT-2 and associated systems at Palatana Power Plant.	**47,10,000/-**
IB	All applicable taxes, duties and levies on IA above.	**8,47,800/-**
IC	**Total Price : Supply including Taxes, Duties and Levies (IA + IB)**	**55,57,800/-**
II	**SUPPLY PRICE FOR ONLINE MONITORING SYSTEM FOR 63MVAr LINE REACTOR-1 AND 2.**	
IIA	Price for supply of Equipment and Materials required for implementing complete online monitoring system for 63MVAr Line Reactor-1 and 2 associated systems at Palatana Power Plant.	**62,00,000/-**
IIB	All applicable taxes, duties and levies on IIA above.	**11,16,000/-**
IIC	**Total Price : Supply including Taxes, Duties and Levies (IIA + IIB)**	**73,16,000/-**
III	**INSTALLATION & COMMISSIONING SERVICES, TRAINING & FREIGHT PRICE FOR ONLINE MONITORING SYSTEM FOR ICT-2, LR-1&2**	
IIIA	Price for Freight, insurance, unloading, handling, storage, preservation at site, erection, testing and commissioning and training services for implementation of complete online monitoring system for 125MVA ICT-2 and 63 MVA LR-1& 2 and associated systems.	**11,90,000/-**
IIIB	All applicable taxes, duties and levies on IIIA above.	**2,14,200/-**
IIIC	**Total Price: Freight, Installation, Commissioning and Training Services including Taxes, Duties and Levies (IIIA + IIIB)**	**14,04,200/-**
IV	**TOTAL PRICE FOR SUPPLY, INSTALLATION & TRAINING SERVICES FOR ONLINE MONITORING SYSTEM FOR ICT-2, LR-1&2 (in Figures) INR (IC + IIC + IIIC)**	**1,42,78,000/-**
IV	**TOTAL PRICE FOR SUPPLY, INSTALLATION & TRAINING SERVICES FOR ONLINE MONITORING SYSTEM FOR ICT-2, LR-1&2 (in Words) INR (IC + IIC + IIIC)**	**Rupees One Crore Forty-Two Lakhs Seventy-Eight Thousand Only.**

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Annexure-2

TECHNICAL SPECIFICATIONS

(Attached)

TPC

ONGC TRIPURA POWER COMPANY LIMITED

TECHNICAL SPECIFICATION

FOR

COMPLETE ONLINE MONITORING

SYSTEM FOR ICT-2, LINE REACTOR-1 & LINE-REACTOR-2

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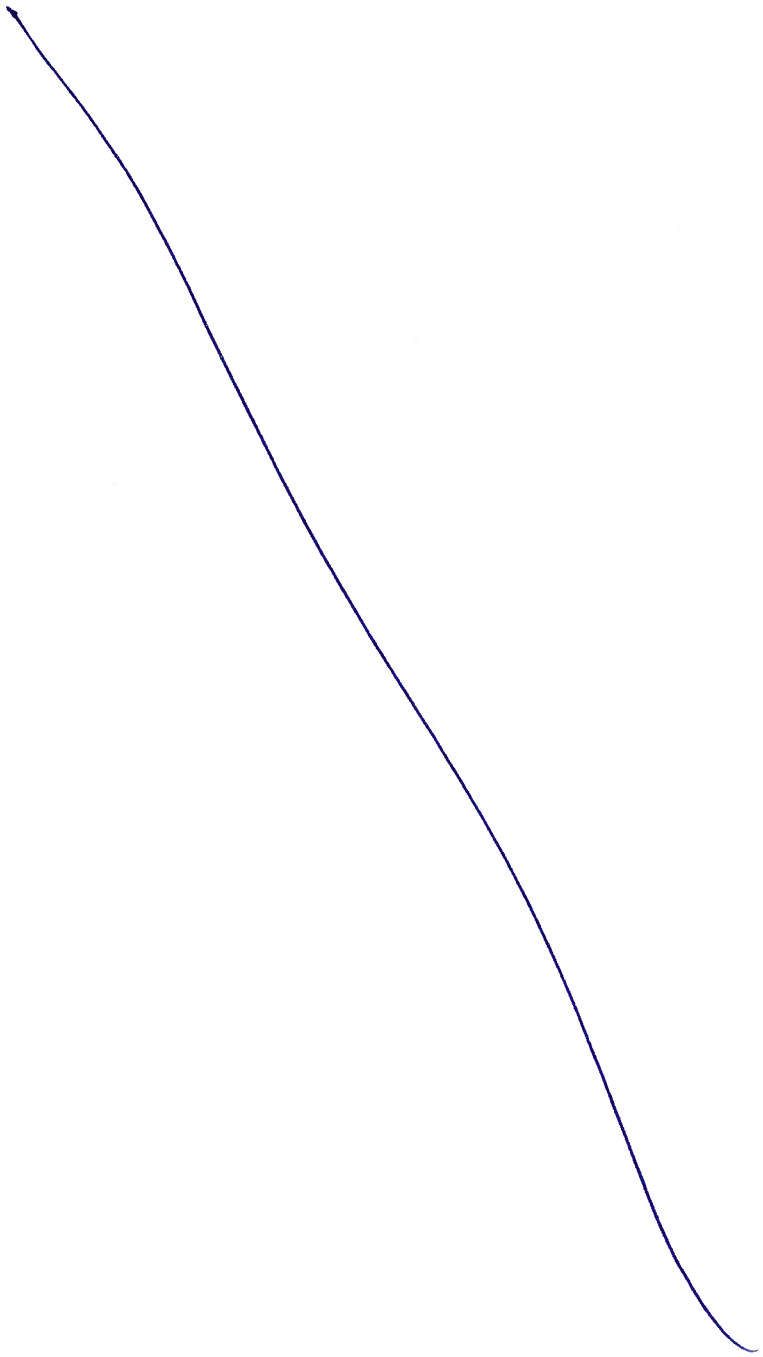

TPC

TECHNICAL SPECIFICATIONS FOR COMPLETE TRANSFORMER MONITORING SYSTEM FOR ICT-2, LINE REACTOR-1 & LINE-REACTOR-2 AT OTPC PLANT, PALATANA, TRIPURA

TABLE OF CONTENT

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1.0 Scope:

The scope of supply and implementation of complete online Transformer Monitoring System for ICT-2, LINE REACTOR-1 & 2 shall include design, manufacture, testing, supply, erection and commissioning. The intended system shall be suitable for monitoring the transformers in whole. All sensors, acquisition units, cables, processors, software, computers, cabinets and other accessories required for successful operation and performance are included in the scope of the contractor. All control & instrumentation cables shall be screened and armored. All power cables shall be steel armored.

Transformers identified for implementation of "Real Time Condition Monitoring Solution". The specifications of this transformer is given below:

ICT-2

Power Rating: 125 MVA, Voltage Rating: 400/132/33 KV, Vector Group: YNa0d11,
(3 HV + 3 LV Bushings)

LINE REACTOR-1

Power Rating: 63 MVAR, Voltage Rating: 400 KV, Vector Group: YN,
(3 HV + 1 Neutral Bushing).

LINE- REACTOR-2

Power Rating: 63 MVAR, Voltage Rating: 400 KV, Vector Group: YN,
(3 HV + 1 Neutral Bushing).

2.0 General Requirements:

2.1 Transformers and reactors should be equipped with an on-line condition monitoring and expert system. Such a system should support the operation and maintenance of a transformer/reactor with regard to at least following aspects:

(a) Line Reactor 1 & 2 monitoring should be from a common system and ICT-2 can have a separate individual system. ok

(b) With use of sensors, sophisticated modeling and diagnostic functions it should help to detect incipient faults at an early stage, in order to avoid a catastrophic outage of the transformer/reactor. ok

(c) It should provide tools which enable the user to operate a transformer/reactor close to its thermal limits, with taking into account thermal aging and avoiding critical hot spot temperature. It should support advanced management of

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possible overload conditions. Unit can continuously measure other critical parameters such as oil temperatures, load current, water content in oil, and cooling status which are complementary to the DGA information. It further incorporates on-board calculations based on the very latest IEC®/IEEE® thermal and moisture models standards and computed from the specific transformer characteristics obtained from the name-plate and test reports of the transformer ok

(d) It should enable the user to perform condition-based maintenance of the transformer/reactor. ok

(e) It should enable the user to have an overview at a glance about the transformer by clear visualization of transformer condition by traffic lights within software user interface and with LEDs on control cubical in the field. ok

2.2 All components of the transformer/reactor (active part, bushings, OLTC, cooling system) should be monitored by one single fan-less Intelligent Electronic Device (IED), so that correlations can be built between the information coming from various components in order to build consistent, comprehensive diagnostics. It should be possible to monitor all transformers and reactors at one substation with one single monitoring IED to allow data correlation of adjacent transformers/reactors. ok

2.3 Configuration of a monitoring system consisting of sub-systems for condition monitoring of OLTC and bushing not produced by the manufacturer of the offered monitoring system is not permitted. ok

2.4 The monitoring modules for data acquisition shall be installed at the transformer/reactors. All monitoring modules at one substation shall be connected to one single monitoring IED which shall be installed either in the control room or in the monitoring module at the power transformer by means of field bus ring topology in order to ensure the communication, even the field bus communication between the monitoring modules is interrupted at any point. The IED shall be equipped with a redundant flash memory and should have the capability of monitoring up to a minimum of 15 transformer/reactor units at one substation. The use of a monitoring IED/server equipped with moving parts such as fans and hard disks is not permitted. ok

2.5 The heart of the system shall be comprehensive and advanced numerical models of the transformer/reactor implemented on the monitoring IED, taking into account design, results of design calculation as well as results of comprehensive tests of the power transformer/reactor such as but not limited to the following: ok

(a) Thermal model oK

(b) Aging model oK

(c) Tap changer model ok

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(d) Moisture model ok

(e) Bushing model ok

(f) Overload model ok

(g) Cooling model ok

3.0 Scope of Work: ok

The scope includes design, development, supply, installation & commissioning and onsite training of OTPC personnel for implementation of a "Real Time Condition Monitoring Solution" for the ICT-2 Transformer and Line Reactor-1 & 2.

(I) The solution shall include On Line Monitoring of the following parameters for ICT-2: ok

(a) 9 Gas in oil and moisture

(b) Partial Discharge of the Transformer

(c) Tan Delta & capacitance of the Bushings

(d) Load current

(e) Ambient temperature

(f) Top oil temperature

(g) Bottom oil temperature

(h) OLTC Tank temperature

(i) Transformer winding moisture tracking

(j) Radiator Bank Temperature monitoring.

(II) The solution shall include On Line Monitoring of the following parameters for LR 1 & 2: ok

(k) 9 Gas in oil and moisture

(l) Partial Discharge of the Transformer

(m) Tan Delta & capacitance of the Bushings

(n) Load current

(o) Ambient temperature

(p) Top oil temperature

(q) Bottom oil temperature

(r) Transformer winding moisture tracking

(s) Radiator Bank Temperature monitoring.

The acquired data shall be available over OTPC Intranet and necessary alarms can be integrated with the existing SCADA (MaxDNA) network.

4.0 Technical Specifications: ok

The on-line monitoring device shall combine in a single system and measure the following:

(a) Partial Discharge (PD) in the transformer main tank and bushings; ok

(b) Relative variations of capacitance and power factor of each bushing; ok

(c) Gas contents in the insulating oils in the transformer main tank using photo-acoustic spectroscopy or NIR technology. The equipment shall measure each gas individually and give results in ppm. Moisture should also be measured in ppm. ok

4.1 The monitoring system shall be housed in a single IP56 acquisition box, wall or stand mounted, to be placed near the transformer. ok

4.2 No additional software shall be required for commissioning the system and to visualize the data. ok

4.3 Central Server/ Computer must be supplied to manage multiple online DGA, Bushing monitor and Partial Discharge system. ok

4.4 Dissolved Gas analysis, Partial Discharge and Bushing monitoring results can be displayed in different formats in which all the data points are linked together. ok

4.5 Furthermore, the system shall:

(a) Include data storage (>1 year) ok

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(b) web-server and integrated modem ok

(c) be GPS free and no active electronics placed on the top of transformer ok

(d) be connected to SCADA or DCS using known protocols such as Modbus, DNP3 or IEC61850 ok

(e) support RS232, RS485, Fiber optic, 3G, Ethernet carriers ok

(f) include 3 x LED Indicators (Power, Service, Alarm) and Alarm relay contacts ok

4.6 Dissolved Gas Analysis:

(a) Be capable of correlating all 9 fault gases, moisture-in-oil, oil temperature, and ambient temperature to the transformer load. ok

(b) Gas Analyzing shall be on the Photo Acoustic Spectroscopy (PAS) or NIR (Near Infra-Red) Spectro-photometry or any other competing technology without the need of any consumables. okwith PAS

(c) Be required to have a separate oil inlet pipe and separate oil return pipe to ensure quality of oil sampling. ok

(d) Have an embedded web-server to allow remote access using any smart device (such as smart phone or tablet) based on the user providing access via Ethernet or SIM. ok

(e) Not require download and install of any third party software for communication with the online DGA monitor. ok

(f) Have an on board 7 inch color touchscreen HMI to allow review of data, graphs and the password protected control of settings. ok

(g) Supply access to Instructions on how to take a manual oil sample accessible via the touch screen HMI ok

(h) The supplier shall be capable of providing a team of transformer experts to support and enhance the customer experience providing monitor support and technical transformer service. Costs for these services will be agreed with the customer in advance based on a per project or transformer basis. ok

(i) The user interface shall provide the following Dissolved Gas Analysis via its 7" on board ok

(j) HMI: ok

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- DGA Graph Trending ok
- DGA Instantaneous Values ok
- DGA Scheduling ok
- DGA Online Monitor Alarm Management ok
- Cross Data Trending ok
- Data Export to User device ok

4.7 Software:

The monitoring IED should allow generating HTML-based web pages in English language that provide an easy and user-friendly presentation of the acquired and analyzed on-line data as well as historical data. It shall include a built-in web server generating HTML5 web pages to support access the user interface using any popular Internet browser without use of any proprietary software. ok

The operating software used in the monitoring server shall be the multitasking and real-time operating system such as QNX.

The software of the monitoring IED must include and not limiting to the following:

(a) The expert system provides the user with recommendations and information to optimize the operation and maintenance of the transformer/reactor by means of algorithms for analyzing the on-line acquired variables which are implemented in the software. ok

(b) Dissolved gas analysis and diagnostic tool according to MSS, Doernenburg, Rogers, extended Rogers, IEC 60599, Duval and Key Gas. ok

(c) Diagnostic tools:

- Furfural determination
- Oil conditions acc. VDE 0370/IEC60422
- Classification of risk acc. IEEE C57.104-2008 ok
- Evaluation of paper insulation condition acc. IEC 60599 ok

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(d) Report generator, which automatically creates protocols with status information about the transformer/reactors and its main components. ok

(e) Simulator tool, which predict chosen parameters such as but not limited to load factor, hot-spot temperature, aging rate, losses and moisture of insulation paper to analyze the transformer and monitoring system´s behavior. ok

(f) The monitoring IED shall provide long term storage of all acquired and analyzed data (15 years plus) from all connected transformer/reactors at one substation. It must be possible to download the contents of the data memory to a remote PC through Ethernet. ok

(g) In case the values will exceed individually defined limits the system generates an alarm record which is also saved in the database. In addition the alarm signal can be sent to the control room by either standard protocols or closing of relay contacts. E-mail notifications and alarm massages should be customizable to specific local needs. ok

Initially, the on-line data acquired by means of the monitoring modules are to be held in the RAM memory of the monitoring IED with a high timely resolution. The monitoring system should have the capability of resolution and processing of the measured values in millisecond grid. In order to optimize the storage capacity, the individual data of the different on-line channels are stored as timely mean or maximum values in the historical database (data reduction). However, events, e.g. tap changing, shut down of the transformer, energizing of the transformer, or alarms, are to be saved with time stamp and high timely resolution in millisecond grid. ok

The system shall provide the capability of synchronizing its internal clock from an external source. ok

It must be possible to communicate with SCADA by means of standard protocols such as IEC 60870-5-101, IEC 60870-5-104, IEC 61850 (reports) certified by KEMA, Modbus or DNP3.0. ok

4.8 Bushing Monitoring shall:

(a) By direct measurement of bushing capacitance and Tan Delta by Schering bridge principle. ok

(b) be connected at the bushings Test Tap, through properly designed adaptors, including protections in order to disallow the Test Tap pin to remain floating, even with the signal cable disconnected from the adaptors. ok

(c) Provide hourly summary, indicating:

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- Transformer Status (ON/OFF) ok
- Current Polar Plot (through web app) ok
- Relative (%) and Referenced (pf) Capacitance, Relative (%) and Referenced (%) Power Factor ok
- Top oil, Bottom oil, Tap Changer and Environmental Temperatures, plus Humidity. Data shall be provided through additional sensors added to the system. ok

4.9 PD solution must have:

(a) Each partial discharge monitoring system shall be based on UHF technique and immune from noise from electrical connections at bushings, line corona etc.
Not required .Measuring PD Through bushing adopter

(b) PD monitoring should be done by providing 2 nos. of UHF sensors of drain valve type suitable for PD frequency range of 100MHz to 1500MHz with fully shielded sensor and extra port for functionality check and calibration signal.
Not required . Measuring PD Throgh Bushing adopter

(c) PD monitoring module shall be based on wide band signal processing technique and should be immune from noise by using transformer tank as faraday cage. oK

(d) The PD monitoring system should be provided with PD monitoring software for trending of PD activity and generating advance warning. Ok

(e) PD monitoring shall be installed and commissioning by vendor to existing drain valve of DN50/DN80 size based on availability. Not required .Measuring PD through Bushing adopter

(f) Vendor to submit the PD data analysis within 15 days of system commissioning and also provide PD assessment once every 6 months for next three years since first commissioning free of charge OK.

(g) Simultaneous (no multiplexing) and 24-hours-continuous acquisitions (not scheduled) in all 4 channels (with option for additional 4) OK

(h) Automatic and real time noise rejection (no manual clustering), with gating option on fourth channel OK

(i) >50 MS/s sampling rate, >20 V peak-peak input measuring range, <1 mV Sensitivity at full scale with 12 bit resolution OK

(j) Hourly summary, indicating:

- Transformer Status (ON/OFF) OK

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- Amplitude (Volts and nC) and Repetition Rate of PD signals in each Phase OK
- Additional PRPD pattern in both Volt and nC for each phase, OK

(k) The system must be commissioned, configured and interrogated without installing any software, by just using common web-browser OK

4.10 Central Server:

It must:

(a) Display the list of all monitored devices OK

(b) Display the status of all monitored devices (connected, not connected, alarm active) OK

(c) Allow direct connection to the monitored device OK

(d) Periodically retrieve the data from each monitoring device OK

(e) Display the Condition Group of each monitoring device (good, normal, defective, faulty, failure) OK

(f) Upgrade each device when a new software release is available OK

(g) Notify alarms through email OK

(h) Provide secure connection with proper user credentials and user roles OK

4.11 Parameters

H_2	5 - 5,000 PPM OK
CH_4	1 – 50,000 PPM oK
C2H6	1 – 50,000 PPM OK
C2H4	1 – 50,000 PPM OK
C2H2	0.1 – 50,000 PPM As per standard practice measuring from 0.5 ppm LDL
CO	1 – 50,000 PPM OK
CO2	3 – 50,000 PPM oK As per standard practice measuring from 20 LDL
O2	100 - 50,000 (± 10%) OK (+/-5%)
N2	100 - 150,000 (± 15%) As per standard practice measuring from 10,000ppm LDL
H20 (RS)	1 - 100% RS OK

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Accuracy	± 5% or ± LDL (whichever is greater) oK

4.12 DATA- DGA

Measurement frequency	1 - 24 hrs. OK
Data Storage	GB micro SD card, 15+ years oK

4.13 Bushing Monitoring

Input channels	2 sets of 3 phases, simultaneous acquisition on all channels OK
Simultaneous channels	3 (up to 6) 03 Ok
Sensors	Bushing Tap Adaptors OK
Input measuring range	0 - 200mA Ok
Accuracy	Amplitude: 0.1%, Relative Phase Angle: 0.05° ok
Resolution	12 bit ok
Sampling rate	>10 kS/s ok
Power system frequency	50 - 60Hz, ± 0.01 Hz ok Type text here

4.14 DATA- Partial Discharge and Bushing

Acquisition mode	Continuous ok
Trending	Hourly, daily, weekly, monthly OK
Storage	> 1 year OK

4.15 Alarms

High-vis LED's	Red, Amber, Green OK
Alarm relay contact	4 x NO or NC, user configurable OK

4.16 I/O

Analog inputs	3 x PT100, 3 x 4 - 20 mA, 1 x Load CT
Digital inputs	5 x 24V isolated OK

OK

4.17 Communication Options

Protocols	Modbus, DNP3 & IEC61850 OK
Carriers	RS232, RS485, Ethernet, Fiber, 3G OK
HMI	7" High Resolution Colour LCD OK

4.18 Power

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Power	90 - 250 VAC, 47 - 63 Hz, 300W max OK

4.19 Environment

Operating temperature	-40 to +55 °C (option for -60 °C) OK
Operating humidity	5 - 95% RH, non-condensing OK
Oil temperature range	-40 to +120 °C OK
IP Rating	IP56 OK

4.20 Data to be Acquired by the Monitoring system:

The following acquired variables should be recorded by the monitoring system:

(a) Load current on HV side OK

(b) Over currents and short circuit currents on HV side OK

(c) Top oil temperature OK

(d) Bottom oil temperature OK

(e) Winding temperatures (from Fiber-Optic Temperature Indicator) OK

(f) Gas-in-oil content [ppm] OK

(g) Relative moisture of oil (water activity) [%] OK

(h) Operating voltages on HV side directly at the bushing test tap by means of sensing devices installed at the bushing test tap OK

(i) Transient over-voltages detection (up to 1.2/50 micro second lightning impulse) OK

(j) Ambient temperature OK

(k) Circuit state of each fan and pump OK (ON/OFF)

(l) In- and outlet temperatures of cooling unit Not required

(m) Circuit state of protection devices (e.g. Buchholz-Relay, overpressure relief device, ...) ok

(n) OLTC position (Only in ICT-2) OK

(o) Active power consumption of OLTC motor drive (Only in ICT-2) OK

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(p) Oil temperature in OLTC compartment (Only in ICT-2) OK

It must be possible to retrofit additional sensors in the future in order to extend the monitoring functionalities. It should be also possible to integrate existing transformers in the monitoring system.

The transformer monitoring system shall be able to fully integrate DGA equipment for individual detection of Hydrogen (H2), Methane (CH4), Ethane (C2H6), Ethylene (C2H4), Acetylene (C2H2), Carbon monoxide (CO), Carbon dioxide (CO2), Oxygen (O2), Nitrogen (N2) and moisture (H2O), based on PAS (Photo Acoustic Spectroscopy) or NIR (Near Infra-Red).
The DGA sensor shall not use any consumables like carrier or calibration gases. OK

4.21 Information to be provided by the System:

On the base of received on-line measurements, it should calculated/analyzed for each transformer/reactor individually:

(a) Apparent power (MVA) OK

(b) Load factor ok

(c) Number of over currents and short-circuit currents on HV side Yes
(d) Last over current and short-circuit current on HV side Yes

(e) Actual losses Yes

(f) Top oil temperature according to thermal model OK

(g) Hot spot temperature in accordance with IEC 60076-7 OK with IEEE C-57.91-2011

(h) Ageing rate in accordance with IEC 60076-7 OK

(i) Lifetime consumption in accordance with IEC 60076-7 OK

(j) Gas in oil gradient [ppm/day] OK

(k) Water content in oil [ppm] OK

(l) Moisture of insulation paper OK

(m) Bubbling temperature OK

(n) Bubbling safety margin OK

(o) Breakdown voltage of insulation oil

(p) Overload capacity Yes

(q) Emergency overloading time when overloading Yes

(r) Number of transient over-voltages on HV bushings (up to 1.2/50 micro second lightning impulse) 900+ is a transformer monitoring system which helps to maintain for longer service proactively. As it is not incident recorder, the above parameters through bushing leakage current can be seen by monitoring tan delta & capacitance

(s) Last transient over-voltage on HV bushings (up to 1.2/50 micro second lightning impulse) 900+ is a transformer monitoring system which helps to maintain for longer service proactively. As it is not incident recorder, the above parameters through bushing leakage current can be seen by monitoring tan delta & capacitance

(t) Change of capacitance of condenser bushings on HV bushings OK

(u) On-line capacitance of condenser bushings on HV bushings OK

(v) Capacitive displacement currents on HV bushings OK

(w) Operating times of fans and pumps OK

(x) Cooling efficiency (thermal resistance Rth) OK

(y) Cooling Power oK

(z) In- and outlet temperatures difference of cooling unit OK .

(aa) OLTC position (last and actual) Yes

(bb) Active power consumption of OLTC motor drive Ok

(cc) Last OLTC operation Ok

(dd) Number of switching operations of OLTC Complied

(ee) Number of switching operations of pre-selector Complied

(ff) Number of switching operations of selector complied

(gg) Sum of switched load current of OLTC complied

(hh) Diverter switch current during switching operation Complied

(ii) Number of OLTC operations until service Complied

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(jj) Sum of switched load current until service OK

(kk) Time of inrush current Yes

(ll) Switching time OK

(mm) Index of switched energy OK

(nn) Maximum power consumption of sector 1 Yes

(oo) Maximum power consumption of sector 2 Yes

(pp) Maximum power consumption of sector 3 Yes

(qq) Assessment of mechanical quality of tap changer ok

(rr) Oil temperature in OLTC compartment oK

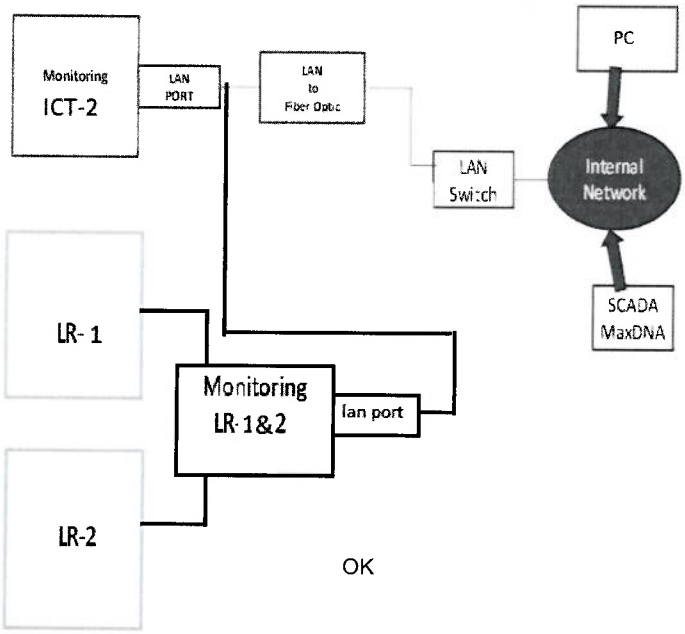
(ss) Oil temperature difference OLTC- main tank ok

(tt) Oil level in OLTC compartment ok

** OLTC is available only in ICT-2.

5.0 Schematic Diagram

The Monitoring Unit shall have a configuration as shown below:



OK

6.0 Sensor Schedule: OK

(I) Following sensors shall be minimum provided for ICT-2:

Sl no	Type of sensor	Quantity Per Transformer	Application	Performance Parameter
1	RTD/Pt100	1	Top oil temperature	To measure top oil temperature as a function of load
2	RTD/Pt100	1	Bottom oil temperature	To measure bottom oil temperature and evaluating the cooling efficiency of the Transformer
3	RTD/Pt100	1	Ambient temperature	To measure the ambient temperature to evaluate the differential of the top oil temperature and the ambient temperature to understand the extent of heating of the Transformer oil.

Ok

4	RTD/Pt100	2	OLTC Tank Temperature	To measure the OLTC tank temperature to evaluate the differential of the OLTC Tank temperature and the Top Oil temperature to understand the extent of heating of the oil in the OLTC tank and hence identifying any suspicious activities in the OLTC. Only for ICT-2.
5	Humidity sensor	1	Humidity in the atmosphere	To understand the moisture content in air and its associated impact on the Transformer oil
6	Bushing Tap Coupler Sensors	6	Tan Delta, Capacitance of the Bushings and Partial Discharge of the Transformer Tank	To measure the overall health of the Bushings and the insulation level/defects of the Transformer (Partial Discharge)
7	Load CT	3	Load Current	To measure the load current of the Transformer.

(II) Following sensors shall be minimum provided for LR 1 & 2: OK

Sl no	Type of sensor	Quantity Per Transformer	Application	Performance Parameter
1	RTD/Pt100	1	Top oil temperature	To measure top oil temperature as a function of load
2	RTD/Pt100	1	Bottom oil temperature	To measure bottom oil temperature and evaluating the cooling efficiency of the Transformer
3	RTD/Pt100	1	Ambient temperature	To measure the ambient temperature to evaluate the differential of the top oil temperature and the ambient temperature to understand the extent of heating of the Transformer oil.

4	Humidity sensor	1	Humidity in the atmosphere	To understand the moisture content in air and its associated impact on the Transformer oil 02 seprate boxconnected with one communication cable
5	Bushing Tap Coupler Sensors	8	Tan Delta, Capacitance of the Bushings and Partial Discharge of the Transformer Tank	To measure the overall health of the Bushings and the insulation level/defects of the Transformer (Partial Discharge)
6	Load CT	6	Load Current	To measure the load current of the Transformer.

7.0 Bill of Material, Approved Makes and Services for ICT-2: (Tentative List) OK

Sl.	Item	Qty	Make/Model	Remarks
1.	Total Transformer Monitoring Solution as per the specifications for Transformer and consisting of the following: • Partial Discharge (PD) in the transformer main tank and bushings; • Bushing Monitoring System - Relative variations of capacitance and power factor of each bushing; • On-line DGA - Gas contents in the insulating oils in the transformer main tank using photo-acoustic spectroscopy technology or NIR (Near Infra-Red) Spectro-photometry. The equipment shall measure each gas individually and give results in ppm. Moisture	01	Camlin/GE/MTE or equivalent make	Ok, with GE make Model DGA 900 Plus for On Line DGA Using PAS Technology and electrical PD and bushing Monitoring

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Sl.	Item	Qty	Make/Model	Remarks
	should also be measured in ppm. The monitoring system shall be housed in a single IP56 acquisition box, wall or stand mounted, to be placed near the transformer. Schematic Drawing is attached in the Specifications for reference			ok 02 Separate boxes will be installed nearby transformer (Hub and analysis) and the both boxes will connect with single server for remote communication Type text here
2.	Sensors i. Top Oil Temperature Sensor ii. Bottom Oil Temperature Sensor iii. Ambient Temperature Sensor iv. OLTC Tank Temperature Sensors v. Humidity Measuring Sensor vi. Bushing Tap Coupler Sensors vii. Load CT viii. PD CT in Neutral	 1 nos. 1 nos. 1 nos. 2 nos. 1 nos. 6 nos. 3 nos. 1 nos	Camlin/GE/MTE or equivalent make	Ok Ge make
3	LAN to FO converter FO to LAN Converter with necessary LAN and FO Cables for communication upto Main Control Room.	1 Lot	D-Link/ DGLink/ CISCO or equivalent	OK
4	Supply and laying of Multi-Mode 62,5/125um Optic fibre cable	1 Lot	D-Link / Systemax / Panduit / Tyco	As per requirement Ok
5	LAN Switch	1 Lot.	Moxa / Advantech / Cisco	Ok
6	Industrial Based PC with Software	1 Nos	HP/ Dell	Anti-Virus Required
7	Installation & Commissioning and Integrated Testing	1 Lot		Ok
8	Training	2 days		Ok

PC already available for Transformer Monitoring system supplied by Us and for each equipment separate PC not required. One PC for all like 20-30 equipment can be connected together. Software will be same for all equipment. Only upgradation required and same we will be done at the time of Commissioning

8.0 Bill of Material, Approved Makes and Services for LR 1&2: (Tentative List)

Sl.	Item	Qty	Make/Model	Remarks
1.	Total Transformer Monitoring Solution as per the specifications for Transformer and consisting of the following: • Partial Discharge (PD) in the	01	Camlin/GE/MTE or equivalent make	GE KELMAN MAKE

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Sl.	Item	Qty	Make/Model	Remarks
	transformer main tank and bushings; • Bushing Monitoring System - Relative variations of capacitance and power factor of each bushing; • On-line DGA - Gas contents in the insulating oils in the transformer main tank using photo-acoustic spectroscopy technology or NIR (Near Infra-Red) Spectro-photometry. The equipment shall measure each gas individually and give results in ppm. Moisture should also be measured in ppm. The monitoring system shall be housed in a single IP56 acquisition box, wall or stand mounted, to be placed near the transformer. LR-1 & 2 monitoring through a common system. Schematic Drawing is attached in the Specifications for reference	Type text here		Ok
2.	Sensors i. Top Oil Temperature Sensor ii. Bottom Oil Temperature Sensor iii. Ambient Temperature Sensor iv. Humidity Measuring Sensor v. Bushing Tap Coupler Sensors vi. Load CT vii. PD CT in Neutral	 2 nos. 2 nos. 2 nos. 2 nos. 8 nos. 6 nos. 2 nos	Camlin/GE/MTE or equivalent make	OK , GE KELMAN MAKE
5	LAN Switch	1 Lot.	Moxa / Advantech / Cisco	Ok
7	Installation & Commissioning and Integrated Testing	1 Lot		Ok

The above list is tentative. Vendor must provide all the additional materials for fulfillment of the technical specification.

9.0 Compliance sheet:

The bidder must fill the Compliance Sheet given below for the ease of evaluation.

(I) General Compliance for ICT-2

Sl. No.	Description	Yes / No	Remarks
1.	On-line monitoring device to measure a. Partial Discharge (PD) in the transformer main tank and bushings;	Yes	Ok
	b. relative variations of capacitance and power factor of each bushing	Yes	Ok
	c. gas contents in the insulating oils in the transformer main tank	Yes	Ok
	d. shall combine together in a single system	Yes	ok
2.	The Monitoring system shall be housed in a single wall or stand mounted IP56 enclosure near to transformer	Yes	Ok
3.	Solution should include data storage(>1yr)	Yes	Ok
4.	System should have embedded web server & integrated modem	Yes	Ok
5	System should have 3 LED Indicators (Power, Service and Alarm)	Yes	Ok
6	System should have 4 X NO or NC user configurable Alarm Relay Contact	Yes	Ok
7	On board 7 inch colour touch screen HMI to review data, graphs and password protected control of setting	Yes	Ok
8	Other than web server based application no other software shall be used to commission, configure and interrogate	Yes	Ok

A. Dissolved Gas Analysis

Sl. No.	Description	Yes / No	Remarks
1.	System is capable to correlate all 9 fault gases, moisture in oil, oil temperature and ambient temperature to the transformer load	Yes	
2.	System should have a separate oil inlet and oil return pipe	Yes	
3.	Should have remote access using smart	Yes	

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Sl. No.	Description	Yes / No	Remarks
	device(smart phone or tablet)		
4.	Not required to download or install any third party software to communicate with DGA monitor	Yes	
5.	Supplier is capable to provide a team of transformer experts to support and enhance the customer experience providing monitor support and technical service.	Yes	

B. Bushing Monitoring System

Sl. No.	Description	Yes / No	Remarks
1.	Bushing Monitoring system shall be connected at the bushings Test Tap, through properly designed adaptors, including protections in order to disallow the Test Tap pin to remain floating, even with the signal cable disconnected from the adaptors.	Yes	
2.	Provide Hourly Summary indicating (a) Transformer Status (ON/OFF) (b) Current Polar Plot (through web app) (c) Relative (%) and Referenced (pf) Capacitance, Relative (%) and Referenced (%) Power Factor.	Yes	

C. PD solution

Sl. No.	Description	Yes / No	Remarks
1	Simultaneous (no multiplexing) and 24 hours continuous data acquisition in all 4 channels	Yes	Yes
2	Automatic and real time noise rejection (no manual clustering),	YES	
3	>50 MS/s sampling rate, >20 V peak-peak input measuring range, <1 mV Sensitivity at full scale with 12 bit resolution	YES	For Bushing Monitoring 100 KHz and PD 100 MHZ
4.	Provide Hourly Summary indicating: (a) Transformer Status (ON/OFF) (b) Amplitude (Volts and nC) and	Yes	YES

ONGC Tripura Power Co. Ltd. Palatana, Tripura

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Sl. No.	Description	Yes / No	Remarks
	Repetition Rate of PD signals in each Phase (c) Additional PRPD pattern in both Volt and nC for each phase		

D. Sensors & Others

Sl. No.	Description	Yes / No	Remarks
1	Should provide sensors to measure a) Top oil, b) Bottom oil, c) Environmental Temperatures d) OLTC Tap Position e) Humidity f) Load CT	YES YES YES YES YES YES	
2	Data shall be provided through additional sensors added to the system.	YES	

E. Integrated System & Communication

Sl. No.	Description	Yes / No	Remarks
1	Display the list of all monitored device	YES	
2	Display the status of all monitored device	YES	
3	Direct access to the monitored device	YES	
4.	Periodical retrieval of data from each monitoring device	YES	
5	Display of Condition Group (good, normal, defective, faulty, failure) of each monitoring device	YES	
6	Firmware upgradation of each device when a new software release is available	YES	
7	Notify alarm through email	YES	
8	Secure connection with proper user credential and user role	YES	
9	SCADA or DCS compatible using standard protocols like Modbus, DNP3 or IEC61850	YES	
10	Data Communication carriers Supports RS232, RS485, Fibre Optic, Ethernet and 3G	YES	

(II) General Compliance for LR-1 & 2

Sl. No.	Description	Yes / No	Remarks
1.	On-line monitoring device to measure a. Partial Discharge (PD) in the transformer main tank and bushings;	YES	
	b. relative variations of capacitance and power factor of each bushing	YES	
	c. gas contents in the insulating oils in the LR-1 & 2 main tank (combined system)	YES	
	d. shall combine together in a single system	YES	
2.	The Monitoring system shall be housed in a single wall or stand mounted IP56 enclosure near to transformer	YES	
3.	Solution should include data storage(>1yr)	YES	
4.	System should have embedded web server & integrated modem	YES	
5	System should have 3 LED Indicators (Power, Service and Alarm)	YES	
6	System should have 4 X NO or NC user configurable Alarm Relay Contact	YES	
7	On board 7 inch colour touch screen HMI to review data, graphs and password protected control of setting	YE S	
8	Other than web server based application no other software shall be used to commission, configure and interrogate	YES	

A. Dissolved Gas Analysis

Sl. No.	Description	Yes / No	Remarks
1.	System is capable to correlate all 9 fault gases, moisture in oil, oil temperature and ambient temperature to the transformer load	YES	
2.	System should have a separate oil inlet and oil return pipe for LR-1 & 2	YES	
3.	Should have remote access using smart device(smart phone or tablet)	YES	
4.	Not required to download or install any third party software to communicate with DGA monitor	YES	

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Sl. No.	Description	Yes / No	Remarks
5.	Supplier is capable to provide a team of transformer experts to support and enhance the customer experience providing monitor support and technical service.	YES	ok

B. Bushing Monitoring System

Sl. No.	Description	Yes / No	Remarks
1.	Bushing Monitoring system shall be connected at the bushings Test Tap, through properly designed adaptors, including protections in order to disallow the Test Tap pin to remain floating, even with the signal cable disconnected from the adaptors.	YES	
2.	Provide Hourly Summary indicating a. Transformer Status (ON/OFF) b. Current Polar Plot (through web app) c. Relative (%) and Referenced (pf) Capacitance, Relative (%) and Referenced (%) Power Factor.	YES	

C. PD solution

Sl. No.	Description	Yes / No	Remarks
1	Simultaneous (no multiplexing) and 24 hours continuous data acquisition in all 4 channels	YES	
2	Automatic and real time noise rejection (no manual clustering),	YES	
3	>50 MS/s sampling rate, >20 V peak-peak input measuring range, <1 mV Sensitivity at full scale with 12 bit resolution	YES	
4.	Provide Hourly Summary indicating: a. Transformer Status (ON/OFF) b. Amplitude (Volts and nC) and Repetition Rate of PD signals in each Phase c. Additional PRPD pattern in both Volt and nC for each phase	YES	

D. Sensors & Others

ONGC-Tripura Power Co. Ltd. Palatana, Tripura

Sl. No.	Description	Yes / No	Remarks
1	Should provide sensors to measure a. Top oil, b. Bottom oil, c. Environmental Temperatures d. Humidity e. Load CT	YES	
2	Data shall be provided through additional sensors added to the system.		

E. Integrated System & Communication

Sl. No.	Description	Yes / No	Remarks
1	Display the list of all monitored device	YES	
2	Display the status of all monitored device	YES	
3	Direct access to the monitored device	YES	
4.	Periodical retrieval of data from each monitoring device	YES	
5	Display of Condition Group (good, normal, defective, faulty, failure) of each monitoring device	YES	
6	Firmware upgradation of each device when a new software release is available	YES	
7	Notify alarm through email	YES	
8	Secure connection with proper user credential and user role	YES	
9	SCADA or DCS compatible using standard protocols like Modbus, DNP3 or IEC61850	YES	
10	Data Communication carriers Supports RS232, RS485, Fibre Optic, Ethernet and 3G	YES	

10.0 Warranty Requirement

Contractor shall be liable for any defects in the materials supplied and workmanship of services provided by it for period of 60 months after the date of supply of materials and taking over of materials by the owner. YES

11.0 Service Level Agreement (SLA) OK

11.1 Contractor shall give operational guarantees covered in the contract. This includes Transformer Monitoring System availability.

ONGC Tripura Power Co. Ltd. Palatana, Tripura

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11.2 Availability / Uptime will be computed based on availability of the Transformer Monitoring System including accessories supplied and implemented by Contractor to the OTPC users.

11.3 Response may be telephonic, email, remote or onsite. In case the issue cannot be resolved telephonically or by email or by remote support, the Contractor shall need to provide onsite assistance within response resolution window.

11.4 Typical resolution time will be applicable if Transformer Monitoring Systems are not available to the OTPC's users.

11.5 A monthly report shall be submitted at the end of every month indicating availability / uptime etc. Tools / in-built facility to measure availability / uptime of system shall be provided by the Contractor.

11.6 **Availability Measurements:** OK

	Priority	**Measurement / Criteria**	**Response time**	**Maximum Resolution Time**
11.6.1	Priority 1	The defect results in the failure of the complete Transformer Monitoring System, and/or of a sub-system, and/or of a software unit (program or module) within the system where impact on business is severe; there is an interruption of an important business process for one or several business units that cannot be remedied by a manual workaround.	Up to thirty (30) minutes	Four (04) Hours
11.6.2	Priority 2	The defect results in the failure of the complete Transformer Monitoring System, and/or of a sub-system, and/or of a software unit (program or module) within the system. There is no way to make the failed component(s) work completely. However, there are acceptable processing alternatives which will yield the desired result.	Within one (01) hour	Eight (08) Hours
11.6.3	Priority 3	The defect does not result in a failure, but causes the system to produce incorrect, incomplete, or inconsistent results, or the defect impairs the system usability. No significant effect on the business is expected and a manual workaround is available. A general improvement in the system is required.	Within four (04) hours	Twenty Four (24) Hours

ONGC-Tripura Power Co. Ltd. Palatana, Tripura

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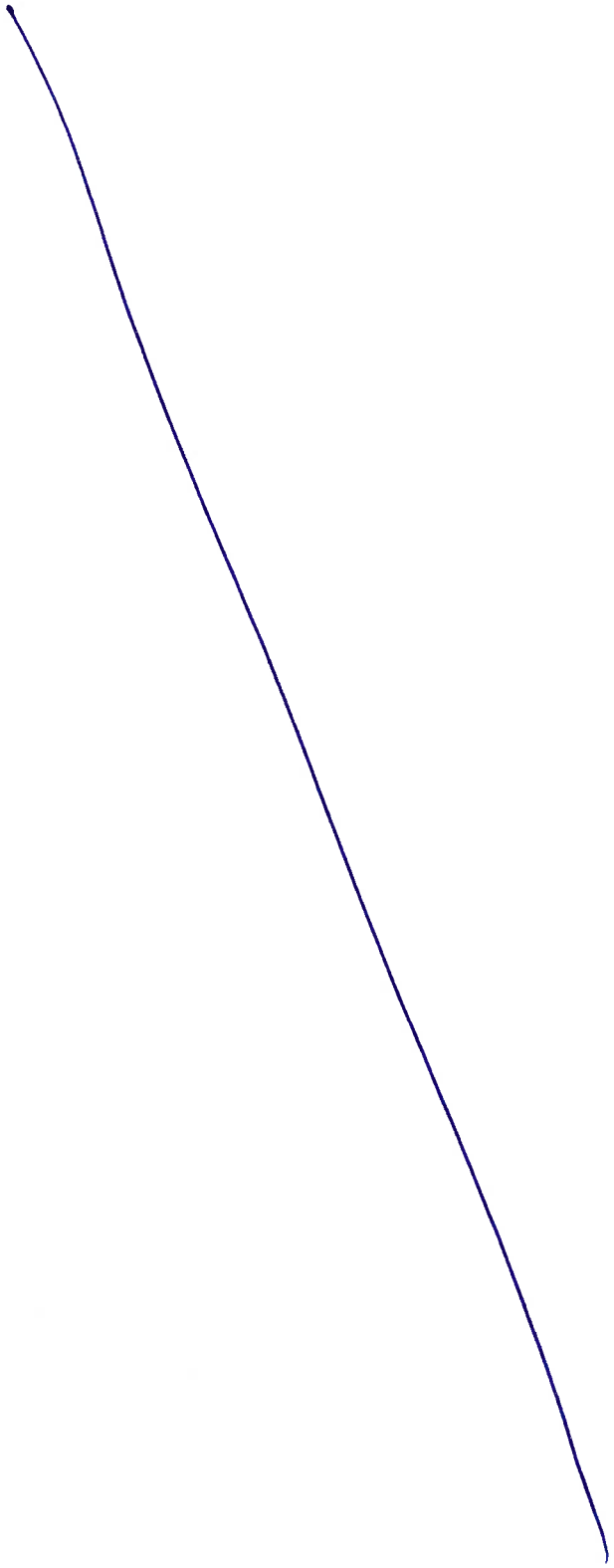


Annexure-3

FORMAT FOR PERFORMANCE BANK GURANTEE

(To be stamped in accordance with Stamp Act)

Bank Guarantee No.

Date

To,
ONGC Tripura Power Company Limited
10th Floor, Core-4 and Central,
Scope Minar, Laxmi Nagar
New Delhi – 110092
Phone: +91-11-22404700

Dear Sirs,

At the request and for the account of our client _____ having its registered office at _____ (hereinafter referred to as the "Contractor", which expression shall, unless inconsistent with the context or meaning thereof, include its successors and assigns), and in consideration of ONGC Tripura Power Company Ltd having its registered office in **ONGC Tripura Power Company Limited, Udaipur-Kakraban Road, Palatana P.O., District Gomti, Tripura-799116.** (India) (hereinafter referred to as the "Owner", which expression shall, unless inconsistent with the context or meaning thereof, include its successors and assigns) having awarded the contract for _____at 2x363.3 MW Combined Cycle Power Plant at Palatana, Tripura, India under reference no. _____ dated _____ to the Contractor (as amended, supplemented or modified from time to time in accordance with the terms thereof, hereinafter referred to as the "Contract") and the Contractor having agreed to provide a contract performance guarantee to the Owner for the full and faithful performance of each of Contractor's payment and other obligations under the Contract in an amount equal to Rs _____ [Rupees _____] (as such, amount may change pursuant to terms of the Contract, hereinafter "Aggregate Maximum Amount"),

we, _____, having our head office at _____ (hereinafter referred to as the "**Bank**", which expression shall, unless inconsistent with the context or meaning thereof, include its successors and assigns) do hereby irrevocably and unconditionally guarantee and undertake to pay to the Owner, immediately on receipt of written demand, any and all monies which the Owner certifies that it is entitled to draw hereunder pursuant to the terms and conditions of the Contract to the extent of the Aggregate Maximum Amount for the claim (s) arising up to the End Date (as defined below) without any demur, reservation, contest, recourse or protest and without any reference to the Contractor. Any such demand made by the Owner on the Bank under this Guarantee shall be (a) conclusive evidence that the Owner is entitled to demand payment thereof from the Bank pursuant to the terms and conditions of the Contract and (b) binding on the Bank, in each case notwithstanding any difference between the Owner and the Contractor or any dispute pending before any court, tribunal, arbitrator or any other authority

Multiple drawings may be made under this Guarantee. The Aggregate Maximum Amount under this Guarantee shall be automatically reduced by the amount paid to the Owner against demands for payment under this Guarantee.

ONGC Tripura Power Co. Ltd. Palatana, Tripura

This Guarantee may be amended to extend the then current End Date upon the written request of the Contractor, but this Guarantee shall not otherwise be amended, and the Aggregate Maximum Amount shall not be reduced without the prior written consent of the Owner.

The Owner shall have the fullest liberty, without affecting in any way the liability of the Bank under this Guarantee, from time to time to extend the time for performance of the Contract by the Contractor. The Owner shall have the fullest liberty, without affecting the liability of the Bank under this Guarantee, to postpone from time to time the exercise of any powers vested in the Owner or of any right which the Owner might have against the Contractor, to exercise the same at any time in any manner, and either to enforce or to forbear to enforce any covenants in the Contract or any other course or remedy or security available to the Owner. The Bank shall not be released of its obligations under this Guarantee by any exercise by the Owner of its liberty with reference to the matters aforesaid or any of them or by reason of any other act of forbearance or other acts of omission or commission on the part of the Owner or any other indulgence shown by the Owner or by any other matter or thing whatsoever which under law would, but for this provision, have the effect of relieving the Bank from such obligations.

The Bank also agrees that the Owner, at its option, shall be entitled to enforce this Guarantee against the Bank as a principal debtor in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee the Owner may have in relation to the Contractor's liabilities.

The Bank's liability under this Guarantee is limited to the Aggregate Maximum Amount and it shall remain in force up to and including _____, 202_ (such date as may be extended, the "End Date"). The End Date shall be extended from time to time for such period as may be desired by the Owner and accepted by the Contractor on whose behalf this Guarantee has been issued. The Bank hereby agrees to notify the Owner in writing by registered mail not less than 30 (thirty) days prior to any expiration or other cancellation of this Guarantee if for any reason this Guarantee will expire according to its terms or will otherwise be cancelled and the validity of this Guarantee has not been extended beyond the then current End Date. This Guarantee shall expire on the End Date whether returned to us or not, but, Owner may raise a claim occurred on or prior to End Date on Bank within 2 (two) months of End Date of this Guarantee and Bank will honour such claim(s), and no claims will be honoured thereafter.

Dated this ___ day of _____, 2023___ at _____

WITNESS

(Signature)_____ (Signature) _____

(Name) ---------- (Name) ----------

(Official Address)

(Designation with Bank stamp)

Attorney as per Power of Attorney
No.
Dated

Note: Currency of this Bank Guarantee shall be INR (Indian Rupees). This Bank guarantee shall be provided under a cover letter from the bank which is duly signed by 2 (two) authorized officers of such bank.

ONGC-Tripura Power Co. Ltd. Palatana, Tripura

Annexure-4

FORMAT FOR ADVANCE BANK GURANTEE

(To be stamped in accordance with Stamp Act)

Bank Guarantee No.

Date

To,
ONGC Tripura Power Company Limited
10th Floor, Core-4 and Central,
Scope Minar, Laxmi Nagar
New Delhi – 110092
Phone: +91-11-22404700

Dear Sirs,

At the request and for the account of our client ..... having its registered office ..... (hereinafter referred to as the **"Contractor"**, which expression shall, unless inconsistent with the context or meaning thereof, include its successors and assigns), and in consideration of ONGC Tripura Power Company Ltd having its registered office at **ONGC Tripura Power Company Limited, Udaipur-Kakraban Road, Palatana P.O., District Gomti, Tripura-799116.** (India) (hereinafter referred to as the **"Owner"**, which expression shall, unless inconsistent with the context or meaning thereof, include its successors and assigns) having awarded the contract for _____ at 2x363.3 MW Combined Cycle Power Plant at Palatana, Tripura, India under reference no. _____ dated _____, to the Contractor (as amended, supplemented or modified from time to time in accordance with the terms thereof, hereinafter referred to as the **"Contract"**) and the Owner having agreed to make advance payments to the Contractor as provided therein in an amount not to exceed **Rs** _____ (**Rupees** _____) (as such amount may change pursuant to conditions of the Contract, hereinafter **"Aggregate Maximum Amount"),**

we, _____, having our head office at _____ (hereinafter referred to as the "**Bank**", which expression shall, unless inconsistent with the context or meaning thereof, include its successors and assigns) do hereby irrevocably and unconditionally guarantee and undertake to pay to the Owner, immediately on receipt of written demand, any and all monies which the Owner certifies that it is entitled to draw hereunder pursuant to the terms and conditions of the Contract to the extent of the Aggregate Maximum Amount for claim(s) arising up to the End Date (as defined below) without any demur, reservation, contest, recourse or protest and without any reference to the Contractor. Any such demand made by the Owner on the Bank under this Guarantee shall be (a) conclusive evidence that the Owner is entitled to demand payment thereof from the Bank pursuant to the terms and conditions of the Contract and (b) binding on the Bank, in each case notwithstanding any difference between the Owner and the Contractor or any dispute pending before any court, tribunal, arbitrator or any other authority.

This Guarantee may be amended to extend the then-current End Date upon the written request of the Contractor Owner with due consent of the, but this Guarantee shall not otherwise be amended, and the Aggregate Maximum Amount shall not be reduced without the prior written consent of the Owner.

The Owner shall have the fullest liberty, without affecting in any way the liability of the Bank under this Guarantee, from time to time to extend the time for performance of the Contract by the Contractor. The Owner shall have the fullest liberty, without affecting the liability of the Bank

ONGC-Tripura Power Co. Ltd. Palatana, Tripura

under this Guarantee, to postpone from time to time the exercise of any powers vested in the Owner or of any right which the Owner might have against the Contractor, to exercise the same at any time in any manner, and either to enforce or to forbear to enforce any covenants in the Contract or any other course or remedy or security available to the Owner. The Bank shall not be released of its obligations under this Guarantee by any exercise by the Owner of its liberty with reference to the matters aforesaid or any of them or by reason of any other act of forbearance or other acts of omission or commission on the part of the Owner or any other indulgence shown by the Owner or by any other matter or thing whatsoever which under law would, but for this provision, have the effect of relieving the Bank from such obligations.

The Bank also agrees that the Owner, at its option, shall be entitled to enforce this Guarantee against the Bank as a principal debtor in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee the Owner may have in relation to the Contractor's liabilities.

The Bank's liability under this Guarantee is limited to the Aggregate Maximum Amount and it shall remain in force up to and including [_____, 20__] (such date as may be extended, the "**End Date**"). The End Date shall be extended from time to time for such period (not exceeding one year), as may be desired by the Contractor on whose behalf this Guarantee has been issued. The Bank hereby agrees to notify the Owner in writing by registered mail not less than 30 (thirty) days prior to any expiration or other cancellation of this Guarantee if for any reason this Guarantee will expire according to its terms or will otherwise be cancelled and the validity of this Guarantee has not been extended beyond the then current End Date. This Guarantee shall expire on the End Date whether returned to us or not, but, Owner may raise a claim occurred on or prior to End Date on Bank within two months of End Date of this Guarantee and Bank will honour such claim(s), and no claims will be honoured thereafter.

Dated this ___ day of _____, 20___ at _____

WITNESS

(Signature)_____ (Signature) _____

(Name) ---------- (Name) ----------

(Official Address) (Designation with Bank stamp)

Attorney as per Power of Attorney
No.
Dated

Note: Currency of this Bank Guarantee shall be INR (Indian Rupees). This Bank guarantee shall be provided under a cover letter from the bank which is duly signed by 2 (two) authorized officers of such bank.

ONGC Tripura Power Co. Ltd. Palatana, Tripura

UTILITY POWER DELHI

Annexure-5

LIST OF ACCEPTABLE BANKS

Foreign banks

Sl. No.	Name of Bank
1.	Citigroup, USA
2.	HSBC Holdings, United Kingdom
3.	Standard Chartered

Indian banks

Sl.No	Name of Indian Banks
1.	Allahabad Bank
2.	Bank of Baroda
3.	Bank of India
4.	Canara Bank
5.	Indian Bank
6.	Oriental Bank of Commerce
7.	Punjab National Bank
8.	State Bank of India
9.	Axis Bank
10.	ICICI Bank
11.	Indusind Bank
12.	HDFC Bank

ONGC Tripura Power Co. Ltd. Palatana, Tripura

QUALITY POWER DELHI

Annexure-6

DELETED

Annexure-7

GUARANTEED PERFORMANCE

Following are the functional guarantees for the ICT-2, LR-1 & 2 Monitoring System:

Sl	Parameters	Guaranteed Value
1.0	Availability during Guarantee Test / Trial Operation	**99.50%**
2.0	Availability during 1st Operating Year / 1st Warranty Year	**99.50%**
3.0	Availability during 2nd Operating Year/ 2nd Warranty Year	**99.50%**
4.0	Availability during 3rd Operating Year/ 3rd Warranty Year	**99.50%**
5.0	Availability during 4th Operating Year / 4th Warranty Year	**99.50%**
6.0	Availability during 5th Operating Year / 5th Warranty Year	**99.50%**

1. Availability shall be calculated as follows:

   A = [TSH – (TUD-TEPD)]*100/TSH

   Where,

   A = Availability (in %)

   TSH = Total Service Hour;

   TUD = Total Unscheduled Downtime (Hour); and

   TEPD = Total Excused Performance Downtime (Hour)

2. Total Service Hour during guarantee test shall be 24 x 30 = 720 Hours
3. Total Service Hour in any operating year shall be 24 x 365 / 366 i.e. 8760 / 8784 Hours
4. Unscheduled downtime shall mean the time when ICT-2, LR-1 & 2 Monitoring System is not available for functional use and which is outside scheduled downtime
5. Scheduled downtime is the planned ICT-2, LR-1 & 2 Monitoring System Maintenance downtime jointly agreed by Owner and Contractor in advance.
6. Excused performance downtime is the time when ICT-2, LR-1 & 2 Monitoring System is not available for functional use for reason which is excused in the Contract.

ONGC-Tripura Power Co. Ltd. Palatana, Tripura

UTILITY POWER TEST DELHI

Annexure-8

DELETED

Annexure-9

SITE

SITE CONDITIONS - OTPC GAS POWER PLANT AT PALATANA, TRIPURA

Ambient temperature:

Maximum / Minimum temperature: 37.5 °C and 6.7°C

Daily maximum mean temperature: 30.5 °C

Daily minimum mean temperature: 20.5 °C

Design temperature for electrical

Equipment/device/System: 40 °C

Rainfall:

Average annual rainfall: 2000 mm

Max. Recorded in 24 Hrs : 164.9 mm

Period of Monsoon (Avg) Showers: May to October

Relative Humidity: Varies up to 100%

Maximum RH: 100%

Minimum RH: 40%

Mean RH: 77%

Winter season:

December to February: Heavy fog for about two months in a year.

Seismic data: (Data from FI)

Seismic intensity: As per IS-1893.

Zone: V

Importance factor: 0.36

Wind data: (Data from FI)

Max Wind Speed: 55 m/s

ONGC-Tripura Power Co. Ltd. Palatana, Tripura

UTILITY POWER TEST DELHI

Annexure-10

DELETED

MARSH

OPERATIONAL RISK SURVEY REPORT

ONGC TRIPURA POWER COMPANY, UDAIPUR, TRIPURA, INDIA

APRIL 2019

Prepared by: Sundeep Pugliya BE(Mechanical), CPM
Sundeep.pugliya@marsh.com
Global Energy Risk Engineering - India

Following: A survey visit to the OTPC, Udaipur, Tripura, India Power Plant on 5th and 6th April 2019 and discussions with the site personnel

REV. OTPC.U.UW.1.0

Revision History

Revision	Date	Comments
OTPC.U.UW.1.0	30 April 2019	Draft issue following April 2019 survey

OTPC, Udaipur, Tripura, India

It is acknowledged that this report is based upon analysis of information that has been provided by persons other than Marsh, and Marsh makes no representation or warranty in relation to the accuracy, currency or completeness of factual information contained in it. This report is not intended to identify all hazards that may exist, nor is it intended to be an exhaustive view of all possibilities or eventualities.

Any recommendations for risk improvement contained herein are purely advisory, and the decision and responsibility for implementation rests with the recipient's management. This report does not guarantee, assure or warrant that compliance with any recommendations will eliminate all hazards or accidents, or that the recipient is in compliance with any laws, statutes, regulations or directives.

The report is intended for use by the intended recipient only and not by any third party; it is a condition of delivery of this report that Marsh shall not be held liable for any loss or damage (including any special, indirect or consequential damages, loss of profit or loss of revenue), including any arising out of or in connection with the data, calculations or opinions expressed herein.

Abbreviations

AC	Alternating Current
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
AP	Authorised Person
APH	Air Preheater
ASCE	American Society Of Civil Engineers
APS	Automatic Plant start-up (Shutdown)
CEMS	Continuous Emissions Monitoring System
CO_2	Carbon Dioxide
COD	Commercial Operation Date
CW	Cooling Water
DC	Direct Current
DIN	Deutsches Institut für Normung.
DGA	Dissolved Gas Analysis
DLN	Dry Low NOx
EDG	Emergency Diesel Generator
EPC	Engineering Procurement & Construction
ERP	Emergency Response Plan
ESD	Emergency Shutdown Device
ESP	Electrostatic Precipitator
FD	Forced Draught
FGD	Flue Gas Desulphurisation
FOF	Forced Outage Factor
GCF	Gross Capacity Factor
GSU	Generator Step Up (transformer)
ha	Hectares
HFO	Heavy Fuel Oil
HP	High Pressure
HSE	Health, Safety & Environment
HWP	Hot Work Permit
HV	High Voltage (>1000V)
Hz	Hertz (cycles)
I&C	Instrument & Control
I/O	Input-Output
ID	Induced Draught
IOSH	Institution of Occupational Safety and Health

IPP	Independent Power Producer
IPD	Iso-Phase Bus Duct
ISO	International Standards Organisation
kV	One thousand volts
LDO	Light Diesel Oil
LP	Low Pressure
LV	Low Voltage
Maj	Major
MCR	Maximum Continuous Rating
MFL	Maximum Foreseeable Loss
Min	Minor
MMD	Mechanical Maintenance Department
MPa	Mega (Million) Pascal (pressure)
MV	Medium Voltage
MW	Mega (Million) Watt electrical
NCF	Net Capacity Factor
NFPA	National Fire Protection Association
NOx	Nitrous Oxides
NRV	Non Return Valve
OE	Owners Engineer
OEM	Original Equipment Manufacturer
O&M	Operations & Maintenance
OMA	Operation & Maintenance Agreement
OHSAS	Occupational Health & Safety Assessment System
PCOD	Project Commercial Operation Date
PML	Probable Maximum Loss
PPA	Power Purchase Agreement
ppb	Parts per billion
PPE	Personal Protective Equipment
RC	Reinforced Concrete
SAP	Senior Authorized Person
SWFGD	Sea Water Flue Gas Desulphurisation
tph	tonnes per hour
UBS	Uniform Building Standard
UPS	Uninterruptible Power Supply
VDU	Visual Display Unit
WMS	Work Management System

Company Specific Abbreviations

BHEL	Bharat Heavy Electrical Limited
BIS	Bureau Of Indian Standards
DGM	Deputy General Manager
EHS	Environment Health and Safety
EMD	Electrical Maintenance Department
EOP	Emergency Operating Procedure
FLOP	Fire Loss of Profit
FOLHS	Fibre Optic Linear Heat Sensing Cables
GM	General Manager
IBT	Inter connecting Bus Transformer
IIF- II	India Infrastructure Fund – II
IL&FS	Infrastructure Leasing and Financial Services Limited
INR	Indian National Rupees
IR	Infra-Red
LOTO	Lock Out Tag Out
MLOP	Machinery Breakdown Loss of Profit
OFS	Off site Services
ONGC	Oïl and Natural Gas Company
OTPC	ONGC Tripura Power Company
PTW	Permit To Work
RLA	Residual Life Assessment
SOP	Standard Operating Procedures
TAC	Tariff Advisory Committee
TC	Technical Cell
TMD	Turbine Maintenance Department

CONTENTS

SECTION ONE

INTRODUCTION

This Risk Survey report has been prepared at the request of insurers and reinsurers on behalf of OTPC following a two day survey of OTPC, Udaipur, Tripura Plant on 5th and 6th April, 2019.

Marsh visited OTPC, Udaipur, Tripura previously in November 2015 for the risk engineering survey of the plant.

Objectives and Acknowledgements

The principal objectives of this report are to provide an exposure information update for the projects incumbent operational insurance partners market, and to provide OTPC with the benefit of independent loss control opinion with experience in the specific technology adopted.

Information contained in this report was to an agenda sent to the plant prior to the visit. Discussions with site personnel at the time and following the visit, and observations made during a tour of the plant provided more information of site operations.

There was no physical testing of systems carried out at the time of this visit.

The survey was carried out by Sundeep Pugliya of Global Energy Risk Engineering, Marsh India. The visit was arranged by OTPC in Udaipur Plant and was coordinated by Mr. Sajjan Kumar Sharma (Sr. Manager, Finance and Accounts) and Mr Sital Ray (Manager (EHS).

We gratefully acknowledge the contribution of everyone involved in the survey and in particular the following personnel.

Mr. Bibek Roy	-	DGM (O&M) and Plant In charge
Mr. Sajjan Kumar Sharma	-	Sr. Manager (F&A)
Mr. Narendra Kumar Gupta	-	Sr. Manager (Operation)
Mr. Sital Ray	-	Manager (EHS)
Mr. Premananda Nath Sharma	-	Manager (F&A)
Mr. Souvik Chowdhury	-	Manager (Technical Cell)
Mr. Md. Musa	-	Head C&I Maintenance
Mr. Bhaskar Sen Chowdhury	-	Head Mechanical Maintenance
Mr. S R Das	-	Head Electrical Maintenance
Mr. Raju Singh Parihar	-	Assistant Manager (Fire)

SECTION TWO

EXECUTIVE SUMMARY

Background

Oil & Natural Gas Corporation Ltd. (“ONGC”), a company of the Government of India, owns significant natural gas reserves in the North Eastern state of Tripura. However, these natural gas reserves were not developed commercially due to low industrial demand in the North-Eastern region.

The complexities of logistics and attendant costs limited the economic viability of transportation of gas to other parts of the country where gas is in deficit. In order to optimally utilize the gas available in Tripura and to supply power to the deficit areas of North Eastern States of India, ONGC along with Infrastructure Leasing and Financial Services Limited (IL&FS) and Government of Tripura formed a Special Purpose Vehicle ONGC Tripura Power Company (OTPC) by entering into a Shareholders’ Agreement (SHA) on September 18, 2008 to implement a 726.6 MW Combined Cycle Gas Turbine (CCGT) thermal power plant at Palatana, Tripura.

The first block (363.3 MW) of the power plant was declared under Commercial Operation from 4th January, 2014 and the second block (363.3 MW) of the two blocks was declared under Commercial Operation from 24th March 2015. BHEL was the EPC contractor for setting up of the power plant.

Description Summary

Location

The site co-ordinates are: Longitude 91.4396 (E) and Latitude 23.4992 (N).

The plant is located at Palatana, Udaipur Village at Gomoti District in the Indian state of Tripura.

As per Munich RE Nathan charts, the plant site is located in Zone 2 for earthquakes, Zone 5 for lightning, Zone 2 for tornados and in Zone 3 for flash floods. For the other natural perils including storms, cyclones, tsunami and volcanoes, the site is in “no hazard” or low hazard zones. All the critical structures like chimney, HRSGs, TG buildings, Tall Transfer towers etc. are provided with the lightning protection covering the respective areas.

The area of the plant is approximately 80 ha and the layout of the site provides good spatial separation.

The nearest commercial airport is at Agartala, which is the main airport for the region and is situated around 73 km to the North West of the plant. There was no indication of flight paths over the site during the survey.

The road access to the plant is through State Highway.

Plant

The first block (363.3 MW) of the power plant was declared under Commercial Operation from 4th January, 2014 and the second block (363.3 MW) of the two blocks was declared under Commercial Operation from 24th March 2015. BHEL was the EPC contractor for setting up of the power plant.

The plant comprises two blocks of Combined Cycle Gas Turbine power stations having capacity of 363.3 MW each. Apart from the main plants (Gas Turbines Generators, Steam Turbine Generators and HRSG Units), the plant is equipped with all the balance of plant facilities such as switchyards, Plant Water Treatment facilities, water intake and storage facilities, cooling water systems, hydrogen generation plant and gas receiving, pressure boosting and processing units.

Project zero date or notice to proceed date was 11th August 2008.

EPC contract was awarded to Bharat Heavy Electrical Limited. Make of the major equipment is as mentioned in the below table:

Package Description	Supplier
Gas Turbine Generator	General Electric, India
Steam Turbine Generator	Bharat Heavy Electrical Limited, India
HRSG	Bharat Heavy Electrical Limited, India
Switchyard	Bharat Heavy Electrical Limited, India
HV Transformers	Bharat Heavy Electrical Limited, India
Fire water Pumps	Flow more, India
DM Plant	Ion Exchange, India

Fire Protection

Plant is equipped with fire detection and protection systems. All the detection systems (installed in the different hazardous areas) are connected to the central fire alarm panels and fire stations for better monitoring and control.

Fire alarm and detection system has been supplied by Detectomat, Germany (https://www.detectomat.com).

A basic level of fire detection and protection system was observed in the plant during the survey.

Fire protection and detection system has been supplied by UTC Fire and Security India Limited.

Fire detection systems are installed at Gas Turbine enclosures, Steam Turbine Generator enclosure, main plant control room, DCS panel rooms, station switchgear rooms, Lube oil skids, Generator Step up Transformers, Station Transformers, Auxiliary Transformers and main plant cable cellar rooms.

Fire and gas detection systems at gas receiving and processing stations and gas booster compressor complex are not installed (Recommendation 2019/04/14).

Automatic fixed fire protection systems are installed at Gas Turbine enclosures, Steam Turbine Generator enclosures, Main control and DCS rooms, Lube oil skids, Generator Step up Transformers, Station Transformers, Auxiliary Transformers and main plant cable cellar rooms.

Fixed fire protection and detection systems at Steam Turbine Generator bearings and Gas Turbine Generator Seal oil tank skids are not installed (Recommendation 2019/04/10 and 2019/04/11).

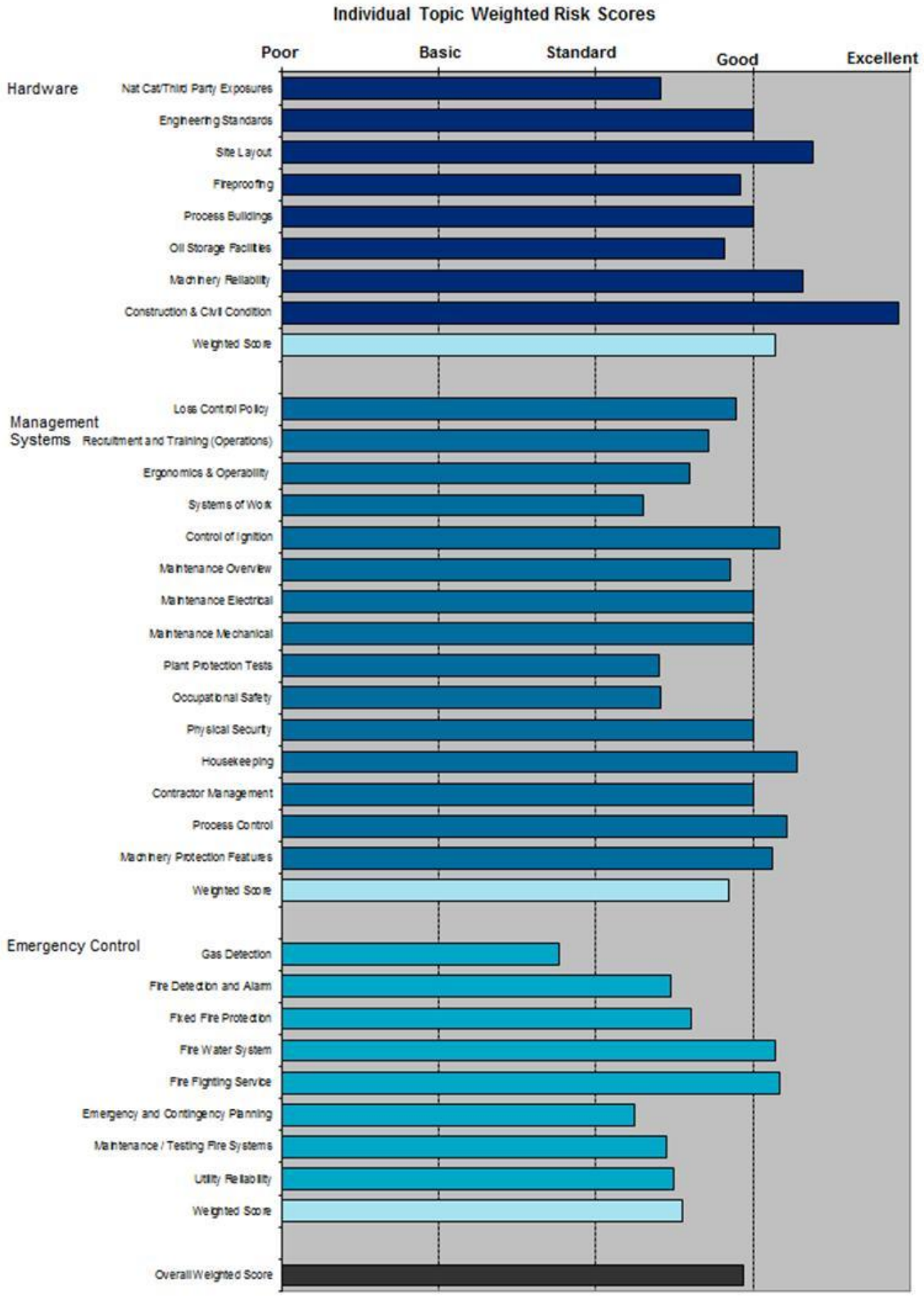
Plant comprises of spray (for fixed fire protection system) and hydrant water reticulation system. These reticulation systems are mostly above ground. Fire water pumps are separate for spray and hydrant fire water system.

Plant is equipped with two numbers of motor driven pumps, one numbers of diesel engine driven pump, two numbers of jockey pumps, two set of compressors and one hydro pneumatic tank for hydrant system and one motor driven pump, one diesel engine driven pump for spray system.

Fire water tank is a concrete tank with a capacity of 3000 cubic meters capacity and is equipped with automatic level control mechanism. The intake to the fire water tank is directly from the clarifiers through gravity with a motorized isolation valve.

Site consists of a raw water reservoir of 1,78,000 cubic meters capacity.

Risk Quality



Recommendations Overview

15 new Risk Improvement Recommendations and eight observations were raised following the survey, which were well received by the site management and are as mentioned below:

2019.04.01	Annual Steam Turbine and Gas Turbine functional overspeed test
2019.04.02	Monthly DC lube oil pump run test on cut in pressure set point
2019.04.03	Monthly Steam Turbine Stop and control Valve exercising
2019.04.04	Annual Emergency shut off valve exercising test
2019.04.05	Implementation of GE upgrade Packages for Gas Turbines
2019.04.06	Gas Turbine door fan test
2019.04.07	Emergency Diesel Generator annual load test
2019.04.08	Fire water testing as per NFPA 25
2019.04.09	Fire detection identification below false flooring in control room
2019.04.10	Fixed fire protection system for Steam Turbine Generator bearings as per NFPA 850
2019.04.11	Gas Turbine seal oil system fixed fire protection system
2019.04.12	Annual foam solution test
2019.04.13	Critical Piping inspection
2019.04.14	Gas detection and interlocking of the gas leak signal with the emergency shut of valve
2019.04.15	STG AC and DC Lube Oil Pump Power Cables

Following Observations also made during the survey

- During the discussions with the site team, it could not be established that the positive fire zoning/isolation in the control and DCS rooms above false sealing has been envisaged effectively.
- Fire signal to respective area equipment trip interlocking is not envisaged.
- Unit 1 steam turbine got jammed during the Turbine costing down after the trip because of station black out scenario.
- Presently, Ware house fire detection system is limited to some of the air conditioned areas only whereas, it needs to be extended to cover the whole covered area as a lot of expensive spare parts are stored.
- Uncontrolled growth of vegetation near critical area like transformer and switchyard area need to be controlled.
- Fault signals were persisting on main and repeater fire alarm panels since last three months, which need to be attended on priority.
- An audit to verify Plant illumination level is required as in some critical area like fire water pump house the illumination level was observed low.
- Standard and Emergency Operating Procedures were last updated in 2015. These should be updated at least once in two years.

Insured Values and Estimates

Following values are considered based on John Foord Paper.

Main Equipment Value	Million US $
Gas Turbine + Generator	81
Transformers	27
Steam Turbine + Generator	40
HRSGs	40
Balance of Plant	80

The loss scenarios have included additional clean-up costs and work on the assumption that equipment will be replaced at the same contract value.

The loss scenarios do not include the potential of third party damage and claims.

Lead Times

Lead times for the critical equipment have been considered as mentioned below (for the loss calculation):

Equipment	Months
Gas Turbine	16
Generators	16
HRSG	13.5
Steam Turbine	13
Transformers	10

In practice OEM's look to improve on standard lead times and will deal with the supply on a case to case basis.

Insured Values

Following are the sum insured values based on the latest policy in place:

- Property Damage Sum Insured: INR 3,822 Cr
- Business Interruption Sum Insured: INR 653 Cr (Annual)
- Business Interruption Indemnity Period: 18 months
- Deductibles:
  - Property Damage: 5% of claim amount subject to minimum of 5,000,000.
  - Deductibles for Mobile / office equipment's – 5% of the claim amount subject to minimum of INR 1,000,000 for each and every loss.
  - Fire Loss Of Profit: 14 days of Gross Profit.
  - Machinery Breakdown Loss Of Profit: 21 days OF Gross Profit.

History

Losses

No losses reported till date.

Upgrades

No upgrades reported.

Technical Issues

Jamming of Unit 1 steam turbine rotor, during the Steam Turbine costing down after the trip due to station black out.

Conclusion

Strengths

- Critical equipment has proven technology.
- Good site layout.
- Good civil construction of various plant and non-plant buildings and structures like chimney.
- Good housekeeping.
- Fire proofing levels are good.
- Good plant firefighting services and good mutual support from the fire stations in the plant vicinity.
- Good record of previous recommendation implementation.

Weaknesses

- Plant safety systems need improvement.
- Testing and inspection of fire water equipment needs improvement.
- Fixed fire protection system for Steam Turbine Generators bearings and seal oil skid (for Gas Turbine Generators).
- Gas detection is not available at gas receiving station and gas booster compressor building.

Opinion

In our opinion, the plant can be considered to be:

- **Better than standard risk** with respect to emergency control, including fire protection.
- **Better than standard risk** with respect to management systems.
- **Good risk** with respect to hardware systems.

Overall, in our opinion, the plant can be considered to be a **Better than standard risk** based on our method of combining the individual risk ranking scores.

SECTION THREE

RISK IMPROVEMENT RECOMMENDATIONS

Prioritisation

The criteria used to prioritise the recommendations are summarised in the following Table.

Code	Description
Critical	Extreme Risk; should be brought to the attention of plant management and immediately progressed.
A	High Priority; requires attention of senior management and an action plan developed as a priority.
B	Moderate Risk; requires action at the earliest opportunity.
C	Low Risk; Opportunity for industry best practice initiatives providing long term benefits.

As a result of this survey 15 new recommendations and eight observations have been made which were well received by the management team.

12 out of 28 previous recommendations were closed and one is superseded, which demonstrates good response.

New Recommendations Summary

Description	Category	Reference
Annual Steam Turbine and Gas Turbine functional overspeed test	Critical	2019.04.01
Monthly DC lube oil and seal oil pump run test on cut in pressure set point	Critical	2019.04.02
Monthly Steam Turbine Stop and control Valve exercising	Critical	2019.04.03
Annual Emergency shut off valve exercising test	Critical	2019.04.04
Implementation of GE upgrade Packages for Gas Turbines	A	2019.04.05
Gas Turbine door fan test	B	2019.04.06
Emergency Diesel Generator annual load test	B	2019.04.07
Fire water testing as per NFPA 25	B	2019.04.08
Fire detection identification below false flooring in control room	C	2019.04.09
Fixed fire protection system for Steam Turbine Generator bearings as per NFPA 850	A	2019.04.10
Gas Turbine seal oil system fixed fire protection system	A	2019.04.11
Annual foam solution test	B	2019.04.12
Critical Piping inspection	B	2019.04.13
Gas detection and interlocking of the gas leak signal with the emergency shut of valve	A	2019.04.14
STG AC and DC Lube Oil Pump Power Cables	B	2019.04.15

Following Observations also made during the survey

- During the discussions with the site team, it could not be established that the positive fire zoning/isolation in the control and DCS rooms above false sealing has been envisaged effectively.
- Fire signal to respective area equipment trip interlocking is not envisaged.
- Unit 1 steam turbine got jammed during the Turbine costing down after the trip because of station black out scenario.

- Presently, Ware house fire detection system is limited to some of the air conditioned areas only whereas, it needs to be extended to cover the whole covered area as a lot of expensive spare parts are stored.
- Uncontrolled growth of vegetation near critical area like transformer and switchyard area need to be controlled.
- Fault signals were persisting on main and repeater fire alarm panels since last three months, which need to be attended on priority.
- An audit to verify Plant illumination level is required as in some critical area like fire water pump house the illumination level was observed low.
- Standard and Emergency Operating Procedures were last updated in 2015. These should be updated at least once in two years.

Previous Outstanding Recommendations Summary

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/1	1. Establish a fire protection impairment system to supervise all fire protection and detection system impairment regardless of the reason or duration of the impairment. The program should also include the reminders to be sent to the respective department that valve(s) are/is closed, the pump is not in “Auto” mode, isolation valves are closed/ partially shut and immediate attention is required to restore the protection. 2. Provide additional protection measures till the impairment is fixed and record the same in the impairment form (e.g. informing the local fire brigade to be on standby in the event of breakdown of fire pumps).	Complete Within 3 months	Impairment procedures need to be prepared	Sample Impairment Procedure copy shared with OTPC.	Under Progress
2015/2	All the isolation valves in the fire protection system i.e. from the fire water tank to the remotest hydrant point, including valves in the sprinkler system and deluge system should be chained and locked in fully open position to prevent malicious or accidental closure of the isolation valve leading to impairment of the fire protection system. Valves in the supply line of the diesel to the fire engine should also be chained in normal operating position.	Complete Within 3 months	All isolation valves of the deluge system kept chain locked. It has been found that 30% of the isolation valves of hydrant line are installed at underground level and there are chances of water accumulation and sometime during heavy rain it got submerged. So, in those cases the locks get rusted/damaged in locking condition and unable to be opened which can lead to major abnormalities.	A Bund of about 200 mm can be constructed around the pit and plastic Ties can be used for the locking of isolation valves.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/4	Carry out weekly property loss prevention rounds to cover the entire power station. The visits should be conducted using check sheet which should typically list down but not limited to the following: 1. Storage of ordinary combustibles below the cable trays in cable gallery, hydrogen manifold room, Diesel generator room etc. 2. Storage of the oil drums in proper containment so that they may not be affected by the knock on damage. 3. The electrical cables are properly laid and terminated. 4. Hot work permit system is being followed in totality as per the hot work policy. 5. “No Smoking” procedure is being followed. 6. Impairment management system is followed. 7. Leakage of oil from level gauges other connections in diesel day tanks to be avoided.	Complete Within 3 months	All completed except Point number 6.	Sample Impairment Procedure copy shared with OTPC.	Under Progress
2015/5	Improve the existing hot work permit by including the following in the precaution list: 1. To check whether the fire protection and detection system in the area is operational. 2. The combustibles within 11 m of the work should be relocated or covered with fire retardant blankets when hot work is carried out at ground level. 3. For elevated hot work, combustible materials should be either relocated a minimum of 50 ft. (15.2 m) from the hot work area or properly protected with fire retardant welding blankets or the hot work operation isolated with welding screens. Suspend fire-resistive welding blankets under hot work conducted near the ceiling. Place noncombustible screens around hot work at the floor to trap sparks. Every elevated hot work operation needs to be evaluated on a case-by-case basis to determine a reasonable safe distance from hot work to combustible occupancies or construction. 4. Seal all floor penetrations and opening on walls in the above mentioned distance using noncombustible materials. 5. Fire watch should be continuously provided during hot work and one hour after the hot work is complete. Furthermore, the watch period should be extended three hours after the continuous watch period. This could be intermittent watch and the fire alarm system can be used in this period for monitoring. Finally, the permit should be closed by the fire watch. 6. Ensure all personals involved in hot works are using all personal protective equipment.	Complete Within 3 months	All completed except Point 4.	Sealing of cable openings below false floor at Battery charger room is balance. Moreover, intumescent paint should be applied to the cables near to the sealing area.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/7	Inspection and Testing: 1. Conduct weekly system inspections to see that nozzles are clear and in proper position, that all operating controls are properly set, and that system components have not been damaged 2. Check the agent quantity and pressure of clean agent containers semi-annually. Refill or replace halocarbon clean agent containers if they show a loss in agent quantity of more than 5% or loss in pressure (adjusted for temperature) of more than 10%. Refill or replace inert gas clean agent containers if they show a loss in pressure (adjusted for temperature) of more than 5% 3. Inspect thoroughly inspect clean agent systems for proper operation exclusive of a discharge test every year. Inspect and test all actuating and operating devices in accordance with the system manufacturer's recommendations as outlined in the appropriate system design, installation, operation and maintenance manual. Regular service contracts with the system manufacturer's authorized representative are advised. 4. Inspect thoroughly the clean agent system protected enclosure every year. Determine if penetrations or other changes have occurred that could adversely affect agent leakage or change the volume of the hazard or both. Correct any conditions discovered during the inspection that could result in inability to maintain the clean agent concentration. If uncertainty still exists with regard to the enclosure integrity, conduct an enclosure integrity test of the enclosure. Maintenance: 5. Maintain clean agent systems in operating condition at all times and restore to service promptly after any impairment or operation. 6. Seal any penetrations made through the clean agent system protected enclosure immediately.	Complete Within 3 months	Completed	Checklist for the inspection and test of Argonite system to be prepared and preserved as records for verification.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/12	1. Pre-plan with the local fire brigade by inviting them for the annual mock fire drills. During their visit, they should be appraised on the various hazards prevailing at the location and providing them with the details of the firefighting capabilities of the plant. 2. Alternatively, the plot plan of the plant displayed at the entrance gate should be revised to indicate the number and the capacity of the fire pumps, fire water storage and the locations of the electrical panel rooms.	Complete Within 3 months	Under Progress		Under Progress
2015/13	1. Provide a copy of business continuity plan to Marsh Risk Consultancy for review. 2. Meanwhile, verify whether the existing Business Continuity plan includes a scenario where-in the main transformers, steam generators and the cooling towers are damaged due to fire. If these scenarios are not included then the plan should be revised to include the time required to procure, install and commission the equipment and the back up plans to ensure continuous production. 3. It is also recommended to keep a copy of business continuity plan at site along with corporate office.	Complete Within 3 months	Business Continuity Plan is to be obtained from Delhi Office.	Please provide the Business Continuity Plan.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/15	1. Verify if the containment provided for the main lube oil tank and emergency/drain lube oil tank is designed to contain the largest expected lube oil spill and water spray system discharge and is designed and installed as per NFPA/FM Global standards. 2. Close all the openings in the existing containment made for the lube oil system area of steam turbine. 3. Provide approved flange guards over the flanges of the lube oil pipeline available at the level of the solid turbo-generator operating floor, flanges on the cooling canister and the flanges at the level of the main lube oil tank that fall outside the secondary containment along with adequate drainage leading to outside the building. 4. Extend spray system on flanges, lube oil coolers, lube oil filters and also above and below main oil tank. 5. Provide Sprinkler system for turbine operating floor, under the turbine floor, on mezzanine floors as per the guidance in FMDS 7-101. 6. Provide the layout drawings and hydraulic calculation for the water spray system being installed for the main lube oil tank and emergency/drain lube oil tank to verify whether the discharge density of the system is 12 mm/min over the exposed area of the main lube oil tank. The verification will be based on the guidance provided in FM Global Property Loss Prevention Data Sheet, 7-101. 7. Test the Lube oil pumps every month as per FMDS 13-3 to ensure the reliability of the lube oil system.	Complete Within 6 months	Completed	Flange guards on oil piping flanges near Steam Turbine to be provided and extension of fixed fire spray system till lube oil coolers and filters to be provided.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/18	1. Maintain the Argonite flooding system in auto mode. Automatic detection system should be integrated with the Argonite flooding system to activate in case of fire. It should always be ensure that Argonite flooding system is always maintained in the auto mode. 2. Install Argonite nozzles below raised floorings as required in FMDS 5-32 for combustible false floorings. 3. Conduct an enclosure integrity test for the control room in guidance provided in NFPA 2001. 4. Acknowledge the alarms/troubles in the fire alarm panel. Maintain a log book of all the alarms and trouble. 5. Wire the fire detection system to the air conditioning units/air handling units and cut-off the air supply when the fire detection system is activated. 6. Provide self-closing mechanism for doors of the control room to avoid open doors at the time of release of extinguishing agent. 7. Provide design calculation of Argonite flooding system to Marsh Risk consulting for review to ensure the adequacy of the system.	Complete Within 3 months	Under Progress	Interfacing of fire signals with the HVAC equipment for tripping and enclose integrity test is to be carried out.	Under Progress
2015/20	1. Ensure all the filled and empty cylinders are chained properly. 2. Provide automatic fire detection and protection systems in hydrogen generation plant as per FMDS 7-91 section 2.4.3. 3. Route the signal from hydrogen analyser installed in the hydrogen generation plant to the unit control room.	Immediate Action	Under Progress	Automatic fire detection and protection system in hydrogen generation plant to be provided.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/21	1. Seal the opening between the hydrogen manifold room and the gas turbine hall on the ground floor. 2. Provide ventilation in the room at ceiling level at a minimum of ten air changes per hour. The ventilation rate should increase to 25 air changes per hour upon operation of the hydrogen gas analyser at not more than a 2% level (50% of LEL). 3. Provide approved hydrogen gas analysers to sound an alarm and increase ventilation at a 2% hydrogen concentration in room. At present hand held hydrogen detector is used to monitor the hydrogen concentration. 4. Chain all the filled and empty hydrogen cylinders. 5. Avoid any loose connections/tapings on the electrical wires	Immediate Action	Under Progress	Under Progress	Under Progress
2015/22	1. Provide adequate containment and drainage for the maintenance oil tank located in BFP (Boiler Feed Pump) room. Containment was provided for maintenance oil tank in the BFP room but it was open from one end. 2. Provide adequate containment for the lube oil tank of Gas booster compressors. 3. Install Automatic fire detection and protection system on the lube oil tank area of the Gas booster compressor area at ground floor. 4. Provide automatic shutdown of oil pumps of Lube oil tanks of GBC (Gas Booster Compressor) actuated by heat detectors located at ceiling level or by activation of sprinklers.	Complete within 3 months	Under Progress	Point number 3 and 4 are superseded by new recommendation 2019/04/14	Under Progress
2015/23	1. Provide Continuous ventilation that is provided at a rate of not less than 1 ft3/min/ft2 (5.1 L/sec/m2) of floor area of the room or cabinet as per NFPA 70E. 2. Provide Hydrogen detector in the battery bank room with alarm in control room. 3. Smoke detector in battery charging room was observed to be capped. 4. Install Argonite system considering the openings in the false ceiling, main access door etc. 5. Provide design calculation of Argonite flooding system. 6. Conduct enclosure integrity test for battery rooms and battery charging area after installing Argonite system.	Complete within 3 months	Under Progress	Under Progress	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/24	Provide sprinkler protection for the inside of the cooling towers as per the guidelines available in FM Global datasheet 1-6.	Complete within 3 months	Under Progress	Under Progress	Under Progress
2015/25	1. Provide proper bolting/grouting of the control panels in the CER room to prevent shake damage due to shaking of ground during earthquake. 2. Install Argonite nozzles below raised floorings as required in FMDS 5-32 for combustible false floorings.	Complete within 3 months	Completed	Argonite nozzles have been provided but the Sealing of cable openings below false floor at Battery charger room is balance.	Under Progress

Previous Completed Recommendations Summary

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/3	Create a valve supervision program for all the valves in the fire protection network. Following should be include in the program: 1. Create a valve list which lists down all the valves with each having a unique number. 2. Carry out weekly visual valve inspection to inspect whether the chain and the locks are in place. 3. Once every month, carry out physical inspection of the non-indicating gate valves which means opening the valve in fully open position, then closing the valve three turns and then re-opening the valve in fully open position and finally chain and lock the valve. 4. Once every month fully operate the butter fly valves by closing and then re-opening them. Chain and lock the valve in close position after testing. 5. Operate each valve fully once every year to ensure reliable operation of the control valves. 6. Document the status of each valve.	Complete Within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/6	1. Maintain all electrical driven firefighting pumps in auto mode to operate as per the signal given by installed pressure switches for initiation. 2. Plan and do an annual pump test according to NFPA 25 to compare the achieved flow and pressure against the design pump curve. 3. Maintain fire pumps at regular intervals (daily, weekly, annually) to deliver rated pressure at rated flow. Note all the pump parameters i.e. pressure, flow rate (if possible), water level etc. during every test. (Checklist for the fire pump system maintenance is included in the Appendix) 4. Train pump room operators to put all systems in Auto/ safe mode post testing/ at all times. 5. Verify the level of the fire water in fire water tanks and diesel level in diesel day tanks respectively. The water level should be at least 90% of that of the normal water level and the diesel should be at least 75% full. 6. Verify the manual operation of the fire pumps in the weekly tests	Complete Within 3 months	Completed	Completed	Completed - Closed
2015/8	Develop a preventive maintenance program for testing of the safety interlocks, automatic starting of the emergency lube oil pumps and over speed trip tests for gas turbines and steam turbine as per the guidance provided in FMDS 13-17 and FMDS 13-3 respectively for gas turbine and steam turbine.	Complete Within 3 months	This recommendation is superseded by Recommendation 2019/04/01, 2019/04/02, 2019/04/03 and 2019/04/04		Superseded
2015/9	Augment existing electrical inspection program to include regular inspection of all the electrical fittings such as junction boxes, electrical cables and other electrical and illumination fittings at high hazard areas and other sections throughout the site. Following points can be incorporated in the inspection schedule: 1. Eliminate usage of temporary wiring (such as extension cords) within the facilities. Temporary or loose wiring and connections in electrical cables should be avoided at the site. 2. All electrical bulbs should be provided with enclosures and mechanical guards to prevent hot filament from falling and acting as potential ignition source. 3. All electrical fittings should be properly clamped and protected from any knock on damage.	Complete Within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/10	Following recommendation are made to improve the existing emergency response plan (ERP): 1. Include following in the ERP: - Sprinkler control valve operator: A person who knows where all valves are located and is responsible for operating them in the event of a fire. - Fire pump operator: A person who checks the automatic starting pump when the fire alarm sounds - Salvage team: Team that gets the facility back in operation as soon as possible after an emergency. 2. Since site is exposed to 50 years EQ zone , 60 m/s wind zone and close to 500 year flood zone. It is recommended to include natural hazard such as Earthquake, Flood, and Wind in the ERP as per the recommendation made below. 3. Each type of emergency event has specific characteristics that must be anticipated and prepared for. Hence it is recommended to include specific control measures as per each event considered in ERP. 4. Frequently, back-shifts will have a reduced staff. This may require that personnel be assigned to perform multiple functions. Hence it is required to conduct mock drill at night time also. 5. Provide alternate for each key position. Ensure that people from emergency response team is available in all shift and during holidays also.	Complete Within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/11	Formalize an earthquake emergency plan and include the following in the earthquake emergency response plan: 1. Examine all fuel-fired equipment for leaks. 2. Consider shutdown of gas supplies as appropriate. 3. Examine fire protection water supplies to determine if they are impaired. 4. Examine all fire protection systems to determine if they are damaged. 5. Initiate repairs to all fire protection equipment as needed to have them restored to service. 6. Examine production equipment for damage and make necessary repairs before starting up. 7. Control ignition sources including hot work, smoking, etc., particularly if fire protection systems are impaired. 8. Use the FM Global Hot Work Permit System for any hot work to be performed in and around the facility. 9. Examine all electrical equipment and conduct necessary repairs. 10. Examine building structures and facades for damage and take necessary steps to repair and/or stabilize. 11. Examine exterior structures, equipment, and storage and take appropriate action. 12. Other site-specific activities as outlined in the Emergency response Plan.	Complete Within 3 months	Completed	Completed	Completed - Closed
2015/14	1. Avoid storage of combustible materials in the hydrogen manifold room. 2. Prevent storage of unused cables in the fire pump room. 3. Arrest oil leakage in the lube oil system area of the steam turbine. Source of leakage should be identified and proper measures should be taken to prevent such occurrence.	Immediate Action	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/16	1. Provide secondary containment to hold the entire contents of the Lube oil tank of gas turbine plus 50 mm of freeboard. 2. Make the CO2 flooding system operational for lube oil system enclosure of gas turbine. 3. Close all the doors of the lube oil enclosure to ensure proper operation of CO2 flooding system. Supervisory alarm should be triggered in control room if the gate is opened. 4. Conduct enclosure integrity test (i.e. door fan test) of Lub oil enclosure in guidance with NFPA 2001. 5. Provide a metal hood of at least 0.5 mm thickness over the seal oil tank and provide sprinkler or deluge system along with adequate drainage & containment designed and installed as per NFPA/FM global standards with a discharge rate of 12 mm/min over the exposed area of the seal oil tank. Wire the sprinkler/deluge system to cut-off the seal oil pumping action in the event of a spray fire. 6. Test the Lube oil pumps every month as per FMDS 13-17 to ensure the reliability of the lube oil system of gas turbines.	Complete within 6 months	Completed	Completed	Completed - Closed
2015/17	Following recommendations are made to improve the reliability of the fire pumps: 1. Detect leakages in the fire protection line and normalise the jockey pump operation. 2. Maintain all the fire pumps in auto mode. 3. Arrest the leakages from the discharge side control valve of diesel engine driven fire pump. 4. Provide individual pressure sensing to test each fire pump and test them as per the recommendation made earlier. 5. Provide containment for diesel day tank to prevent the spillage of oil from diesel day tank. 6. Seal all the cable penetrations in the fire pump rooms. Remove unused electrical cables from the fire pump room. 7. Provide easy identification of all the fire control panels by painting them red and providing identification tag. 8. Install the fire pump control panel for electrical panel near the pumps. As informed, at present the control panel for electrical fire pump is located away from the fire pump house in the cooling water pump house electrical room.	Complete within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/19	1. Provide emergency oil spillage containment below the diesel day tanks of emergency diesel generator installed in fire Pump room and DG room respectively, to contain emergency oil spillage from the day tanks. The minimum height of the curb should be 100 mm. As per NFPA 20, standard for the Installation of Stationary Pumps for Fire Protection, 2013 Edition, 11.4.1.2.4 Single wall fuel tanks shall be enclosed with a wall, curb, or dike sufficient to hold the entire capacity of the tank plus 50mm free board or 110% of the tank capacity. 2. Provide level transmitter or magnetic type level indicator or protected glass type level indicator instead of plastic sight tube for diesel day tank measurement. 3. Provide regular checks for possible diesel leakage from flange joints, level gauges etc. 4. Provide spray nozzles on the HVWS (High Velocity Water Spray System) pipeline installed on the diesel day tank of the emergency diesel generator. 5. Remove the covers provided on the Quartzite bulb type heat detector line installed on diesel day tank. 6. Provide hood on the vent of the diesel day tank. Check for the provision of providing the vent outside the diesel generator room.	Immediate Action	Completed	Completed	Completed - Closed
2015/26	1. Repair the existing fire detection system installed in the electrical panel room. Caps on the smoke detectors should be removed to make it operational. 2. Arrest the leakages observed on the MVWS (Medium velocity spray system) line installed on the cable galleries in cable vault located at 0m elevation. 3. Seal all the cable openings present in the cable vault. Some openings were due to the drain pipes installed in the cable vault room. Same should also be sealed properly. 4. Provide adequate fire extinguishers in the cable vault room. Carry a weekly loss prevention round to ensure that all the fire extinguishers are properly placed and easily accessible. 5. Provide design calculation for the spray system provided in the cable vault room to Marsh risk consultancy for review and verify adequacy of the system.	Complete within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/27	Provide the following engineering information in order to verify the adequacy of the metal roof sheet of main power block and metal wall cladding attachments of the GBC (Gas booster compressor area): - Linear dimensions of the building. - Peak and eaves height of the building. - Thickness of roof sheet. - Distance between the purlins. - Linear distance of the fasteners on the purlins. - Diameter of the metal fasteners head.	Complete within 3 months	Completed	Completed	Completed - Closed
2015/28	1. Provide earthquake protection for fixed fire protection system as per FMDS 2-8. Following recommendation should be followed in this regards: - Brace fire protection piping to minimize uncontrolled differential movement between the equipment and the structure(s) to which they are attached. - Provide flexibility on piping systems and on other equipment where differential movement between portions of those piping systems or equipment is expected. Except where large differential movement occurs over a short distance, flexible couplings provide sufficient flexibility between portions of sprinkler piping systems where needed. - Provide clearance between piping or equipment and structural members, walls, floors, or other objects so that potential damage from impact is minimized. - Provide anchorage to minimize potential sliding and/or overturning. - Use appropriate types of pipe hangers and sway bracing, properly located and attached to the structure to minimize the potential for pullout. - Use appropriate types of piping and pipe-joining methods to minimize potential pipe breaks 2. Provide seismic safety shut off valves on the natural gas pipelines as per guidance in FMDS 1-11. 3. Properly bolt/grout all the electrical panels, control panels, racks in maintenance store room to prevent over toppling of equipment during earthquake.	Complete within 6 months	Completed	Completed	Completed - Closed

New Recommendations Details

Annual Steam Turbine and Gas Turbine functional overspeed test	Critical	2019/04/01
Date Raised / Revised	April 2019	
Risk Exposure	Machinery Breakdown	
Description	Steam Turbines and Gas Turbines are equipped with electronic over speed protection devices. Physical overspeed test was carried out during the commissioning stage and there after overspeed protection tests were not conducted. It is imperative to conduct the steam turbine and Gas Turbine overspeed tests on regular basis to ensure the integrity of the protection devices. Huge losses have occurred around the world because of the steam turbine/Gas Turbine overspeeding as the protection devices didn't work.	
Recommendation	It is recommended to carry out the functional steam turbine and Gas Turbine overspeed test on annual basis. This functional test can be carried out at reduced speed set point.	
Client Response	Client agreed to carry out the test as recommended.	
Status	***April 2019: New***	

Monthly DC lube oil and seal oil pump run test on cut in pressure set point	Critical	2019/04/02
Date Raised / Revised	April 2019	
Risk Exposure	Machinery Breakdown	
Description	During the discussions with operation department, it was informed that DC emergency lube oil and generator seal oil pump auto start at lube oil header pressure low set point is not being tested though the weekly push button start test is carried out. Testing of DC emergency lube oil and eal il Pumps should include activation of the pressure switch to verify functionality of the system. In the event that main and standby lube oil pumps were to fail, the DC Emergency Lube Oil Pump is required to ensure that the bearings are supplied with oil whilst the turbine generator runs down. Failure of DC lube oil pump systems has resulted in insurance losses due to journal damage.	
Recommendation	It is recommended to test the auto operation of DC lube oil and seal oil pumps at least on monthly basis to ensure the availability of these pumps in need.	
Client Response	Client agreed to carry out the test as recommended.	
Status	***April 2019: New***	

Monthly Steam Turbine Stop and Control Valve exercising	Critical	2019/04/03
Date Raised / Revised	April 2019	
Risk Exposure	Machinery Breakdown	
Description	Load demand from the grid is varying on continuous basis and so is the control valves' position. In view of the above, control valves are exercised on daily basis. Moreover, it was noted during the discussion with site team that there is no routine to check the freeness/smooth movement of Steam Turbine stop valves. Free movement of stop and control valves is a must in order to ensure the full closure of the valves (without any sticking of valve stems inside gland) when the steam turbine trip command initiates. Closure of the valves reduces risk of Steam Turbine overspeed to a great extent.	
Recommendation	It is recommended to test the free movement/floating of steam Turbine stop valve on monthly basis.	
Client Response	Client agreed to carry out the test as recommended.	

Monthly Steam Turbine Stop and Control Valve exercising		Critical	2019/04/03
Status	***April 2019: New***		

Annual Emergency shut off Valve test		Critical	2019/04/04
Date Raised / Revised	April 2019		
Risk Exposure	Fire		
Description	Site is equipped with the Emergency Shut off valve at the plant gas receiving station. Upstream of the plant gas receiving station, ONGC (the gas supplier) has its gas receiving and processing station, which is just besides the OTPC gas receiving station. Client informed that currently there is no routine of Emergency Shut off valve testing however, the shut off valve installed at ONGC side is tested annually. Each GT has a double block and bleed valve arrangement on its gas supply line. It was further noted during the discussion that currently the plant gas leak detection is not wired for the closure of Emergency Shutoff device.		
Recommendation	It is recommended to wire the plant gas leak detection signals for the Emergency Shut off valve closure and that the Emergency Shut off valve should be tested on annual basis.		
Client Response	May trip the unit in the event of false/spurious signal. May require further discussion before implementation.		
Status	***April 2019: New***		

Implementation of GE upgrade Packages for Gas Turbines		A	2019/04/05
Date Raised / Revised	April 2019		
Risk Exposure	Machinery Breakdown		
Description	Site is equipped with GE's 9FA machines. GE has issued upgrade packages one to five for the Gas Turbines. Site has implemented package one and two only till date.		
Recommendation	It is recommended to implement the upgrade packages suitably.		
Client Response	It requires significant investment which may not get approved by CERC outside O&M expense. Hence this point needs further discussion before implementation.		
Status	***April 2019: New***		

Gas Turbine door fan test		B	2019/04/06
Date Raised / Revised	April 2019		
Risk Exposure	Fire		
Description	The top sections of the gas turbine enclosures are generally dismantled during a major overhaul. Following reassembly after overhaul, the enclosures are not tested to verify the integrity of its seals. It is important to ensure that in the event of a fire, the discharged CO2 would be able to maintain the required concentration for the required amount of time, generally accepted as 30 minutes, to extinguish the fire. If the fire is not extinguished due to leaks in the enclosure, thereby compromising the CO2 concentration, the fire may reignite, causing significant property damage and generation downtime.		
Recommendation	It is recommended that enclosure air tightness tests are performed either through Door Fan Testing – this test involves the use of a fan to pressurise the enclosure and measuring the air leakage rate from the enclosure over a period of time. (or) CO2 Discharge Testing – this test involves an actual CO2 discharge in the enclosure and measuring the resulting CO2 concentration over a period of time.		
Client Response	Client agreed to carry out the recommendation.		
Status	***April 2019: New***		

Emergency Diesel Generator annual load test	B	2019/04/07
Date Raised / Revised	April 2019	
Risk Exposure	Fire	
Description	Emergency Diesel Generators are push button started on weekly basis. Currently auto synchronization and load test is not being carried out. When a diesel generator is run unloaded very little fuel is injected into the cylinders. As a result, the combustion is not robust and incomplete combustion products can collect behind the compression rings of the piston and prevent them from sealing properly. Over time this will cause the engine to run poorly and lose power.	
Recommendation	It is recommended to carry out the load test on Emergency Diesel Generator as per NFPA 110.	
Client Response	Client agreed to carry out the recommendation.	
Status	***April 2019: New***	

Fire water testing as per NFPA 25	B	2019/04/08
Date Raised / Revised	April 2019	
Risk Exposure	Fire	
Description	The site has electric and diesel firewater pumps. These are understood to be run weekly however these are not performance tested in accordance with NFPA 25 standard. Monthly and Annual testing of fire pumps comes under NFPA 25, '*Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, and 2008 Edition*'. Note: There is an updated version 2014 Edition The standard annual flow test requires testing the pump at minimum, rated and peak flows by controlling the quantity of water discharged through an approved test device. A full set of performance readings should be taken at each flow condition including; electrical motor current and voltage, pump speed in rpm, pump suction and discharge pressure, and discharge flow. Pump performance should be compared with the pump design curve and with previous annual flow test reports. Degradation in excess of 5% of the pressure of the initial unadjusted acceptance test curve or nameplate shall require an investigation to reveal the cause of degraded performance and restorative maintenance. The standard monthly no flow test requires testing of motor driven pumps for 10 minutes and testing of diesel engine driven pumps for 30 minutes as per NFPA 25. Reference should be made to NFPA 25, which also makes other recommendations and precautions to be taken, and gives full details of the test requirements.	
Recommendation	It is recommended that monthly no flow and annual flow tests of fire pumps should be carried out in accordance with NFPA 25 standard. The results should be plotted and compared to the pump design curves to check for degradation.	
Client Response	Client agreed to carry out the same.	
Status	***April 2019: New***	

Fire detector identification below control room false flooring	C	2019/04/09
Date Raised / Revised	April 2019	
Risk Exposure	Fire	
Description	During the control room visit, it was observed that below the false flooring, smoke detectors were installed for the fire detection. On the false floor tiles, however, there were no identification marks to locate the smoke detectors, which are installed below.	
Recommendation	It is recommended to put the identification marks at the respective false floor tile for the ease of identification of smoke detectors.	
Client Response	Client agreed to carry out the recommendation.	
Status	***April 2019: New***	

Fixed fire protection system for Steam Turbine Generator bearings and diesel engine for fire water pump as per NFPA 850	A	2019/04/10
Date Raised / Revised	April 2019	
Risk Exposure	Fire.	
Description	The main steam turbine generator bearings have no fixed fire protection as per NFPA 850. If a major failure occurs followed by fire the entire plant will be shut down for an extended period of time. Steam turbine generator lubricating oil fires do occur and these events are among the most severe of loss incidents resulting in extensive damage and long durations to repair. Within the insurance industry a steam turbine generator lubricating oil fire is considered as an MFL (Maximum Foreseeable Loss) event.	
Recommendation	It is recommended that fixed fire protection system should be provided for the main steam turbine generator bearings in accordance with NFPA 850 'Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations', 2015 Edition.	
Client Response	Client shall discuss internally and revert.	
Status	***April 2019: New***	

Gas Turbine seal oil system fixed fire protection system as per NFPA 850	A	2019/04/11
Date Raised / Revised	April 2019	
Risk Exposure	Fire.	
Description	The Gas Turbine Generator seal oil system has no fixed fire protection. Gas Turbine seal oil system is a mineral oil and very critical as it seals generator hydrogen. In the event of fire, the seal oil system may be out of operation and this may cause hydrogen leak from the generator.	
Recommendation	It is recommended to provide fixed fire protection system on the Gas Turbine generator seal oil system in line with NFPA 850.	
Client Response	Client shall discuss internally and revert.	
Status	***April 2019: New***	

Annual foam solution test	B	2019/04/12
Date Raised / Revised	April 2019	
Risk Exposure	Fire	
Description	It was observed and discussed during the site visit that the fire-fighting foam solution (Aqueous Film Forming Foam for fuel oil tanks) is not tested on regular basis. Foam concentrate can deteriorate and is affected by high ambient temperature conditions	
Recommendation	As per NFPA 25, fire-fighting foam solution should be tested annually.	
Client Response	Client agreed to comply with this recommendation.	
Status	***April 2019: New***	

Critical Piping Inspection	B	2019/04/13
Date Raised / Revised	April 2019	
Risk Exposure	Machinery Breakdown	

Critical Piping Inspection		B	2019/04/13
Description	During the discussion with Mechanical maintenance team it was noted that critical piping like Main steam, Hot Reheat, Cold Reheat, Feed water piping etc. are not inspected periodically. Critical piping have many critical welds, bends and pipe support system (including variable and constant spring hanger supports), which need periodic inspection and maintenance. Critical Pipe supports need to be inspected in both hot and cold condition and should be subject to adjustments or replacements based on the inspection outcome.		
Recommendation	It is recommended to inspect critical piping and inspection should cover critical bends, welds and piping supporting system.		
Client Response	Client informed that the critical weld inspection will be difficult to perform as the arrangement of resources and spares will be difficult because of the remoteness of site but client agreed to perform the support inspections as recommended.		
Status	***April 2019: New***		

Gas detection and interlocking of the gas leak signal with the emergency shut of valve.		A	2019/04/14
Date Raised / Revised	April 2019		
Risk Exposure	Fire		
Description	It was observed during the site tour and discussions with the site team that currently, gas detection system is not installed at gas booster compressors. Gas leakage is an extreme fire and explosion hazard and needs to be monitored on continuous basis. Moreover, the gas leak detectors should be interlocked with the closure of emergency shutdown valve, installed at gas receiving station.		
Recommendation	It is recommended to install the gas detection system at gas booster compressors and to interlock/wire the gas leak signal with the Emergency shut off valves.		
Client Response	Client agreed to comply with the recommendation.		
Status	***April 2019: New***		

STG AC and DC Lube Oil Pump Power Cables		B	2019/04/15
Date Raised / Revised	April 2019		
Risk Exposure	Fire		
Description	Steam Turbine Lube oil tank is cited at “0” meter TG building. The power cables to the STG AC and DC oil pump motors are running together in the proximity of the main lube oil tank. A fire in this area could quickly burn out both cables and starve the bearings of oil before the STG has been brought to rest. The following extract is taken from the 2010 edition of NFPA 850: 7.7.3.8 “cable for operation of lube oil pumps should be protected from the fire exposure. Protection can consist of separation of cable AC and DC oil pump or 1- Hr fire resistive coating (derating of cable should be considered)”.		
Recommendation	It is recommended that fire proof paint (intumescent paint) to be applied to the power cables from the STG AC and DC lube oil pump motors terminals up to the conduit portion.		
Client Response	Client agreed to comply with the recommendation.		
Status	***April 2019: New***		

SECTION FOUR

SITE DESCRIPTION

Power Plant is located at Village Palatana, Udaipur in Gomoti district in the Indian state of Tripura. The plant comprises two blocks of Combined Cycle Power plants i.e. power block 1 and block 2.

The first block (363.3 MW) of the power plant was declared under Commercial Operation from 4th January, 2014 and the second block (363.3 MW) of the two blocks was declared under Commercial Operation from 24th March 2015.

Owners

Shareholding pattern of the company is as mentioned below:

Company Name	Percentage Shareholding
Oil and Natural Gas Company Limited (ONGC)	50
Infrastructure Leasing and Financial Services Limited (IL&FS)	26
India Infrastructure Fund – II (IIF- II)	23.5
Government of Tripura	0.5

Operator

Plant Operation and Maintenance contract has been awarded to STEAG Energy Services since 3rd January 2017 for three years.

STEAG GmbH operates power plants using fossil fuels and renewable energy sources.It produces and supplies electricity and thermal energy worldwide. It also provides district heating for households, utilizing residues from coal fired power plants in concrete industry, and large scale battery systems to secure electricity supply.

It serves to energy utilities, municipal enterprises, and industrial and commercial businesses; and customers ranging from private individuals to large consumers and property companies.

STEAG GmbH was formerly known as Evonik STEAG GmbH and changed its name to STEAG GmbH in June 2011.

The company was founded in 1937 and is based in Essen, Germany.

Business Model

Currently OTPC have long term power purchase agreement for 726 MW with the following state electricity boards:

State	Capacity (MW)
Assam	240
Meghalaya	79
Manipur	42
Nagaland	27
Arunachal Pradesh	22
Mizoram	22
Tripura	196
Balance on Merchant Sales	98

State	Capacity (MW)
Total	**726**

Site Description

Location

The grid coordinates for the sites are:

Co-ordinates:	Longitude	Latitude
OTPC, Udaipur, Tripura	91.4396° (E)	23.4992° (N)

The plant is located at Palatana, Udaipur Village at Gomoti District in the Indian state of Tripura.

As per Munich RE Nathan charts, the plant site is located in Zone 2 for earthquakes, Zone 5 for lightning, Zone 2 for tornados and in Zone 3 for flash floods. For the other natural perils including storms, cyclones, tsunami and volcanoes, the site is in “no hazard” or low hazard zones. All the critical structures like chimney, HRSGs, GTT buildings, etc. are provided with the lightning protection covering the respective areas.

The area of the plant is approximately 80 ha and the layout of the site provides good spatial separation.

The nearest commercial airport is at Agartala, which is the main airport for the region and is situated around 73 km to the North West of the plant. There was no indication of flight paths over the site during the survey.

The road access to the plant is through State highway.

Natural Perils

The most recent Nathan Single Risk Assessment Report is shown in the following chart.

Hazard Score Rating

Hazard zoning values for significant natural hazards

	low	high	hazard rating
Earthquake			Zone 2
Volcanoes			No hazard
Tsunami			No hazard
Tropical cyclone			Zone 1
Extratropical storm			No hazard
Hail			Zone 2
Tornado			Zone 2
Lightning			Zone 5
Wildfire			Zone 2
River flood			Zone 0
Flash flood			Zone 3
Storm surge			No hazard

Overall the risk is considered as high due to higher storm/cyclone and lightening exposure.

Third Party Risks

Plant is surrounded by agricultural land from three sides and Udaipur town from the forth side. There are no third party hazards in the locality.

Layout

The plant occupies a large area and is well laid out.

Both the Gas Turbines are housed at “0” meter TG building with a separation of around 70 meters in parallel configuration.

Both the Steam turbines are housed in the turbine building at TG floor with an axial configuration having separation of around 75 meters.

HRSGs are outdoor installations located within their own steel frame support structures to the West of the Turbine Hall with approximately 70 m separation. The flue gas from each HRSG is released via steel stake located to the West of the HRSGs. The Plant Gas receiving and conditioning facilities are located to the North East of the main plant with about 350 meters of separation and can be considered as separate risk.

Hydrogen Generation Plant is located in the South East of Turbine hall with a separation of around 550 meters and can be considered as a separate risk as well.

Steam Turbine Generator lubricating oil tanks and pumps are located at Turbine hall “0” meter floor and the tanks are bunded with oil drainage facility in place. Lubricating oil tanks are equipped with fixed fire protection system. Fixed fire protection system is not extended up to the lube oil filters and coolers. Fixed fire protection system for steam turbine generator bearings and lube oil piping is not installed (Recommendation 2019/04/10).

Gas Turbine lube oil system is located just besides respective Gas Turbine enclosure at “0” meter floor and in a separate enclosure. The enclosure is equipped with CO_2 based compressed gas fire protection system.

The seal oil skids/tanks for Gas Turbine are located in a pit at the ground floor of the Turbine Hall (besides Gas Turbine Enclosures). These tanks are not equipped with fixed fire protection system (Recommendation 2019/04/11).

The Station transformers, Generator Step up (GSU) Transformers (for Gas Turbine Generators and Steam Turbine Generators) and Unit Auxiliary transformers are located to the East of the turbine hall.

A blast/ fire wall and containment (filled with stone chips) has been provided between each GSU transformer, Unit Auxiliary transformer and station transformer suitably as per NFPA 850.

GSUs, Station transformers and Unit Auxiliary Transformers are equipped with fixed fire protection systems.

Chemical house is located around 170 meters south east of TG building.

Cooling towers are located around 250 meters south west of TG building.

Construction

All the major buildings like turbine hall, ware house building, admin building, Fire water pump house, switchyard control building, DM Plant and other water treatment buildings are constructed of non-combustible material.

Details of various plant and non-plant buildings are as mentioned below:

Description	Roof material	Walls material	Remarks
Turbine Generator hall	Non-combustible Unprotected	RCC walls	
Unit Control Room	Combustible	RCC walls with wooden interior decoration on partition walls	False floorings tiles are also combustible in nature (made up of wooden dust)
Fire Pump Room	Non-combustible Unprotected	RCC walls	
Fire Station	Non-combustible Unprotected	RCC Walls	
Gas receiving station and GBC (Gas Booster Compressor) area	Non-combustible Unprotected	Steel structure	

SECTION FIVE

PROCESS DESCRIPTION

Gas Turbines

Gas turbines (model MS 9001FA+e) is supplied by General electric.

This is single fuel fired machine which can only run on natural gas. This machine has 18 stages compressor with 1:16.5 compression ratio. Gas Turbines are equipped with Dry Low Nox type (DLN 2.0) combustors.

Gas turbine is a three stage impulse type turbine with shaft rated speed at 3000 rpm. The various interlocks on the gas turbine includes but not limited to low lube oil pressure (alarm and trip), generator trip lockout, exhaust pressure high (trip), excessive vibrations (alarm and trip), control system fault (trip) etc.

Pre-ignition trips includes DC lube oil DC pump under voltage (trip), failure to ignite on gas (trip), shutdown gas leak test failed (trip), start-up gas leak test failed (trip), gas purge fault (trip), natural gas level Hi Hi level (trip), seal oil DC motor under voltage (trip) etc.

Post ignition trip on gas turbines includes loss of flame, high exhaust temperature, load tunnel temperature high, exhaust over temperature, exhaust thermocouple open, compressor bleed valve position trouble etc.

Master protective trip on gas turbine includes protective status trip, pre-ignition trip, post-ignition trip, starting device trip, inlet guide vane control trouble, gas purge fault trip etc. Compressor degradation program is in place which includes online and offline water washing of the compressors.

Online water washing is done for 15 min. every 48 hours. Offline water washing is done during shutdown of the unit or every six months whichever is earlier.

Cross section view of the 9FA machine is as shown below:

Cross sectional view of DLN 2.0 combustor is as shown below:

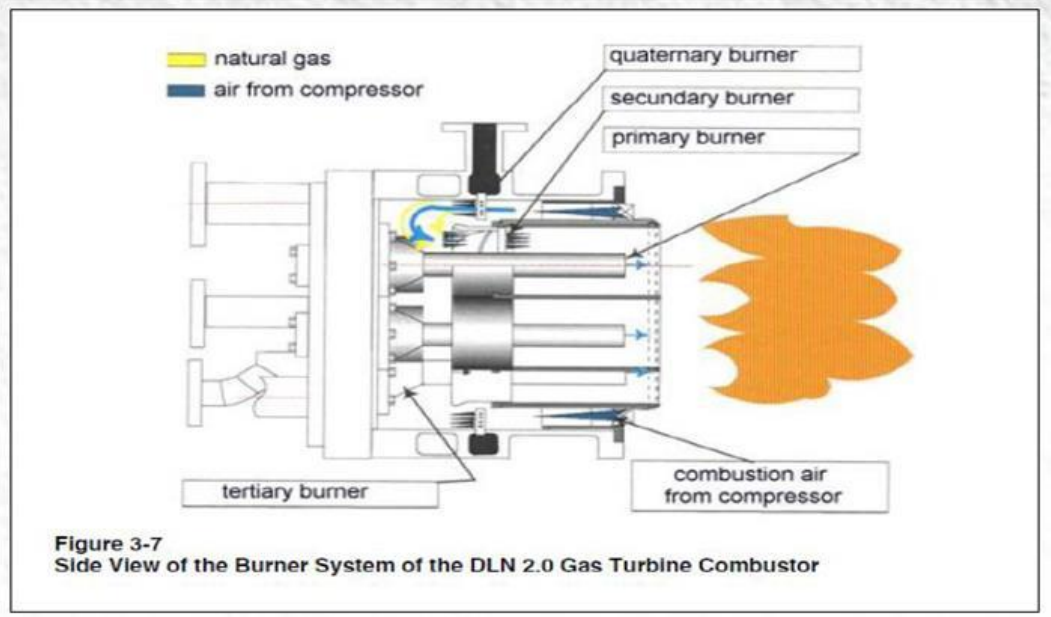


Figure 3-7
Side View of the Burner System of the DLN 2.0 Gas Turbine Combustor

Gas Turbine Specifications are as mentioned in the below table:

Designation	GT1 and GT2
General	
Service Status	Base Load
Spacing	50 meters
Turbine	
Designer	GE
Commissioning Year	For Block 1 it is 2014 and for Block 2 it is 2015
Model Number	9FA
Compressor stages	18
Compression Ratio	16.5:1
Compressor extraction stages	9th and 13th stages
Turbine stages	03
Type of Gas Turbine	Impulse Type
Combustor Chamber	Annular arrangement
No. of Combustors	18
Type of Combustors	Reverse Flow, Can annular
Type of burners	DLN 2+
Rating (MW)	232 (at site condition)
Fuels	Natural Gas
Liquid fuel NOx control type	No provision for liquid fuel injection. No use of water for Nox control.
Exhaust Temp (°C)	700
Speed RPM	3000
On line vibration analysers	Seismic velocity type (12 mm/sec alarm and 25 mm/sec Trip)

Lubricating Oil/Seal Oil	
System/Type	Mineral Oil ISO VG32
Piping	Welded
Containment	Yes

Steam Turbines

Details of the Steam Turbines are outlined in the following Table.

STEAM TURBINE - General Specifications	
Designation	**ST 1 and 2**
Spacing	50 meters
GENERAL	
Service Status	Continuous
Number of units	2
TURBINE	
Designer	Bharat Heavy Electrical Limited, India
Type & N° of cylinders & reheat	Two cylinder reheat condensing turbine
PCOD / Year	Unit 1 in 2014 and Unit 2 in 2015
Rating (MW)	131
Speed (RPM)	3,000
Online vibration monitoring system	Available (Alarm: 7 mm/sec, Trip: 11 mm/sec)
Online relative shaft vibrations	Alarm value 22 µm
LUBRICATING OIL/SEAL OIL	
Type	Mineral Oil
Piping	Stainless steel, Welded
Containment	Provided
Reservoir location	Lube Oil Tank at “0” meter TG Building
VIBRATION MONITORING	
HP/ IP/LP Steam Temperature and Pressure	
Pressure (MPa)	13.4/3.46/.44
Temperature (°C)	540/330/230

HRSG

The Heat Recovery Steam Generator (HRSG) is of horizontal, natural circulation, unfired, triple pressure reheat type.

The HRSG is designed to generate steam at 134 Kg/cm^2 & 540ºC (+/- 5ºC) at Main Steam Stop valve outlet at GT (gas turbine) base load in designed ambient temperature of 27ºC with natural gas firing in GT.

The HP steam is generated from HRSG at a pressure of 134 Kg/cm^2 and temperature of 540ºC with a flow rate of 289.6TPH (Tonnes per hour).

The IP steam is generated from HRSG at a pressure of 34.6 Kg/cm^2 and temperature of 330ºC with a flow rate of 35.6 TPH.

The LP (Low Pressure) steam is generated from HRSG at a pressure of 4.4 Kg/cm^2 and temperature of 230ºC with a flow rate of 36.7 TPH.
Safety relief valves are installed on IP economizer and water pre heater. As informed they are tested every year as per statuary law.

All the parameters of HRSG are continuously monitored using BHEL make MAXDNA DCS controllers in the unit control room.

Details of the HRSGs are outlined in the following table.

Designation	HRSG 1 and 2
Service Status	Continuous
Spacing	50 meters
GENERAL	
Number of units	2
Designer	BHEL (Bharat Heavy Electrical Limited), India
PCOD / Year	Block 1 in 2014 and Block 2 in 2015
Type	Horizontal, Natural Circulation, Water tube, top supported, fully drainable, modular design, Triple Pressure with Reheat type waste heat boiler.
Steam flow (t/h) HP / IP/LP	289.6/35.6/36.7
Steam pressure (MPa) HP/IP/LP	13.4/3.46/.44
Steam temperature (°C) HP /IP/LP	540/330/230
Boiler Fuels	NA
MISCELLANEOUS	
Water Chemistry Testing/Controls	Ammonia and Hydrazine as low pressure and Tri Sodium Phosphate as high pressure Dosing.
Boiler Feed water Pumps	2X100% HP BFP and 2x100 LP BFP (motor driven)

Gas Turbine Generators

Details of Generators are outlined in the following table.

Generator	
Designation	**Generator Unit 1 and 2**
Make	Bharat Heavy Electrical Limited
PCOD / Year	Unit 1 in 2014 and Unit 2 in 2015
Rated voltage (kV)	15.75
Rated output	232.39 MW (at site conditions)
Phase	3 Phase
Frequency (Hz)	50
Power Factor lagging / leading	0.85 Lagging
Rotor cooling	Hydrogen
Stator cooling	Hydrogen
Insulation Class	F

Plant comprises two Emergency Diesel Generator sets of 750 kVA each and has been supplied by Jackson, India.

Steam Turbine Generators

Generator	
Designation	**Generator Unit 1 and 2**
Make	Bharat Heavy Electrical Limited
PCOD / Year	Unit 1 in 2014 and Unit 2 in 2015
Rated voltage (kV)	15.75
Rated output	131 MW
Phase	3 Phase
Frequency (Hz)	50
Power Factor lagging / leading	0.85 Lagging
Rotor cooling	Air
Stator cooling	Air
Insulation Class	F

Transformers

Details for Transformers are as mentioned in below table.

Transformers	Gas Turbine Generator Transformer	Steam Turbine Generator Transformer	Station Transformer	Unit Auxiliary Transformer
Number	02	02	02	02
PCOD Year	Unit 1 in 2014 and Unit 2 in 2015	Unit 1 in 2014 and Unit 2 in 2015	Unit 1 in 2014 and Unit 2 in 2015	Unit 1 in 2014 and Unit 2 in 2015
Rating (MVA)	287 (@27ºC)	150	20/25	16
Serial Voltage (kV)	15.75 – 420	15.75 - 420	132 – 6.9	15.75 – 6.9
# Phases	3	3	3	3
Frequency (Hz)	50	50	50	50
Cooling	OFAF	ONAF	ONAN/ONAF	ONAF
Oil type	Mineral	Mineral	Mineral	Mineral
Drainage/Containment	Available	Available	Available	Available
Blast wall to NFPA 850	Available	Available	Available	Available
Protection Relays	Available	Available	Available	Available
Vector Group	YNd1	YNd1	YNyn0	Dyn11
Tap Changing equipment type	OLTC +/- 10% IN 1.25% Steps in HV side	OLTC +/- 10% IN 1.25% Steps in HV side	OLTC – 12.5% to +7.5% IN 1.25% Steps in HV side	OLTC +/- 05% IN 2.5% Steps in HV side

Switchyard

Plant comprises of air insulated switchyard of 400 kV and 132 kV.

All the generators are connected to 400 kV switchyard through generator transformers and 132 KV switchyard through Inter connecting transformers. Two overhead 400 kV outgoing overhead transmission lines supply the power grid sub stations and two overhead 132 KV lines are connected to state sub stations.

Generator circuit breakers are installed in the 400 kV switchyard side. They are supplied by ABB.

Station transformers are connected to the 132 kV switchyard.

Fuel Supply Systems

Natural Gas receiving station

ONGC supplies natural gas to the plant from the wells, which are located around 10 km to 57 km from plant.

Gas from ONGC side is supplied at a pressure of 14-15 Kg/cm^2 at a temperature of 27-28ºC. Upstream of the OTPC gas conditioning skid, ONGC also has gas conditioning skid, which is just besides the OTPC skid and is being operated by ONGC personnel.

There are two streams, one running and one standby present in Initial Gas Conditioning Skid (IGCS), each having scrubber and Filter-Separator.

There are 3 Gas Booster Compressors (GBCs) in the Gas Boosting Compressor Station (2 running, 1 standby for 2 Units).

From the IGCS, the gas flows to GBCs where the pressure of the gas increases to 32-34 Kg/cm^2 and temperature increases to 130ºC.

From IGCS the gas flows to Final Gas Conditioning Skid (FGCS), separate for both Units, where the temperature of gas is increased to 185ºC.

There is a gas flow Measure Control Room in the IGCS.

There was no gas detection and alarm system provided in the said Control Room in the event of any leakage of natural gas (Recommendation 2019/04/14).

Online Chromatography is done at the site near the gas metering station.

There are two redundant lines for chromatography. Helium is used as the carrier gas for gas chromatography.

Site is located in 50 years earthquake zone (as per FMDS 1-2), seismic shutoff valves were not installed on the natural gas pipelines to shut off the gas supply automatically in case of earthquake.

River Water Supplies

The source of plant raw water is river Gomati and the water intake point is only 2 km away from the project site.

There are four numbers of vertical pumps of capacity 1100 m^3/h installed to supply water to the project through a GRP pipeline of 900 mm diameter, which is stored in a reservoir of capacity 1, 78,000 cubic meters.

Raw water is clarified in the pre water treatment plant and then stored in the clarified water tank and fire water tank.

Water from clarifiers is directly routed to clarified water tank and fire water storage tanks through gravity with a motorized isolation valve.

From clarified water tanks, water is either used as service water, make up water for condenser cooling water system, or at Demineralised plant.

Plant comprises two raw water clarifiers.

There is a chemical house for chemical treatment of raw water. Alum, biodispersent and Flocculent are added in the raw water before it is clarified in clarifiers.

Compressed Air

Plant comprises of two screw air compressors (of 100% capacity each), supplied by Atlas Copco

Out of the two compressors, one is in service for service and instrumentation air requirements and the other one is in standby.

Cooling Towers

The cooling towers employed at site are counter flow induced draft parabolic masonry cooling towers with plastic fills (Each unit have one cooling tower with 8 cells out of which 7 are in running mode while one is redundant).

The condenser cooling system is water cooled with vacuum extraction pumps.

Cooling water cycle can only run in closed cycle mode. It is not designed to be operated in once through cycle.

Plant Protection Systems

Gas Turbine Protection systems

Gas Turbine Protection and control Systems are implemented through the Distributed Control System (DCS).

DCS for Gas turbine protection and control systems has been supplied by GE (MARK VI).

Gas Turbine major protections include (but not limited to):

- Over speed protection (electronic protection systems are in place).
- Lube/control oil pressure low.
- Vibration high (12 mm/sec alarm and 25 mm/sec Trip).
- Loss of flame.
- Over Temperature.
- Combustion monitoring.

HRSG Protection Systems

Plant HRSG Protection System is implemented through the Distributed Control System (DCS).

HRSG is equipped with BHEL make (MAXDNA 4.2.2 – SP4) DCS systems. This is (Safety Instrumented Level) SIL 2 rated system.

HRSGs are not equipped with duct burners and have three pressure drums i.e. High pressure, Intermediate pressure and Low pressure drums.

Each drum is equipped with three level transmitters and one hydrastep. These level transmitters are used for HRSG protection and control based on 2oo3 voting. These level transmitters are calibrated on annual basis by C&I maintenance during annual shutdown.

There are 2X100% High pressure Boiler Feedwater pumps and 2X100% Low Pressure Boiler feed water pumps, which feed HRSG.

Steam Turbine Protection System

Plant Steam Turbine Protection System (TPS) and Steam Turbine Control system (TCS) are implemented through the Distributed Control System (DCS).

DCS for Steam turbine protection and control systems has been supplied by BHEL (MAXDNA 4.2.2 SP4) only.

Steam Turbine protections include (but not limited to):

- Turbine over speed protection (both mechanical and electronic protection systems are in place).
- Turbine lube/control oil pressure low.
- Turbine vibration high (200µm is Alarm and 320 µm is Trip).
- Turbine shaft and Casing differential expansion.
- Turbine eccentricity high.
- Turbines exhaust pressure high.
- Lube oil level low in Main Lube oil Tank.

Generator and Transformer Protection System

Generators have following (but not limited to) digital protections installed:

- Generator protection trip, where in the electrical tripping is getting initiated by the various differential protection relays installed.
- Generator vibration high.
- Generators lube oil pressure low.
- Generator seal oil pressure low.

Transformers (for both the blocks) have different type of differential protection relays, and Buchholz relays, installed for all the electrical protections.

Control Systems

There is a control room for the plant. Control room is located on the steam turbine floor, overlooking the Steam Turbine floor.

Plant comprises of following DCS/control system:

- BHEL's MAXDNA 4.2.2 SP4 for HRSG and Steam Turbine control systems.
- GE's MARK VI for Gas Turbine control and protection.
- Other Balance of plant systems like DM Plant, Hydrogen generation plant, cooling water systems are equipped with GE make PLC systems.
- Fire water system is equipped with Rockwell Make PLC.

UPS / DC Power Supplies

Plant is equipped with 220V DC system comprises of Ni-Cd battery banks and battery chargers (one working and one stand by) for critical drives operation, switchgear control supply and emergency lighting.

For gas turbine control systems (GE make MARK VI), 125 V DC systems have been installed (1 Working and 1 standby per Block)

For HRSG and Steam Turbine control systems following UPSs are installed.

- 230V (50Hz) AC UPS (one working and one standby) have been installed in each unit.
- 230V AC supply is directly fed to DCS as a power supply.

The 230V UPS is installed to cater the power requirements of HMIs (Human Machine Interfaces), SCADA and power supply for some critical valves and actuators like actuator for boiler feed water pump scoop coupling actuator.

Projects

No new projects reported.

Insurance Loss History

No Losses reported till date.

SECTION SIX

PLANT STATUS

Operational Performance

System Control and Dispatch

Plant receives load demand from a Load dispatch centre located in Shillong, Meghalaya.

On the day of the survey, only Block 2 was operational with the gross output as 328 MW.

Block 1 was out of operation due to the jamming of the steam turbine post a steam turbine trip initiated due to plant black out.

Performance Data

Station Performance

Year	Availability Factor	Plant Heat Rate (Kcal/KWh)
2016 - 2017	67%	1805
2017 - 2018	64%	1834
2018-2019	85.15	1790

Fired and Outage Hours

Year	Unit 1fired Hours	Unit 2 Fired Hours	Plant Planned outage Hours	Plant Forced outage hours
2016 - 2017	7591	7726	1428	797
2017 - 2018	8026	8083	944	485
2018-2019	8223	8401	384	479

Warranties

All the warranties are expired.

Technical Issues

Steam Turbine

During the survey, Block 1 steam turbine was out of operation due to jamming, post a trip on account of station black out.

After the Steam Turbine trip, while coasting down, both the AC and DC jacking oil pumps didn't come into operation in auto at the RPM set point and finally AC jacking oil pump was started in manual mode locally.

By the time AC Jacking oil pump started in manual mode, steam turbine got jammed.

As informed by the site team, this issue has occurred many times earlier as well. Historically, after cooling down (to around 170ºC), the steam turbine gets free and then rolled again.

It was understood that OTPC has discussed the issue with OEM (Bharat Heavy Electrical Limited) and carried out steam turbine inspections (Based on the OEM's recommendations) like checking internal clearances, bearings etc. and found the same in order.

Further, site informed that same issue is there in the similar steam turbines installed for the other clients as well.

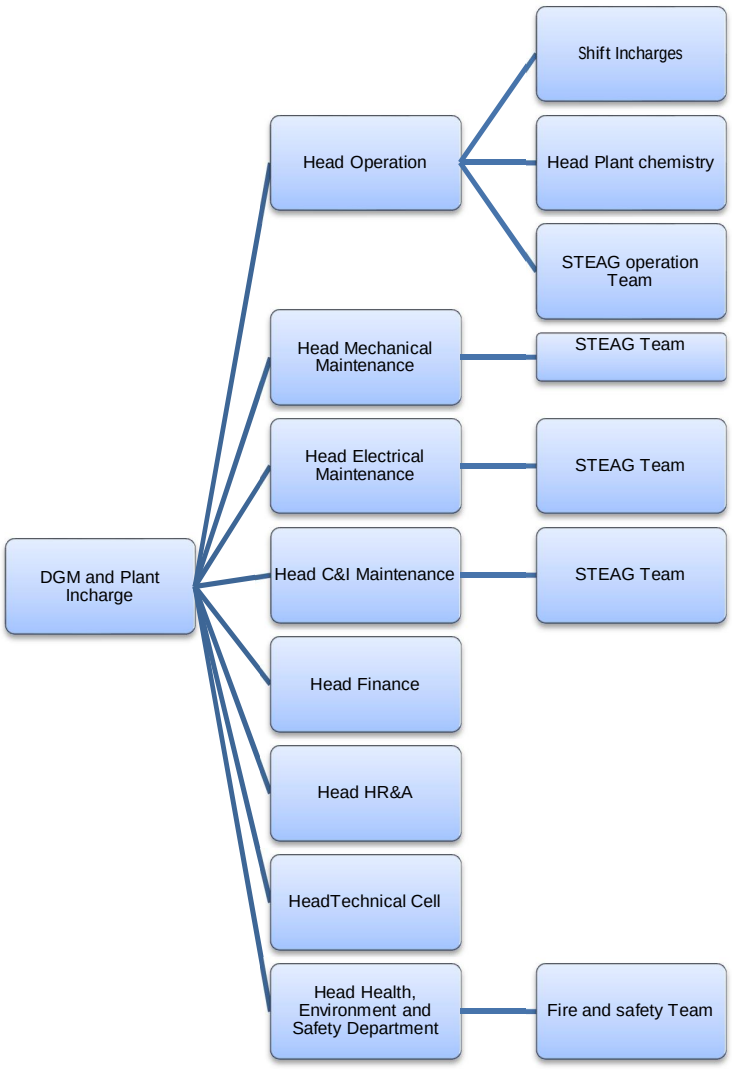
Site is in discussion with BHEL on this issue and awaiting the response.

SECTION SEVEN

MANAGEMENT SYSTEMS

Site Organisation

The Owner's management team at site includes:



Accreditations

OTPC has acquired following accreditations:

- ISO 9001:2015.
- ISO 14001:2015.
- BS OHSAS 18001:2007.

Management of Change (MOC)

During the control room visit it was observed that OTPC has a good system of trip bypass control.

OTPC has divided the protection / permissive bypass control into two groups for better monitoring. First group is for equipment protection bypass control. This bypass request is initiated by unit control room operators. This request is then approved by shift charge engineers.

Second group pertains to the unit protection / trip bypass control. In this, further approval of Plant In charge is also sought.

In Plant daily O&M meetings, each bypass is discussed in detail. Any trip/protection bypass getting extended beyond the approved time period is brought to the higher management's notice and plan to expedite the normalization is also prepared and followed up.

Document Management

Standard and Emergency Operating Procedures are being managed in electronic as well as physical form.

Physical copies of the procedures are kept at control room but these are not updated on regular basis. These procedures were last updated in 2015.

Individual maintenance departments hold records of their respective maintenance reports.

During the control room visit, various documents like start-up procedures, permissive and protection documents, pre start check list and pre start check list for electrical operations observed in paper form and operators informed that the above mentioned procedures were used extensively.

Operations

Organisation

Plant Operation and Maintenance contract has been awarded to STEAG Energy Services since 3rd January 2017 for three years.

There are four shift groups, which rotates in three shifts. Morning shift runs from 7AM to 2PM, evening shift from 2 PM to 10PM and night shift from 10PM to 7AM.

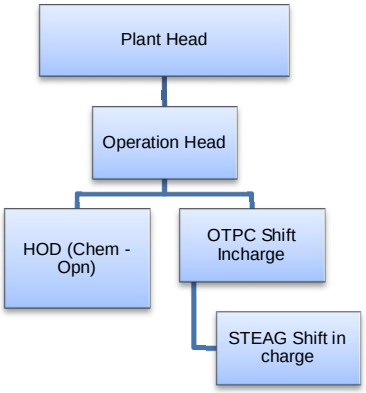
STEAG is currently deploying three desk engineers and one shift in charge engineer at control room and four operators and two helpers at site, per shift.

OTPC deploys one control room shift in charge in each shift. STEAG team reports into OTPC shift in charge and OTPC shift in charge further reports into plant operation head.

In view of the above, STEAG deploys 35 persons in plant operation.

Desk operators report into shift in charge and shift in charge reports into Operation head.

Organogram of the operation team is as mentioned below:



Operations Staffing

The operation staff level currently seems to be sufficient.

Shift Handover Procedure

Three levels of shift handover are there as mentioned below:

- Shift handover at desk operator (STEAG) level: This happens face to face with an overlap of 30 Minutes. Desk operators maintain manual logbooks.
- Shift handover at shift charge (STEAG) Level: This also happens face to face with an overlap of 40 -50 Minutes. Shift Charge Engineers maintain manual log books.
- Shift handover at shift charge (OTPC) level: This also happens face to face with an overlap of 40 -50 Minutes. Shift Charge Engineers maintain manual log books

Operating Procedures

Standard Operating Procedure documents are being managed in physical as well as electronic form and are not updated on regular basis (captured in observations).

During the control room visit, various documents like start-up procedures, permissive and protection documents, pre start check list and pre start check list for electrical operations observed in paper form and operators informed that the above mentioned procedures were used extensively.

Training and Competence Assurance

Selection procedure for trainee engineers at OTPC includes rounds of technical and personal interviews.

After the selections candidates are designated as Trainees and are going through one year rigorous training programme. This training programme comprises of class room sessions and site visits.

After completion of the training, candidates are absorbed into various OTPC departments for different roles.

Regular refresher trainings are also conducted for operation and maintenance staff.

Simulator trainings have not been planned till now.

Safe System of Work

Equipment isolation

This subject has been covered in standard operating procedures described above. This system involves all the departments, sections, individuals and contractor working at the plants and pipelines.

Prior to issuance of any permit to work, requisitioner needs to submit the duly approved job safety analysis form (JSA) by safety department. JSA form enlists the type of work, requirement of PPEs, lifting tackles to be deployed and health of this equipment, requirement of scaffolding and health of this etc.

There is a lock out tag out (LOTO) system in place for equipment isolation and support the production of Isolation Certificates by the Authorised Persons. Authorised person is a competent person adequately trained and appointed in writing by OTPC, after testing, to carry out specific work on any system, apparatus or plant. The certificate of appointment shall state the type of work the person is authorised to carry out, and the apparatus, plant or section to which it applies. The authorised person can receive, clear and suspend his Permit to Work (PTW).

Hot Permits are issued for a day only. It was observed that this is followed rigorously and the hot PTWs are cancelled on the same day and if required these are issued the next day.

Types of permits based on work are as mentioned below:

1. PTW: Permit to work where electrical isolations are required.
2. LWC: Permits where no electrical isolations are required but the area of work is limited.
3. SFF: Sanction for test permit.
4. Auxiliary PTW: For any hot work.

Control of Work

Permission for the execution of work is controlled through Permits issued by the Authorised Person and based on Isolation Certificates. There are a range of different permits in use depending on the result of the risk assessment carried out by the AP, permits used includes:

- Permit to Work.
- Hot Work Permit.
- Confined Space Permit.
- Working at Height Permit.
- Permit for Excavations.

Operational Testing Routines

Steam Turbines and gas turbines are equipped with electronic overspeed protection devices. Functional overspeed test at reduced RPM is not conducted annually (Recommendation 2019.04.01). Presently actual overspeed test are planned during major shutdowns.

Control Valves of the Steam Turbines are subjected to continuous exercising as the load set point is changed based on the demand however; stop valves are not subject to exercising (Recommendation 2019.04.03). Quick closing NRVs' are checked for freedom of movement on monthly basis.

Stop and control valve tightness test is conducted on opportunity or at least on annual basis, which is good practice.

DC Oil Pumps for lube and seal oil are operated on daily basis by push button start but the starting of the pumps on low oil pressure is not simulated on regular basis (Recommendation 2019/04/02).

Annual emergency shut off valve (installed at gas receiving station) testing is not carried out (Recommendation 2019/04/04).

The Emergency Diesel Generator (EDG) is push button started on weekly basis but synchronization and full load test is not conducted during annually (2019/04/07).

Capacity test for DC batteries (full discharge) is carried out on annual basis.

In HRSG annual Trevi test (online) is being carried out on annual basis by third party.

HRSG drum level transmitters are tested and calibrated on annual basis.

Changeover of UPS is carried out on regular basis.

Water / Steam Chemistry Controls

All volatile treatment (Reducing) is being carried out presently where in both ammonia and hydrazine is dosed after the condensate polishing units.

Tri sodium Phosphate (TSP) is dosed directly into the HRSG drums.

Cation Conductivity meters is installed at all the strategic location to detect any tube leakages in condenser.

Grab samples are collected per shift to cross check the correctness of online analysers.

Off Load Preservation

Following off load preservation practices are being followed for different equipment:

- HRSGs are preserved by wet preservation and regular monitoring and correction of water quality.
- Steam Turbines are preserved by hot air circulation and periodic barring.
- For generators, hydrogen is charged all the time.

Ergonomics & Operability

Control Rooms were observed to provide good spatial separation between unitized control desks and well laid out. The majority of the critical equipment was observed with labels and good access all around.

Lighting levels in the plant need an audit (captured in observations) and access to all the critical equipment and valves is provided.

Standard and emergency Operating Procedures are maintained both in electronic and physical form in control room but the same are not updated on regular basis. It was last updated in 2015 (captured in observations).

During the control room visit, various documents like start-up procedures, permissive and protection documents, pre start check list and pre start check list for electrical operations observed in paper form and operators informed that the above mentioned procedures were used extensively.

Alarm Management

During the discussions with the site team, it was observed that currently alarms are managed based on the priority with colour coding however, number of alarms per operator per shift is currently not monitored.

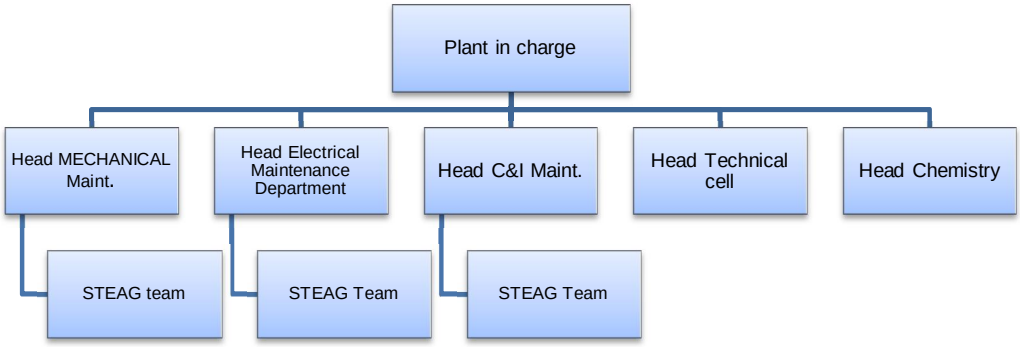
For Fire detection system, Fire alarm reporting system has been installed in the control room. The repeater Fire alarm reporting system has been installed in the fire control building as well. All the fire alarms are displayed both at control room and fire control building simultaneously.

Maintenance

Organisation

Plant Operation and Maintenance contract has been awarded to STEAG Energy Services since 3rd January 2017 for three years.

The maintenance organisation (OTPC) is shown in the following chart.



OTPC persons are deployed only at the key positions to supervise the O&M contractor and for spare part management.

In all there are around 65 persons in maintenance department (including STEAG).

Work Identification, Planning and Control

The Maintenance Philosophy is based on a blend of Preventive, Predictive, Pro-active and Corrective Maintenance activities.

Maintenance management module of SAP is currently in place for planning all types of routine maintenance activities, spare part management, capturing and monitoring regular defects and managing store activities like material issue, stock maintenance, material receipt etc.

Any abnormality, defects etc. are also captured in the SAP. While capturing the defects, concerned departments are assigned and notified with the maintenance jobs.

Regular follow up on the pending defects is being carried out during daily O&M Meetings.

Currently, for Gas Turbines Hot Gas Path Inspection (HGPI) is carried out every 32000 factored fired hours and Major Inspection (MI) is planned every 64000 effective burning hours (i.e. 32000 hrs, after the HGPI).

Block 1 GT HGPI was carried out in Aug 2017 and Major Inspection is planned in Aug 2021. Block 2 GT HGPI is planned in Aug 2019 and Major Inspection is planned in March 2023.

Steam Turbine Minor Shutdown is planned every 25000 Hrs and major shutdown is planned in every 1,00000 hrs.

Condition Monitoring Tools used for Predictive Maintenance include:

- Online Vibration Monitoring.
- Portable Vibration Monitoring by portable instrument.
- Temperature Monitoring.
- Thermography.
- Ultrasonic thickness gauging (UT).

- Material Identification.
- Dye penetrant test (DPT).

Gas Turbines

OTPC has entered a long term service agreement with GE.

This LTSA is in force till 2026 and covers HGPI and Major inspection and supply of all the required spares, which need replacement. Moreover, two GE persons are deputed at site for coordination.

During HGPI Following activities are carried out:

- Boroscope inspection of compressor.
- IGV calibration.
- Bell mouth cleaning.
- Replacement of all (three stages) gas turbine buckets, shrouds and nozzles.
- Replacement of combustor fuel nozzles, transition piece, liners and end cap.

During Major inspection other than the above activities, compressor is thoroughly inspected after opening the compressor casing.

Steam Turbines

Minor Steam Turbine overhauls are scheduled to be carried out every 25,000 effective running hours and the scope of the work includes:

- Bearing inspection.
- Alignment checks.
- Stop valves and governor valves are inspected and overhauled.
- Inspections of last stage blades.

In Major Steam Turbine overhauls (scheduled every 1,00000 effective running hours), in addition to the work carried out during minor overhauls, the scope of work for the major overhauls includes:

- Casing removal and full strip down of the Turbine.
- Rotor removal, cleaning and inspection.
- Magnetic particle inspection and ultrasonic inspection on Turbine rotor, blades, piping and flanges.
- Metallurgical replication on welded joints.

Steam Turbine Lube oil analysis is carried out on monthly basis where in Lube oil viscosity, colour, moisture and acidity is analysed and trended.

OEM is contracted for the Steam Turbine overhauling. This subcontract is both for spares and service.

Generators

Minor overhaul are scheduled to be carried out on the Generators every 25,000 effective running hours.

The scope of work for a minor overhaul includes:

- Visual inspections and cleaning.
- Excitation system overhaul.
- Bearing inspections.
- Cleaning and inspection of coolers.
- Replacement of all consumables and gaskets.

- Inspection of all connections.
- Hydrogen seal clearance inspection.

Testing during minor overhauls includes Insulation Resistance (IR), Polarisation Index (PI) and testing of current transformers and voltage transformers. Generators protection testing is performed and includes both secondary and primary injection.

The scope of work for a major overhaul (scheduled every 100,000 effective running hours) also includes:

- Generator rotor removal.
- Full inspection of all Generators.
- Wedge tightness checks- the wedged are of the spring type.
- Tan Delta testing of the windings.
- Dye Penetrant.
- Ultrasonic testing for flaws / cracks.

Testing during major overhauls includes IR, PI, testing of current Transformers and voltage transformers, off line partial discharge monitoring and a high voltage tests.

OEM team members are contracted for supervision of Generator overhauling.

HRSGs

The scope of overhauls includes:

- Full visual inspection of all tube banks, headers, steam drum and deaerator.
- Ultrasonic thickness checks in critical areas on tubes, headers and piping.
- Hydro tests are performed after repairs have been carried out. Final hydro tests (at 1.25 times the design pressure) are witnesses by a boiler inspector (Represents Statutory Body under the constitution of India; Boiler Regulation Act 1950).
- Dismantle pressure safety relief valves; inspect components including the use of dye penetrant inspection and recalibrate.
- Flanged pressure safety relief valves are removed, overhauled by a specialist company and bench tested in the presence of an OTPC representative.
- All rotating equipment is internally inspected, bearings are inspected and alignment is checked.
- All the headers are subjected to Ultrasonic tests and die penetrant tests to check any defects.

HRSG safety valves are Trevi tested on Annual basis.

High Energy Pipework

High energy piping inspection is not being carried out currently (Recommendation 2019/04/13).

Transformers

Transformer insulation oil is sampled from all the transformers biannually and sent to CPRI, Guwahati labs or STEAG Labs, Noida for DGA. The STEAG lab for DGA oil analysis is NABL accredited.

Tests for Furans and corrosive sulphur are also performed on transformer oil.
Results for last DGA analysis were observed and TDGC levels were observed satisfactory with respect to the levels as per IEEE C57.104 -2008.

Major Transformer maintenance is scheduled to be carried out every 2 to 3 years. The scope of work includes:

- Visual inspection including High Voltage and Low Voltage bushings.

- Cleaning.
- Cooling system maintenance.
- Protection testing.
- The tap changer is cycled through its full range.
- Tan Delta test on Bushing and winding.
- Turn ratio test.
- Magnetic balance test.
- Magnetising current test.
- Trips interlock tests.

Balance of Plant

Motors

Large High Voltage motors are scheduled every six months for maintenance. During this maintenance, vibration analysis, current and temperature trend monitoring is done during running.

The overhaul of large motors is carried out on annual basis where in rotors are threaded out for full electrical test.

Generator Circuit Breaker

During the annual overhauls following activities are carried out on Generator circuit breakers:

- Contact Resistance test.
- Time elapse in make or break of the contact.
- Open-close- open test.
- Dynamic Contact resistance

DC Power System

Routines have been established for maintenance of batteries and inverters. Batteries are of Nickle cadmium type.

Following activities are done on DC system as a preventive maintenance:

- Voltage Monitoring.
- Terminal tightness.
- Insulation resistance test for chargers.
- Earth Fault monitoring.

Battery full discharge / capacity tests are carried out on annual basis.

I&C Systems

Maintenance routines have been established for instrumentation and control equipment on a weekly, monthly, annual, minor overhaul and major overhaul basis.

Critical transmitters are inspected, calibrated and certified every year. Non critical transmitters are tested once in every 2 years.

DCS loop testing is carried out in every minor overhaul. One static IP (with firewalls) has been assigned to the DCS OEM for online fault diagnosis.

Predictive Maintenance

Vibration Monitoring

Gas Turbine Generators, Steam Turbine Generators and large motors (High Voltage Motors like Condensate extraction pumps, boiler feed water pumps and CW pumps) are equipped with fixed vibration monitoring system.

Vibration readings are displayed in the control rooms and are being monitored.

Vibration checks on the other rotating equipment are carried out, using a portable device on quarterly basis.

Vibration data is downloaded analysed and equipment vibration levels are trended.

Thermographic Surveys

Thermographic surveys on electrical equipment such as transformers, large motors, Switch gear etc. are carried out on regular basis.

Site is equipped with Thermographic cameras.

Lube Oil Analysis

Quarterly Steam Turbine Lube oil analysis is carried out where in colour, viscosity, acidity and moisture is analysed and trended.

Metal particles analysis is carried out on request or after equipment overhaul.

Spares

SAP is deployed for spare part management.

Optimum spare part inventory levels are defined in the SAP system for all the equipment. Material issue, new arrival is also captured into the SAP system. Notifications are generated and sent to the concerned maintenance team member if inventory falls below a certain levels.

Moreover, existing spare parts are categorized as per criticality and Usage.

Different type of storage facilities like Open yards, closed and semi closed, air-conditioned etc. are there for different materials.

Currently gas turbine spares, which are envisaged to be replaced during HGPI and MI, are available but the compressor spares are not available. This was discussed with the site team and it is understood that OTPC has connections with GE and other clients having similar GT sets for the arrangement of compressor spares if required.

Safety

Tripura State Rifles, a security force of government of Tripura is deployed in the plant for security of the plant whereas fire and safety is being taken care by STEAG and OTPC staff.

All contractors' staff and new staff have initial safety induction (orientation) training. Safety procedures follow Occupational Safety and Health Administration System (OSHAS) guidelines. New recruits initially work under a foreman and an individual work specific training plan includes safety training.

Near Miss, first aid, reportable and fatal incidents are monitored.

Smoking is not allowed in the plant.

There is a procedure for investigating accidents including determining root cause. The investigation team members are dependent on the severity. Action from the investigation is reviewed quarterly for progress. Near misses are reported.

For contract labours, prior to issuance of gate passes safety training and medical examination is a must.

A full-fledged executive training program on fire and safety is mandatory along with the annual refresher training.

Plant safety parameters are as mentioned in the below table:

Parameter	Units	2015	2016	2017	2018
Loss Time Injury	Nos.	0	0	0	1
First- aid cases	Nos.	26	97	34	12
Occupational Diseases	Nos	0	0	0	0
Safety Training Hours	Man-hours	283	657	2460	2596

Environment

The plant emission limits are outlined in the following Table (measured in March 2019):

Parameter	Unit of Measurement	Limit	Typical
Particulates(PM10)	PPM	50	44
SOx	PPM	200	0.94
NOx	PPM	50	19 - 20
Effluent PH	PH	6.5 – 8.5	6.92 – 7.79
ETP Effluent - TSS	Mg/l	NA	16.19

Physical Security

Tripura State Rifles, a security force of government of Tripura is deployed for the Plant security.

Access to the site is through a gatehouse that is continuously manned by armed guards.

Visitors require prior approval for issue of a Gate Pass and are accompanied from the gatehouse by a member of the plant staff.

The site is surrounded by approximately 2 m high brick and RCC Wall (topped with strands of barbed wire).

Cyber Security

Good cyber security measures observed at site.

Site intranet is completely isolated from the internet through firewalls.

All Units have independent LAN systems.

External memory device ports have been disabled in all the laptops and PCs.

SECTION EIGHT

EMERGENCY CONTROL

Fire Protection Features

Plant is equipped with fire detection and protection systems. All the detection systems (installed in the different hazardous areas) are connected to the central fire alarm panels and fire stations for better monitoring and control.

Fire alarm and detection system has been supplied by Detectomat, Germany (https://www.detectomat.com).

A basic level of fire detection and protection system was observed in the plant during the survey.

Fire protection and detection system has been supplied by UTC Fire and Security India Limited.

Fire detection systems are installed at Gas Turbine Enclosures, Steam Turbine Generator enclosure, main plant control room, DCS panel rooms, station switchgear rooms, Lube oil skids, Generator Step up Transformers, Station Transformers, Auxiliary Transformers and main plant cable cellar rooms.

Fire and gas detection systems at gas receiving and processing stations and gas booster compressor complex are not installed (Recommendation 2019/04/14).

Automatic fixed fire protection systems are installed at Gas Turbine enclosures, Steam Turbine Generator enclosures, Main control and DCS rooms, Lube oil skids, Generator Step up Transformers, Station Transformers, Auxiliary Transformers and main plant cable cellar rooms.

Fixed fire protection and detection systems at Steam Turbine Generator bearings and Gas Turbine Generator Seal oil tank skids are not installed (Recommendation 2019/04/10 and 2019/04/11).

Plant comprises of spray (for fixed fire protection system) and hydrant water reticulation system. These reticulation systems are mostly above ground. Fire water pumps are separate for spray and hydrant fire water system.

Plant is equipped with two numbers of motor driven pumps, one numbers of diesel engine driven pump, two numbers of jockey pumps, two set of compressors and one hydro pneumatic tank for hydrant system and one motor driven pump, one diesel engine driven pump for spray system.

Fire water tank is a concrete tank with a capacity of 3000 cubic meters capacity and is equipped with automatic level control mechanism. The intake to the fire water tank is directly from the clarifiers through gravity with a motorized isolation valve.

Site consists of a raw water reservoir of 178,000 cubic meters capacity.

Plant fire water system comprises of following pumps:

Pumps	Quantity	Flow (m^3/hr)	Head (m)	Supplier	Type
Main Hydrant Pumps (Electrical)	02	273	88	Flow more, India	Vertical Centrifugal
Stand by hydrant Pump (Diesel Engine driven)	01	273	88	Flow more, India	Vertical Centrifugal
Main Spray Pumps (Motor driven)	01	273	88	Flow more, India	Vertical Centrifugal

Pumps	Quantity	Flow (m^3/hr)	Head (m)	Supplier	Type
Stand by Spray pump (Diesel Engine driven)	01	273	88	Flow more, India	Vertical Centrifugal
Jockey Pump	02	20	95	Flow more, India	Vertical Centrifugal
Air Compressors	2	30	NA		
Hydro pneumatic tanks	1	80 M^3	NA		

Standards

As informed by the site team fire protection and detection systems have been designed based on respective NFPA standards.

Critical areas like Steam Turbine Generator bearings lube oil piping and GT Generator seal oil system as per NFPA 850 (Recommendation 2019.04.10 and 2019.04.11).

Passive Fire Protection

Separate Fire Compartments and Other Aspects

The plant occupies a large area and is well laid out.

Both the Gas Turbines are housed at “0” meter TG building with a separation of around 70 meters in parallel configuration.

Both the Steam turbines are housed in the turbine building at TG floor with an axial configuration having separation of around 75 meters.

HRSGs are outdoor installations located within their own steel frame support structures to the West of the Turbine Hall with approximately 70 m separation. The flue gas from each HRSG is released via steel stake located to the West of the HRSGs. The Plant Gas receiving and conditioning facilities are located to the North East of the main plant with about 350 meters of separation and can be considered as separate risk.

Hydrogen Generation Plant is located in the South East of Turbine hall with a separation of around 550 meters and can be considered as a separate risk as well.

Steam Turbine Generator lubricating oil tanks and pumps are located at Turbine hall “0” meter floor and the tanks are bunded with oil drainage facility in place. Lubricating oil tanks are equipped with fixed fire protection system. Fixed fire protection system is not extended up to the lube oil filters and coolers. Fixed fire protection system for steam turbine generator bearings and lube oil piping is not installed (Recommendation 2019/04/10).

Gas Turbine lube oil system is located just besides respective Gas Turbine enclosure at “0” meter floor and in a separate enclosure. The enclosure is equipped with CO_2 based compressed gas fire protection system.

The seal oil skids/tanks for Gas Turbine are located in a pit at the ground floor of the Turbine Hall (besides Gas Turbine Enclosures). These tanks are not equipped with fixed fire protection system (Recommendation 2019/04/11).

The Station transformers, Generator Step up (GSU) Transformers (for Gas Turbine Generators and Steam Turbine Generators) and Unit Auxiliary transformers are located to the East of the turbine hall.

A blast/ fire wall and containment (filled with stone chips) has been provided between each GSU transformer, Unit Auxiliary transformer and station transformer suitably as per NFPA 850.

GSUs, Station transformers and Unit Auxiliary Transformers are equipped with fixed fire protection systems.

Good cable sealing arrangements were observed in cable rooms and switchgear rooms.

AC and DC lube oil pump, power and control cables are running through the same route but are not painted with intumescent paint (Recommendation 2019/04/15).

Fire and Gas Detection

Detection Systems

Fire detectors installed include:

- Photoelectric smoke detectors.
- Probe type conventional heat detectors.
- Multi sensor.
- Linear Heat Sensing (LHS) cables.

Detection is installed in the following areas:

- Gas Turbines enclosure.
- Control Room (including floor voids).
- All switch rooms and cable rooms.
- DCS room.
- Transformers.
- Cable raceways.
- Lube oil tanks for Gas and Steam Turbines.
- Stores (Air conditioned area only).

Fire and Gas Alarm Systems

Plant is divided into different fire zones as per design. Each zone is equipped with the various types of fire detectors.

These fire detectors are connected to the fire alarm panels located in control rooms and fire station building.

Fire alarm and detection system has been supplied by Detectomat, Germany (https://www.detectomat.com).

Hydrogen Gas detection system is installed in hydrogen generation plant and wired to the local PLC system.

Natural Gas detection system is installed in Gas Turbine enclosures. The signals are wired to DCS for alarm and tripping as mentioned below:

- 5% LEL for high alarm.
- 12% LEL for High- High Alarm.
- 25% LEL for tripping.

Fire Water Systems

Design

Fire water systems are designed based on TAC (Tariff Advisor Committee) guidelines.

Fire water system is equipped with one fire water tank (of 3000 m^3). This is an RCC tank and receives water directly from clarifiers through gravity.

Fire water tank is equipped with level transmitters, which controls the water level in the tank automatically.

Pumps for hydrant and spray fire water systems are separate and has been sized sufficiently as informed by site team.

Fire Main

All the critical areas in the plant such as mentioned below are equipped with dedicated hydrant and spray ring mains:

- TG Building & HRSGs.
- ESP/ESP Control Room.
- Transformer yard & 400 kV/132 kV switch yard/control room.
- DM Plant.
- Fire Station.
- Hydrogen Plant.
- CT MCC Room.
- Plant Air Compressor Building.
- Air washer room.
- Stores.
- Chemical Storage.

Fire water spray and hydrant pipes are mostly laid over ground except some areas like switchyard, which is currently being changed to over ground.

Fire hydrants are installed as per TAC (Tariff Advisory Committee) guidelines and the details are as mentioned below:

- Outdoor hydrants.
- Internal hydrants.
- Double headed hydrants.
- Water monitors.
- Total number of equivalent hydrants.

Fixed Protection

Fixed Fire Protection Summary

A summary of the fixed fire protection systems installed are shown the following Table.

Zone	Activation	Fire Protection
Gas Turbine enclosure	2 Number Gas detectors and 6 Numbers of heat detectors	CO_2 gas system
GTG Lube oil tanks	Heat	Automatic Deluge
STG Lube Oil Tanks	Heat	Automatic Deluge
Gas Turbine Generator step up Transformers	Q B detectors	Automatic Deluge
Steam Turbine Generator step up Transformers	Q B detectors	Automatic Deluge
Station and Unit aux. Transformer	Q B detectors	Automatic Deluge
Control rooms	smoke	Argonite system
DCS and computer rooms	Smoke	Argonite system
Cable cellar rooms	LHS and smoke detectors	Automatic Deluge
Switchgear Rooms	Smoke detectors	None
Gas booster compressor building	None	None
Hydrogen Generation Plant	Hydrogen gas leak detection	None

Mobile Equipment

Fire Appliances

Following fire extinguishers are installed in the plant at different locations:

Type of Fire Extinguisher	Quantity
Water (9 Litre)	40
Mech Foam(9 Litre)	5
ABC 2kg	2
ABC 5 kg	6
ABC 6kg	20
CO_2 4.5 kg	37
CO_2 6.5 kg	3
CO_2 9 kg	10
CO_2 22.5 kg	8
DCP 5 kg	163
DCP 25 kg	7
DCP 50 kg	2
Total	303

Plant is equipped with two numbers of fire tenders of 3000 Litres water capacity each and two numbers of 200 Litre foam trolleys.

Plant consists of following firefighting installations:

Description	Quantity
Fire Hydrant	102
Fire escape hydrant	40
Water monitor	3
Deluge valves (MVWS:12 and HVWS:22)	34
Hose boxes	142
Area isolation gate valves	31

Emergency Plans

There is a disaster management Plan in place which takes care of the various emergency scenarios. As discussed with the site safety team, regular emergency drills are also carried out for the intended spontaneous action from all the employees in case of any emergency.

Based on the various emergency scenarios / situations mentioned in the disaster management plans, following emergency drills are performed at site:

- Annually once involving external agency.
- Mock drill fortnightly internally.

Disaster management plans are updated every two years/ (or) whenever the change is there and these plans are also approved by factory inspectorate office.

Fire Response

Site Fire Response

Deployment of firefighting team is in STEAG's scope as a part of O&M contract.

Firefighting cover is provided on a 24 hour basis on a three 8 hour shift pattern using four shift teams with each team lead by a shift supervisor.

Following persons are deployed per shift:

- Two Fire tender drivers.
- Two Firemen.
- One supervisor.

Around 05 persons are deployed in each shift, as mentioned above. In view of the same the total manpower of the fire team is around 21 persons.

Moreover, fire team has around 14 dedicated persons for the maintenance purpose which is a good practice.

Mutual aid

OTPC has the mutual aid arrangement with the following:

- Udaipur fire service department, Udaipur which is around 10 km from site.
- Kakraban Fire service, which is around 06 kmfrom site.

Mock drills were conducted recently to see the response time for the arrival of fire tender and team from Udaipur and Kakraban fire service department. Both the teams arrived within 10 to 15 minutes at site.

The mutual aid arrangement is for sharing ambulance facilities also.

Site is equipped with one of ambulances also.

Fire Systems Inspection, Maintenance & Testing

Inspection testing and maintenance of the fire water pumps and fire detection and protection system is carried out by fire and safety department.

All the fire extinguishers are inspected on monthly basis and refilled if found empty or with less weight. Fire extinguishers observed with the tags, which show that monthly inspections are carried out.

All the fire hydrants are also monthly inspected. During inspection, correctness of local pressure gauges with respect to actual water pressure, freeness of hydrant valves, availability of water etc. are checked and corrected if found with the problem.

Testing of Fixed fire protection system of transformers, Main Lube oil tanks and cable cellar rooms is carried out on annual basis.

Fire water pumps are tested but as informed by site, these are not tested as per NFPA 25 guidelines (Recommendation 2019/04/08).

Housekeeping

Housekeeping in the plant was generally in order.

Cleaning of dry vegetation in the areas like switchyard and transformer yard is required on immediate basis.

Fire System Impairment Procedure

Formal fire impairment procedure is not available (Recommendation 2015/01).

Ignition Source Control

Hot work is controlled through the Permit to Work system. A fire watch post hot work completion is provided by the fire department.

Vehicle access to the site is strictly controlled by site Security and only essential vehicles are allowed onto the Power Plant area.

Smoking is not allowed in the plant.

SECTION NINE

LOSS SCENARIOS

Loss Definition

In this section of the report, a review is presented of the probable principal Material Damage loss exposures relating to the plant, indicating a Probable Maximum Loss (PML) and Maximum Foreseeable Loss (MFL) for each scenario.

The scenarios considered are those related from physical damage perils conventionally insured and from machinery breakdown.

The definition of PML is as follows:

"The Probable Maximum Loss in respect of Property Damage and Business Interruption from an insured event that is considered to be limited to the initiating object or area and occurs at a time when normal protection is in service and functions correctly."

The definition of the MFL is:

"The Maximum Foreseeable Loss where severely adverse conditions are present. A loss resulting from an event that is considered to be of a major magnitude that causes damage not only to the initiating equipment or area but also to surrounding equipment, buildings and infrastructure and occurs when normal protection is out of service. This includes the consequences of a fire or explosion in the most critical area of the property assuming the loss or failure of all existing fixed fire protection systems but assumes passive fire protection works and emergency response works. It also includes the highly unlikely catastrophic incidents such as earthquake, hurricane etc."

Plant and equipment for the OTPC, Udaipur Plant is those typically associated with the production of electrical energy from Gas fired Turbine Generators, HRSGs and steam turbine generators. Consequently, the losses are those expected from the operation of heavy industrial equipment, large rotating plant, steam pressure vessels, piping, lubricating oil systems, together with transformers, power and control cabling necessary for the operation of the plant.

Property Values

Following values are considered based on John Foord Paper.

Main Equipment Value	Million US $
Gas Turbine + Generator	81
Transformers	27
Steam Turbine + Generator	40
HRSG	40
Balance of Plant	80

The loss scenarios have included additional clean-up costs and work on the assumption that equipment will be replaced at the same contract value.

The loss scenarios do not include the potential of third party damage and claims.

Lead Times

Lead times for the critical equipment have been considered as mentioned below (for the loss calculation):

Equipment	Months
Gas Turbine	16
Generators	16
HRSG	13.5
Steam Turbine	13
Transformers	10

In practice OEMs look to improve on standard lead times and will deal with the supply on a case to case basis.

Insured Values

Following are the sum insured values based on the latest policy in place:

- Property Damage Sum Insured: INR 3,822 Cr.
- Business Interruption Sum Insured: INR 653 Cr (Annual).
- Business Interruption Indemnity Period: 18 months.
- Deductibles:
  - Property Damage: 5% of claim amount subject to minimum of 5,000,000.
  - Deductibles for Mobile / office equipment's – 5% of the claim amount subject to minimum of INR 1,000,000 for each and every loss.
  - Fire Loss Of Profit: 14 days of Gross Profit.
  - Machinery Breakdown Loss Of Profit: 21 days OF Gross Profit.

Probable Maximum Loss

Loss Event	Property Damage Mn US$	BI Estimate MW x Months	Description of Loss
Severe DOD due to combustor failure or compressor blade failure resulting in loss of turbine section	32	363 MW for 12 Months	Assumes loss because of the DOD in either combustor or compressor and damages the hot gas path. Considering 60% damage.
Generator Transformer explosion	3	363 MW for 10 Months	Assumes explosion in Gas Turbine Generator transformer by some electrical fault. Assumes complete replacement of the transformer.
Steam Turbine Generator Fire	8	131 MW for 7 Months	An oil leak in the generator side causes a fire. The fire team responds and damage is minimized. Specialists are required to repair the damage to the Generator. Estimate 20% of STG value.
Loss of HRSG pressure parts requiring replacement during over-pressurization	16	363 MW for 8 Months	Pressure part losses resulting from over pressurization in case safety valves fail to open. Estimate 40% of HRSG value

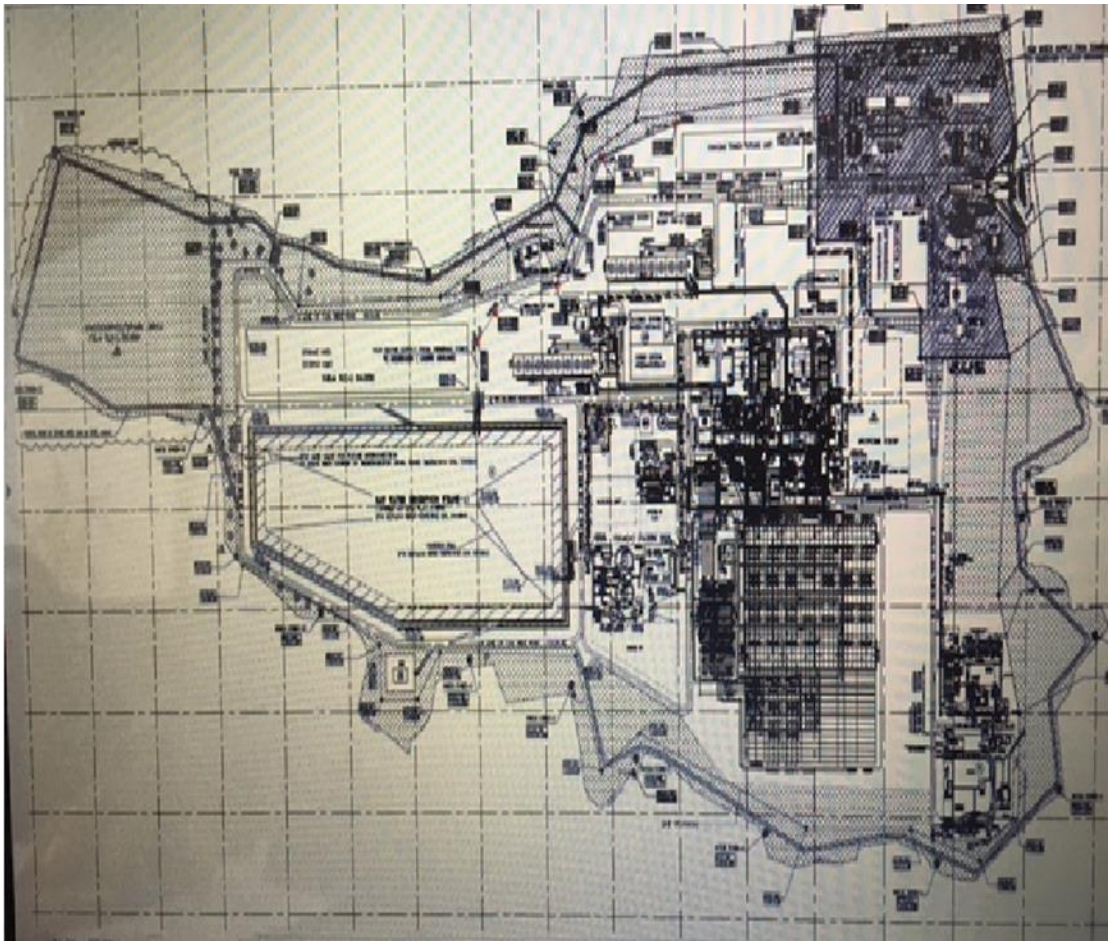
Loss Event	Property Damage Mn US$	BI Estimate MW x Months	Description of Loss
Inundation of ground floor TG Building and GT enclosure where in all the ground floor TG equipment got damaged and need replacement.	10	363 MW for 8 Months	Assuming all the" 0 "meter TG and GT auxiliary equipment got damaged and need replacement. Considered this loss as the area is in high river flood zone (Zone 500) as per Munich re.

Maximum Foreseeable Loss

Loss Event	Property Damage Mn US$	BI Estimate MW x Months	Description of Loss
Earthquake	14	363 MW for 16 Months	An overall damage level equivalent to 5% of the total plant value is suggested for the loss resulting from earthquake event. This represents direct earthquake damage and the following fire damage. Estimate to be 5% of Plant value.
Major GT loss	105	363 MW for 24 Months	Explosion in GT and severe damage to GT and Generator followed by Hydrogen explosion in generator. Assumes total loss of Gas turbine and generator requiring complete replacement + 12% Debris removal+20% damage to the adjacent unit.
Major ST uncontrolled Lube oil fire	53	363 MW for 20 Months	Assumes catastrophic loss of ST, with significant building damage and partial collapse. Assumes most of the major equipment suffers external damage only and can be salvaged. Estimate full replacement cost of 1 STG + debris removal, clean up and minor damage to adjacent STGs.
ST over speed without following fire	53	363 MW for 20 Months	Assumes total loss of turbine and generator requiring complete replacement + 12% Debris removal+20% damage to the adjacent unit.
Major HRSG pressure part loss	15	363 MW for 10 Months	Assumed considerable loss of pressure parts including drum .

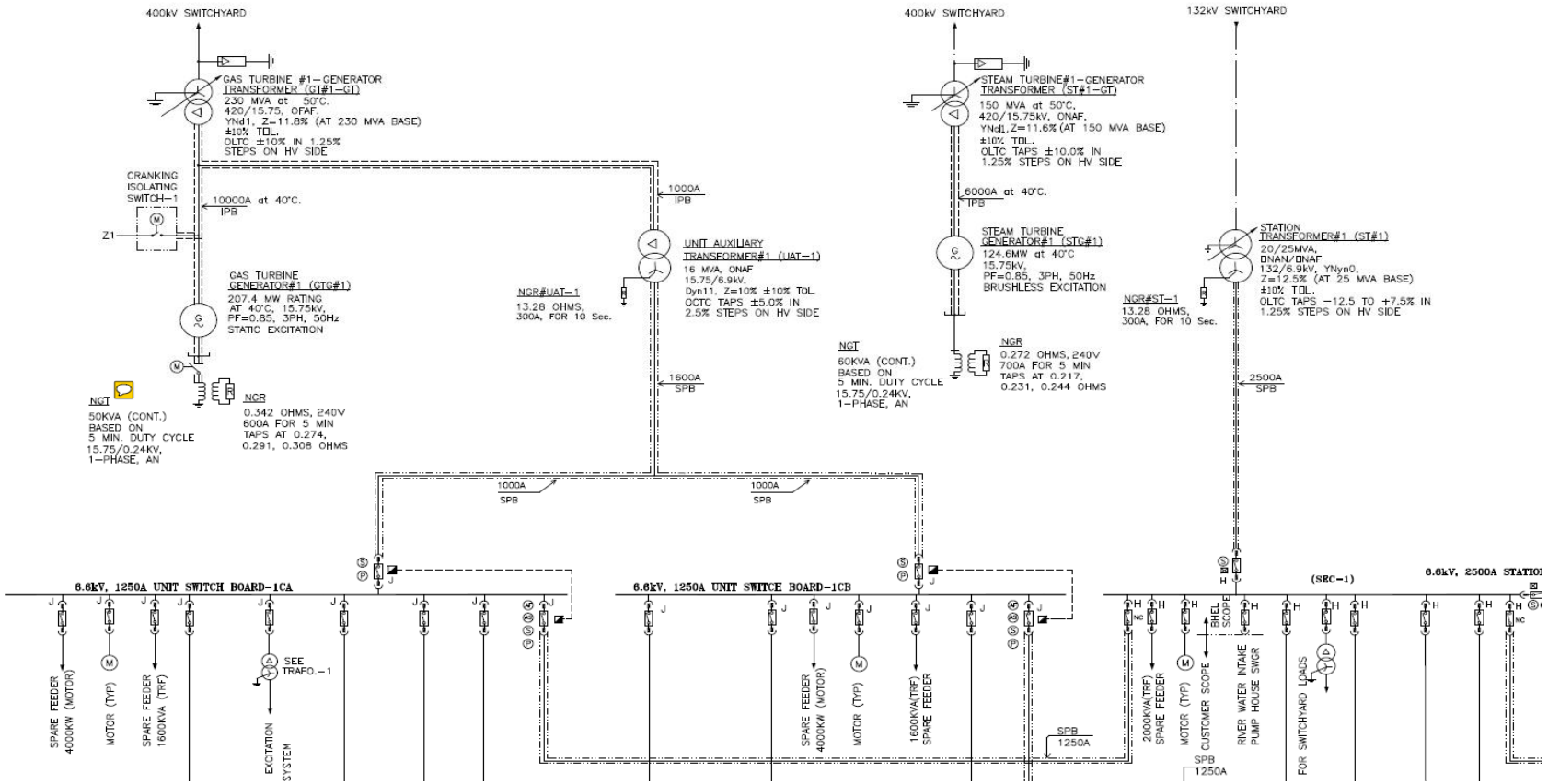
APPENDIX A

PLOT PLAN



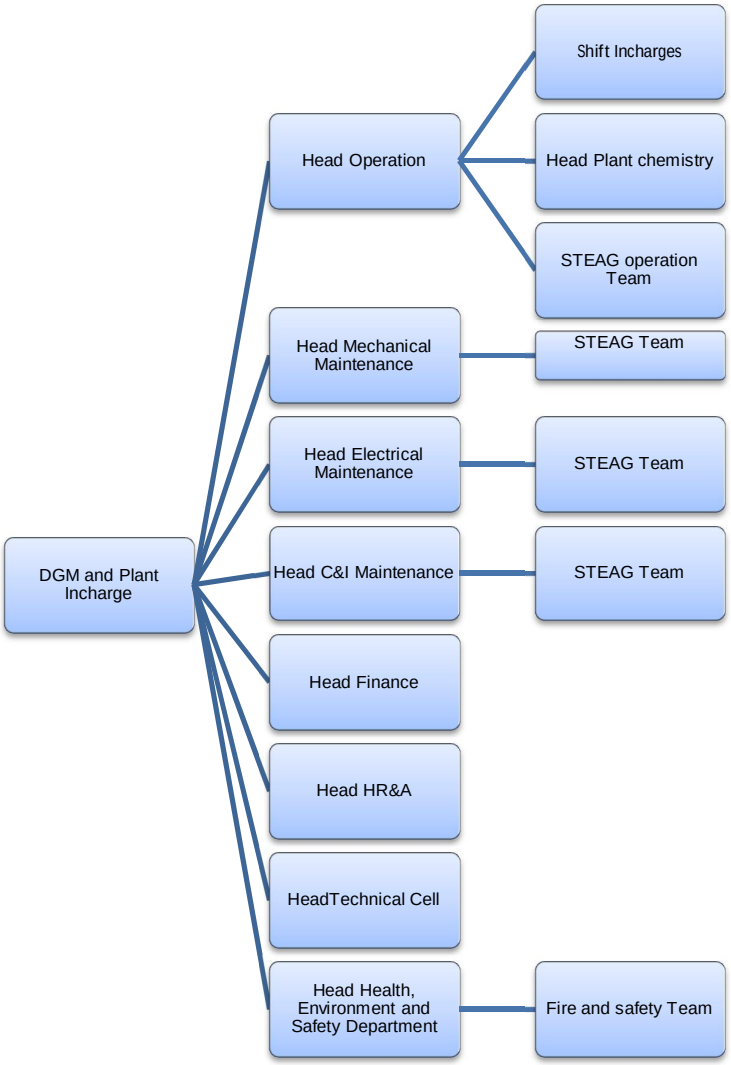
APPENDIX B

SINGLE LINE ELECTRICAL DIAGRAM (FOR ONE BLOCK)



APPENDIX C

ORGANISATION STRUCTURE



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Government of India

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FOR INDUSTRIES

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MINISTER OF POWER

SECRETARY, MINISTRY OF POWER

ADDITIONAL SECRETARY, MINISTRY OF POWER

DIRECTOR GENERAL, BUREAU OF ENERGY EFFICIENCY

DIRECTOR, BUREAU OF ENERGY EFFICIENCY

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LIST OF ABBREVIATIONS

AAS	Actual Air Supplied
AC	Alternating Current
BOP	Best Operating Point
BFP	Boiler Feedwater Pump
CO	Carbon Monoxide
DC	Designated Consumer
DG	Diesel Generator
EC	Energy Conservation
ECBC	Energy Conservation Building Code
EM	Energy Management
ESCOs	Energy Service Companies
FRP	Fibre Reinforced Plastic
GCV	Gross Calorific Value
HVAC	Heating, Ventilation and Air Conditioning
IBR	Indian Boiler Regulation
IEMS	Industry Energy Management Systems
ISO	International Organization for Standardization
kCal	Kilo Calorie
kWh	Kilo Watt-hour
LED	Light Emitting Diode
LPD	Lighting Power Density
LPG	Liquefied Petroleum Gas
M&V	Monitoring and Verification
NAPCC	National Action Plan on Climate Change
NG	Natural Gas
NMEEE	National Mission for Enhanced Energy Efficiency
NPSH	Net Positive Suction Head
OEM	Original Equipment Manufacturer
OLTC	On-line tap changer
PF	Power Factor
PAT	Perform, Achieve and Trade
PVC	Poly Vinyl Chloride
SCADA	Supervisory Control And Data Acquisition
SCM	Standard Cubic Metre
SEC	Specific Energy Consumption
SME	Small and Medium Enterprise
SPC	Specific Power Consumption
SPV	Solar Photo Voltaic
STP	Standard Temperature and Pressure
TFH	Thermic Fluid Heater
VFD	Variable Frequency Drive
WHR	Waste Heat Recovery

LIST OF DEFINITIONS

In the Energy Conservation (EC) Guidelines as defined herein, where the context so admits, the following words and expression will have the meaning as specified:

Accredited Energy Auditing Firm

The accredited energy auditing firm refers to the firm that has been empanelled by the Bureau of Energy Efficiency (BEE) to undertake activities in Designated Consumers (DCs) as prescribed under the EC Act.

Certified Energy Manager

Energy manager means any individual possessing the qualifications prescribed under clause (m) of Section 14 of the Energy Conservation Act (2001). Any reference to the certified energy manager refers to a person who has qualified at the national certification examination for the role of certified energy manager and energy auditor conducted by the BEE. A candidate qualifying as a certified energy auditor automatically qualifies for the role of certified energy manager as well. Such persons can be considered by DCs for appointment or designated as energy manager under the EC Act.

Designated Consumer

The DC means any consumer specified under clause (e) of Section 14 of the Energy Conservation Act (2001). For the purpose of the EC Guidelines, the following industries are covered (1) aluminium, (2) fertilizers, (3) iron and steel, (4) cement, (5) pulp and paper, (6) chlor-alkali, (7) textile, (8) petrochemicals, (9) petroleum refineries, and (10) thermal power stations with a threshold limit for energy consumption as specified by the EC Act (2001), from time to time.

Energy Service Companies

Energy Service Companies (ESCOs) are the firms that offer energy services, usually design, retrofitting, and the implementation of energy-efficiency projects, after identifying energy-saving opportunities through energy audits of the existing facilities, energy infrastructure outsourcing, power generation and energy supply, and financing or assisting host entities in arranging finances for energy-efficiency projects by providing a savings guarantee, risk management in the implementation of the energy-efficiency projects, and also performing Measurement and Verification (M&V) activities to quantify actual energy savings post the implementation of energy-efficiency projects.

Standards

Standards are optimum performance values achieved by an energy consuming utility in daily operation.

State Designated Agency

The state designated agencies (SDAs) are organizations identified by state Governments, in consultation with the BEE, under the provisions of the EC Act, 2001, to coordinate, regulate, and enforce the efficient use of energy and its conservation at the state level.

STP Conditions

STP is defined as a temperature of 273.15 K (0 °C, 32 °F) and an absolute pressure of exactly 105 Pa (100 kPa, 1 bar).

Targets

Targets are equal to the best achievable values of an energy consuming utility in daily operation.

1. BACKGROUND

The Energy Conservation (EC) Act, 2001, provides for the efficient use of energy and its conservation in India. The Government of India set up a Bureau of Energy Efficiency (BEE) under the provisions of the EC Act. The mission of the BEE is to assist in developing policies and strategies—with a thrust on self-regulation and market principles—within the overall framework of the EC Act with the primary objective of reducing the energy intensity of the Indian economy. The BEE coordinates with designated consumers (DCs), designated agencies, and other organizations and recognizes, identifies, and utilizes the existing resources and infrastructure, in performing the functions assigned to it under the EC Act. In addition to providing regulatory and promotional functions of the Bureau, the act also provides a list of energy-intensive industries and other establishments specified as DCs.

One of the flagship programmes of Bureau of Energy Efficiency is Perform, Achieve and Trade (PAT) scheme aimed towards enhancing energy efficiency in Indian industrial sector in general and Designated Consumers (DCs) in particular. The PAT scheme was formed under the National Mission for Enhanced Energy Efficiency (NMEEE). The NMEEE is one of the eight national missions under the National Action Plan on Climate Change (NAPCC) launched by the Government of India in the year 2008.

The Bureau has envisaged that the smooth implementation of PAT scheme can be enhanced and strengthened by formulating and making available a suitable 'Energy Conservation Guidelines' (EC Guidelines) for the targeted industry sub-sectors.

Japan is one of the pioneers in implementing energy efficiency at the global level. As part of their energy efficiency efforts, the Government of Japan had introduced EC guidelines to support industries to improve energy performance. Looking at their success, the Government of India, on similar lines, has also prepared EC Guidelines for different categories of industries operating in India (Table 1.1).

Table 1.1 Different categories of industries covered under the EC Guidelines

Category	Details
Category–A	DCs covered under PAT scheme but limited to the following industries: (1) aluminium, (2) cement, (3) chlor-alkali, (4) fertilizers, (5) iron and steel, (6) petrochemicals, (7) petroleum refineries covering only cracker units, (8) pulp and paper, (9) textile, and (10) thermal power stations.
Category–B	Large industries with energy consumption of less than the existing minimum threshold limits for DCs.
Category–C	Small-scale enterprises with energy costs accounting for more than 30% of the total production cost but limited to the following SME sectors: (1) glass, (2) foundry, (3) forging, (4) ceramics, (5) dairy, and (6) textile industries.
Group–D	Medium enterprises with energy costs accounting for 10% to 30% of the total production costs but limited to the following sectors: (1) brick, (2) hand tools, (3) food, and (4) limestone industries.
Group–E	Micro industries with material costs more significant than energy costs

2. OBJECTIVES

The overall objective of the EC Guidelines for large industries and SMEs is to guide the management and operators in large industries and SMEs to manage energy consumption by standardizing the energy performance values of various energy-consuming equipment and systems deployed for the manufacturing process.

One of the important components under the overarching framework of the EC Guidelines is the benchmarking of standard energy performance values and a procedure for establishing target energy performance values for major energy-consuming equipment, such as boiler, furnace, thermic fluid heater, waste heat recovery (WHR) equipment, motor, etc.

The objective of this document is to provide EC guidelines to large industries that are covered as DCs under PAT mechanism of the EC Act, 2001, but limited to the list as provided in Section 1, hereafter termed as Category-A industries.

3. METHODOLOGY

3.1 Activities followed for preparation of EC Guidelines

A review of the EC Guidelines pertaining to industries in Japan was carried out to draw a blueprint of the EC Guidelines applicable for Indian industries. Relevant secondary data from different industries were collated through a questionnaire survey and field visits. Other sources of secondary data include (i) performance audits and sectoral study reports, (ii) original equipment manufacturers, (iii) industries, (iv) sectoral experts, (v) stakeholder consultations with industries and industry associations, and (vi) secondary sources such as relevant websites. Interactions with industry personnel and industry associations were carried out to understand key operating parameters in different utilities. Further discussions were held with OEMs and sectoral experts in India and Japan to ascertain the relevance of data collated for the different utilities.

A detailed data analysis of the relevant parameters of the various utilities in industries were carried out using statistical tools to benchmark key operating parameters as 'standard value' and 'target value'. These parameters include air ratio, flue gas temperature, surface temperature, level of WHR, efficiency of motors, efficiency of fans, corrected target power factor of electrical equipment, lighting power density, etc. The average values and standard deviations of the data samples of similar groupings were arrived at through data analysis. The collated data were sanitized to exclude extremely high or low values for the purpose of analysis.

In preparing the EC Guidelines, the existing technology standards and practices of various industry sub-sectors in India were considered. The draft EC Guidelines were presented in a stakeholder workshop in which representatives from industries, industry associations, original equipment suppliers, sectoral experts, etc., participated and provided their inputs.

The revised EC Guidelines were again presented in a second stakeholder workshop to ensure synergy with the industry. With these inputs, the EC Guidelines were finalized for Category-A industries.

The 'standard values' of an energy-consuming utility include optimum performance values, which are achieved by the industry under daily routine operations; the 'target values' of the utility represent better performance values than the standard values. These values focus essentially on those benchmarks which shall guide the industry to improve the performance of the existing facilities, new installations, and retrofits in the existing facilities. An empirical equation was considered to arrive at standard values and target values using the average and standard deviation of the data samples, which are discussed below.

3.2 Evaluation of Standard and Target Values

3.2.1 Standard values

The standard values are arrived at by using the following equation:

Standard value = Average value of the data samples

A nominal tolerance of +2.5% to -2.5% of the standard value is considered to accommodate variations in performance of the equipment within the range of standard values.

Upper limit = Standard value + 2.5% of the standard value

Lower limit = Standard value – 2.5% of the standard value

3.2.2 Target values

The target values are arrived at by using the following equation:

Target value = Average value of the data samples – the standard deviation of the data series

A nominal tolerance of +2.5% to -2.5% of the target value is considered to accommodate variations in performance of the utilities within the range of the target values.

Upper limit = Target value + 2.5% of the target value

Lower limit = Target value – 2.5% of the target value

3.3 Revision of Energy Conservation Guidelines

The EC Guidelines applicable for Category-A industries will be revised from time to time on a periodical basis based on inputs from various stakeholders and as per recommendations of the technical committee constituted by the BEE.

4. ENERGY CONSERVATION GUIDELINES

The EC guidelines is a comprehensive, hand-holding document related to major energy-consuming utilities in Category-A industries to guide top management as well as operators in industries to manage energy efficiently. The guidelines shall provide guidance to prepare its own 'Energy Management Manual' (EM Manual) for the efficient operation of various energy-consuming utilities in individual industries under Category-A.

4.1 Standards and Targets

The guidelines consist of two distinct components, namely, (1) the standard component and (2) target component for various common energy-consuming utilities employed across industries covered under Category A. For an industry to operate efficiently, it is essential to run various energy-consuming utilities efficiently and ensure a proper monitoring and recording of all key operating parameters pertaining to each utility.

An industry shall maintain optimum operating parameters of the different utilities based on feedback received from the relevant process sections, thereby achieving optimum operation of the utility, which shall be termed as 'standard values' of operation. Thus the standard values of a utility shall be defined as:

Standards are optimum performance values achieved by an energy consuming utility in daily operation.

The industry shall further improve the performance of the equipment by operating them at the best possible operating parameters, which shall be terms as "target values" of operation. The target values as mentioned in guidelines are better than the standard values, which the industry shall strive to achieve best possible performance of the equipment. Thus, the target values of a utility shall be defined as:

Targets are equal to the best achievable values of an energy consuming utility in daily operation.

4.2 Components of Standards

The standard component comprises four distinct sections that focus on the relevant instructions concerning routine operations of the respective utilities. These include: (1) management and control, (2) measurement and recording, (3) maintenance and inspection, and (4) installation of new facility. The primary focus of the standard components is provided in Table 4.1. The instructions are intended to guide the industries to achieve optimum performance of the utilities. The concrete activities in the standard components (1), (2), (3), and (4) shall be described in the EM Manual.

Table 4.1 Components of standards

Component	Primary focus
(1) Management and control	This section provides guidelines for managing and controlling key operating parameters in different energy consuming equipment in an industry e.g. air ratio, flue gas temperature, surface temperature, WHR, efficiency of motors, efficiency of fans, corrected power factor of electrical equipment, lighting power density etc. It further covers load sharing during part load conditions in a multi-equipment e.g. part load operations of equipment such as boiler, pump, fan, blower, air compressor, air-conditioning system etc.
(2) Measurement and recording	This section provides frequency of measurements and recording of operating parameters e.g. fuel consumption, temperature of steam, temperature of flue gases, analysis of flue gases, inlet and outlet temperatures of heating and cooling media, supply and return temperature of cooling water, etc.
(3) Maintenance and inspection	This section highlights preventive maintenance and the overhauling schedule for various equipment. It further provides schedule for regular calibration of instruments to maintain accuracy in data measurements.
(4) Installation of new facility	This section suggests directions for the installation of energy efficient equipment for retrofitting in the existing utility and system upgradation.

4.3 Components of Targets

The target components provide a set of instructions for the efficient use of energy consuming equipment or equipment and energy management practices that shall be followed to achieve the best performance of the equipment. The instructions under target components shall relate to the existing practices as well as include guidance for selecting new equipment with advanced features.

4.4 Scope of Energy Conservation Guidelines

The DC generally follows energy management (EM) policies to reduce energy consumption in different energy-consuming processes and utilities. The general guidelines for EM policy are provided in section 5. The primary equipment/utilities considered under DCs shall be grouped (Table 4.2).

Table 4.2 Details of equipment under Category-A industries

S. No.	Name of section	Equipment covered
1.0	Combustion of fuel	Boiler, industrial furnace, thermic fluid heater
2.0	Heating, cooling, and heat transfer 2.1 Heating equipment 2.2 Air-conditioning and hot water supply equipment	Boiler, steam system, condensate recovery system, industrial furnace, thermic fluid heater. Heat transport equipment, air-conditioning equipment, hot water equipment, thermic fluid heater
3.0	Waste heat recovery and usage	Boiler, condensate recovery system, industrial furnace, gas turbine, gas engine, diesel engine, thermic fluid heater
4.0	Conversion of heat to electricity 4.1 Power generation facilities 4.2 Cogeneration facilities	Boiler, steam turbine, gas turbine, gas engine, diesel engine
5.0	Prevention of energy loss due to heat radiation and electric resistance 5.1 Prevention of heat loss due to radiation and conduction 5.2 Prevention of electricity loss due to electric resistance	Boiler, steam system, condensate recovery system, industrial furnace, thermic fluid heater, electrical distribution system

S. No.	Name of section	Equipment covered
6.0	Conversion of electricity to motive power, heat, and light 6.1 Facilities using motors and heaters 6.2 Industrial pump and pumping system 6.3 Industrial air compressor and compressed air network system 6.4 Industrial fans and blowers 6.5 Industrial lighting system 6.6 Cooling tower 6.7 Transformer	Motor, industrial heater, pumping system, air compressor and compressed air system, fan and blower, industrial lighting, cooling tower, transformer
7.0	Industry Energy Management System	Overall plant energy management

5. ENERGY MANAGEMENT POLICY

The designated consumer shall manage energy appropriately, depending on the input energy characteristics within the plant or in a utility in line with the existing EM policies. The DCs shall modify EM policies as needed, and in line with points from A to K (mentioned below). The DC shall suitably and effectively conserve energy through complying with various standards, as prescribed in the EC Guidelines, concerning the various energy-consuming utilities associated with different processes used.

Standard Components	
	A. The DC shall develop and adopt EM policies, including the installation of new utilities or the upgradation of the existing ones. B. The DC shall prepare a suitable Energy Policy Statement within the EM policy. It shall revisit the Energy Policy Statement on a periodical basis, and shall modify as required. C. The DC shall develop a management structure for an effective planning and implementation of EC measures. D. The DC shall involve the necessary resources (human and finance) to achieve energy conservation. E. The DC shall designate a Certified Energy Manager to ensure the implementation of EC measures. F. The DC shall prepare a document covering instructions on energy conservation at the plant level (hereafter termed as the 'EM Manual'), including EC targets by retrofitting/ replacing the existing inefficient equipment or installing new facilities as required. G. The DC shall ensure compliance of Energy Management at the plant level. It shall review the implementation status of the target EC measures and provide directions for future improvements. H. The DC shall review the EM manual and its compliance periodically, and modify based on the feedback from the plant personnel. I. The DC shall discuss EM with the employees and provide training to capacitate them. J. The DC shall ensure proper monitoring and maintain the recording in suitable documentation for each utility that would enable generation of status report of individual utility. K. The DC shall undertake calibration of all instruments used in monitoring and measurement on a regular basis to ensure data reliability.

Target Components	
	A. The DC shall manage gate-to-gate energy consumption and implement EC measures that are technically and economically viable to improve the energy performance of the plant. B. The DC shall identify EC measures with appropriate implementation strategies. C. The DC shall consider the existing standards for EM systems such as ISO 50001 to ensure synergy. D. The DC shall ensure an efficient utilization of thermal energy generated from primary energy sources. E. The DC shall optimize the recovery of heat available in either flue gases or surplus steam for use in suitable energy-consuming utilities within the plant. F. The DC shall target to recover and re-use the energy generated while burning or processing combustible waste to the maximum extent. G. The DC shall identify and implement EC measures to improve the performance of electrical equipment and reduce the overall electricity consumption. H. The DC shall utilize services of accredited energy-auditing firms, Energy Service Companies (ESCOs), etc., to identify and implement potential EC measures and achieve energy efficiency. I. The DC shall put in place suitable instrumentation and software tools for monitoring energy consumption and verifying energy savings. J. The DC shall manage the specific energy consumption (SEC) as per targets set under PAT mechanism by complying with various standards of energy-consuming utilities as mentioned in the EC Guidelines and implementing appropriate EC measures. K. The DC if being a lessee shall cooperate with the lessor to promote energy-efficiency activities jointly under the cost-sharing mechanism, so that appropriate and effective EC measures can be implemented as per the clause in the lessee agreement. L. The DC shall put in efforts to facilitate other industries to implement EC measures through information sharing and advisory support to promote a national initiative on energy conservation.

6. COMBUSTION OF FUEL

The energy sources used in industries include both thermal and electrical energy. Thermal energy is generated from the combustion of different types of fuels, such as coal, petcoke and biomass (solid fuels), furnace oil, diesel, naphtha and internally generated liquid fuels (liquid fuels) and natural gas (NG), LPG, off-gases, fuel gas and internally generated gaseous fuels (gaseous fuels). The thermal energy is either directly used in processes for heating, melting, etc., or used for power generation. This section provides the EC guidelines covering combustion of fuels in boilers, industrial furnaces, and thermic fluid heaters (TFH) in a rational way.

Standards Components	
(1) Management and control	A. The industry shall maintain optimum and correct air ratio while burning fuel(s) in boilers, furnaces, and TFHs (hereafter termed as 'combustion facilities'). The fuel combustion process shall be managed and maintained in accordance with the instructions provided on air ratios, which shall be provided in the EM Manual. B. The industry shall maintain air ratio for the boiler, as specified in Table 6.1 as the standard value and use Table 6.2 for industrial furnaces/TFH as the standard value. C. In cases where more than one combustion (of fuel) utilities are used, the combustion load for each utility of the industry shall be manged and controlled to achieve the highest-possible efficiency. The efficiency herein refers to the ratio of heat gained by the material to the total heat input to the combustion utility. D. The combustion utilities shall be suitably operated to achieve a high level of combustion efficiency under specific operating conditions, which shall be described in the EM Manual. The specific operatating conditions shall be finalized based on various factors of fuels, such as the particle size of solid fuels, moisture content, viscosity of liquid fuels, calorific value, pressure of gaseous fuels. E. The combustion utilities shall be managed according to the instructions provided in the operation manual related to draft, operating temperature, and loading conditions for optimum performance, which shall be described in the EM Manual.
(2) Measurement and recording	A. All the key parameters of combustion utility shall be maintained and recorded regularly. The frequency of measurements shall be adhered to, which shall be explained in the the EM Manual. The industry shall use the measured data for evaluating the performance of combustion utility. Some of the parameters that shall be measured and recorded include the quantity of fuel fired, temperature of exhaust gases, residual oxygen (O2), and carbon monoxide (CO) in flue gases and unburnt carbon for solid fuels in bottom ash and fly ash. B. The industry shall measure useful heat gain either through steam generation in boilers or through the quantity of material processed in furnaces for assessing the performance.
(3) Maintenance and inspection	A. The DC shall undertake periodical inspection and maintenance of combustion facilities to maintain good operating conditions which shall be described in the EM Manual.
(4) Necessary measures when installing new facilities	A. The DC shall decide the compatible size and system specifications of the combustion utility based on application, fuel type, temperature of combustion air and heat load fluctuations. B. The DC shall select suitable and appropriate combustion equipment along with accessories (e.g. burner, associated auxiliaries including built-in automation) for new utility. C. The DC shall select appropriate accessories for combustion air supply and integrate with combustion equipment for the automatic regulation of air flow considering real-time plant load and other operating conditions.

Target Components	
	A. The industry shall make consistent and regular efforts to reduce the air ratio of combustion facilities towards the reference air ratio (table 6.1) for boilers (table 6.2) and for industrial furnaces as target values. B. The DC shall retrofit suitable automatic air-fuel ratio control systems in each combustion equipment, and integrate with control loop system, if not already installed, which shall be described in the EM Manual. C. The DC shall select and use appropriate combustion equipment (e.g. burners and auxiliaries), based on the type of combustion equipment and the type of fuel used. The combustion system shall be capable of regulating fuel supply automatically in line with load fluctuations. D. The DC shall suitably modify air train to regulate combustion air flow and furnace pressure automatically. E. The DC shall consider regenerative burner while installing a new burner or replacing an existing one to recover and re-use heat from waste hot gases. F. The DC shall consider computer-aided automatic combustion management system / tool for a finer control of combustion equipment. G. The management shall install suitable on-line measurement and recording equipment to monitor and control key operating parameters in the combustion utility. The measurements shall include fuel supply, temperature of exhaust gases, residual oxygen, and carbon monoxide levels in flue gases. H. The DC shall periodically collect and analyse unburnt carbon in fly ash and bottom ash for solid fuels.

Table 6.1 Air ratios for boilers+

Parameter	Boiler capacity (tph)	Load factor (%)	Air ratio@					
			Coal^			Biomass fuel#	Liquid fuel	Gas fuel&
			Pulverised fuel	Fluidized bed*	Others$			
Standardα	> 100	50 – 100	1.16-1.20	1.15-1.18	-	-	-	-
	51 - 100	50 – 100	-	1.15-1.18	1.20-1.25	-	-	-
	11 - 50	50 – 100	-	1.18-1.24	1.24-1.30	1.47-1.55	1.18-1.25	1.12-1.15
	Upto 10	50 – 100	-	1.20-1.25	1.35-1.40	1.49-1.56	1.26-1.33	1.15-1.18
Targetβ	> 100	50 – 100	1.12-1.17	1.10-1.16	-	-	-	-
	51 - 100	50 – 100	-	1.12-1.17	1.17-1.20	-	-	-
	11 - 50	50 – 100	-	1.14-1.18	1.22-1.26	1.32-1.39	1.13-1.18	1.10-1.14
	Upto 10	50 – 100	-	1.15-1.20	1.32-1.38	1.32-1.39	1.18-1.24	1.12-1.15

Source: Boiler operational data

α Standards are optimum performance values achieved by an energy consuming equipment in daily operation.

β Targets are equal to the best achievable values of an energy consuming equipment in daily operation

\+ Combustion of fuels under Standard Temperature and Pressure (STP) conditions is assumed and the effect of parameters, such as variation in fuel compositions, is ignored.

@ Air ratio is defined as the ratio of actual air supplied AAS to theoretical air requirement. The following formula shall be used for calculating air ratio (value rounded to two digits). The air ratio is considered based on a steady state operation at constant load conditions and can be measured and verified at specific measurement points, while maintaining maximum permissible limit for carbon monoxide (CO) level to 200 ppm.

$$\text{Air ratio} = \frac{21}{(21\text{-\% oxygen in flue gases})}$$

^ Air ratio for petcoke is excluded in the EC Guidelines

* Includes (1) Atmospheric Fluidized Bed, (2) Pressurized Fluidized Bed and (3) Circulating Fluidized Bed

$ Except pulverized fuel and fluidized bed

\# Includes use of wood up to 10 tph capacities; bagasse or rice husk firing for other capacities.

& Gaseous fuel covers natural gas (NG) only. Fuels such as by-product gases as produced and used in steel industries are not considered.

Note 1: Gross calorific value (GCV) of fuels

The GCV of different fuels, considering the standard composition of fuels are given below.

- Indian coal – up to 5,000 kcal per kg; Liquid fuels (light diesel oil, high speed diesel and furnace oil) - 10,500 to 10,800 kcal per kg; biomass fuels – 3,100 to 4,500 kcal per kg (source: https:// beeindia.gov.in/sites/ default/files/2Ch1.pdf)
- Bagasse - 2250 kcal per kg
  (source: http://biomasspower.gov.in/document/ regulatory-order/TN)
- Natural gas - 8,500 to 9,000 kcal per SCM (Standard cubic meter) (Source: GAIL India Limited)

Note 2: Load factor of boiler

- Load factor of the boiler used for power generation shall be considered the same as that of connected turbine load factor

Table 6.2 Air ratio for industrial furnaces+

Parameter	Kiln type	Air ratio@		
		Liquid fuel	Gas fuel&	Fuel gas#
Standard	Oil heating (TFH)	1.20-1.27	1.15-1.18	-
	Reheating furnace	1.18-1.23	1.14-1.17	-
	Process fired heater (Refinery)	-	-	1.14-1.31
Target	Oil heating (TFH)	1.18-1.22	1.12-1.15	-
	Reheating furnace	1.15-1.20	1.12-1.15	-
	Process fired heater (Refinery)	-	-	1.11-1.24

Source: Performance data from different industries

\+ Combustion of fuels under the STP conditions is assumed and the effect of parameters such as variation in fuel compositions is ignored.

@ Air Ratio is defined as the ratio of "actual air supplied" (AAS) to theoretical air requirement. The following formula shall be used for calculating the air ratio (value rounded to two digits). The air ratio is considered based on steady state operation at constant load conditions and can be measured and verified at specific measurement points while maintaining maximum permissible limit for carbon monoxide (CO) level to 200 ppm.

$$\text{Air ratio} = \frac{21}{(21\text{-\% oxygen in flue gases})}$$

& Gaseous fuel covers NG only. Fuels such as by-product gases as produced and used in steel industries are not considered.

\# Mix of fuel gases or off-gases with furnace oil or NG per requirements; data provided by Centre for High Technology.

Note 1: GCV of fuels

The GCV of different fuels, considering the standard composition of fuels are given below.

- Liquid fuels (light diesel oil, high speed diesel and furnace oil) - 10,500 to 10,800 kcal per kg; biomass fuels - 3100 to 4500 kcal per kg (source: https:// beeindia.gov.in/sites/ default/files/2Ch1.pdf)
- Natural gas : 8,500 to 9,000 kcal per scm (Source: GAIL India Limited)

7. HEATING, COOLING AND HEAT TRANSFER

The industry may need heating and/or cooling based on the process requirements. The heat load is met either through direct heat transfer or, indirectly, through heat exchange media. The type of heat source would include steam/hot water from a boiler, combustion products/flue gas in a furnace, hot fluid from TFH, etc. The cooling demand in the industry is achieved with the chiller (refrigeration) system and space comfort through heating, ventilation, and air-conditioning (HVAC) system.

7.1 Heating equipment

Standards Components	
(1) Management and control	A. The equipment (boiler, furnace and thermic fluid heater) shall have capacities appropriate for the desired performance. The facilities that use different sources of heat media such as steam, hot water, hot air, etc. (e.g. heating facilities, cooling facilities, dryers, heat exchangers, etc.) shall follow the instructions, which shall be described in the EM Manual. The instructions are related to temperature, pressure, volume, etc. to automatically control and optimize the supply of heat quantity. B. Industrial furnaces used for heating, melting and heat treatment shall be operated to improve the heat pattern in a way that increases thermal efficiency of the equipment which shall be elaborated in the EM Manual. C. The DC shall ensure optimum loading for better utilization of the capacity without over-loading or under-loading. D. In case of the multiple heating equipment operating in parallel, the load sharing for each equipment shall be regulated/ adjusted in such a way that highest level of thermal efficiency may be achieved as a whole, which shall be described in the EM Manual. E. The DC shall optimise the sequencing of material flow to reduce delays and avoid repeated heating of materials. F. Equipment for intermittent or batch operations shall be scheduled in a way that streamlines the entire chain of operation, which shall be described in the EM Manual. G. The DC shall maintain an appropriate quality of feedwater according to Indian Boilers Regulation (IBR), 1950 or an equivalent standard as suggested by the manufacturers which shall be provided in the EM Manual. H. The DC shall close steam flow to the process that is not in operation. I. The DC shall use dry steam in heating processes to enhance heat transfer.
(2) Measurement and recording	A. The DC shall measure and record operating parameters either on-line or periodically to enhance heat transfer which shall be described in the EM Manual. The operating parameters include the temperature of heated or cooled objects, pressure, and flow rates.

(3) Maintenance and inspection	A. Components related to the heat transfer of equipment, such as heat-transfer surfaces of boilers, industrial furnaces, heat exchangers, etc. shall be maintained according to the instructions concerning their maintenance and inspection, which shall be described in the EM Manual. The equipment shall be periodically cleaned to get rid of soot, scale or dirt to avoid deterioration of heat transfer surfaces and heat transfer performance.
(4) Necessary measures when installing new facilities	A. While installing new equipment for heating, the following points shall be considered. a. Use materials with the highest possible thermal conductivity b. Adopt the best possible layout of heat exchangers to improve total efficiency.
Target Components	
	A. The DC shall use higher dryness fraction of steam for better heat transfer. It shall also install an appropriate steam separator or steam trap to maintain the required dryness fraction of steam. B. The DC shall consider using improved properties and shapes of wall surfaces of industrial furnaces to enhance radiation heat transfer. C. The DC shall consider using improved properties and shapes of heat transfer surfaces to enhance the heat transfer coefficient of such surfaces. D. The DC shall use higher thermal conductivity materials for heat exchanging components employed. E. The DC, wherever feasible, shall use direct heating of objects. F. The DC shall consider increasing the number of stages of evaporators in multiple-effect evaporators based on the potential for enhancing the overall thermal efficiency. G. The DC shall consider improving the efficiency of distillation towers by optimizing parameters such as pressure, reflux ratio, vapour recompression, etc. H. The DC shall optimise the number of stages of heat exchangers and their layout for enhancing the thermal efficiency. I. The DC shall explore possibilities of integrating industrial furnaces operated at high temperatures and low temperatures to promote multi-step use of heat for improving the overall efficiency of furnace systems. J. The DC shall use automatic control systems to ensure an effective use of heat energy. K. The DC shall streamline processes that would require repeated heating. L. The DC shall consider including preliminary treatment methods that would help in energy saving. For example, preparatory steps such as removal of moisture content, preheating, and pre-grinding. M. The DC shall install a boiler or an industrial furnace with the highest efficiency that meets the process requirements. N. Heating with vacuum steam media shall be considered as an alternative to hot water media used in heating facilities.

7.2 Air-conditioning Facilities and Hot Water Supply Facilities

Standards Components	
(1) Management and control	A. The DC shall adopt a section-wise air-conditioning system for operating parameters with signficant variations. For example, air conditioning requirement and load will be different for different sections of manufacturing, storage of products (finished or semi-finished), and workplace environment. Details of these instrutions shall be described in the EM Manual and shall include the necessary parameters, such as operational time, set temperature range (lower limit and upper limit), ventillation air per hour, and humidity. B. The DC shall manage the air-conditioning of office buildings to essential zones, reducing loads with potential options such as window shades, wall with low thermal mass, etc., and operate according to the instructions, which shall be described in the EM Manual. The operating instructions shall include operational time, room temperatures, air ventillation per hour, humidity, and the effective use of outdoor air. The utility shall adhere to air cooling and/or heating temperatures as recommeded in the Energy Conservation Building Code (ECBC). C. The air-conditioning system that includes heat source utilities, heat transport utilities, and air-conditioner utilities shall be controlled in a synchroized manner to improve the overall energy efficiency, which shall be described in the EM Manual. The DC shall attempt to improve by modifying operational parameters without compromising the system performance. Some of the key operational parameters, such as cooling water temperatures, chilled/hot water temperatures, and seasonal variations in outdoor air conditions shall be considered. D. Air-conditioning utilities with one or more heat sources using either similar or different energy sources shall be operated in a manner to achieve improvement in overall energy efficiency of the air conditioning system. The EM Manual shall elaborate on better operating practices for such arrangements. The overall improvement shall be established by opting the optimum number of heat source utilities in service, considering the variations in outdoor air conditions and heat load fluctuations. E. If the heat transport equipment includes more than one pump, the utility shall be managed to achieve improvement in energy efficiency and shall be described in the EM Manual. The DC shall use options such as auto controls to switch off pumps or change (increase or decrease) the speed according to the load variations by integrating with variable frequency drives (VFDs). F. In an air conditioner equipment, having more than one air conditioning equipment of the same model or more than one air conditioner of different types, the utility shall be managed in such a way that it achieves improvement in the overall energy efficiency of the air-conditioner equipment, which shall be described in the EM Manual. G. Efficiency of hot water supply equipment shall be enhanced by reducing supply points with seasonal changes and load requirement in processes as described in the EM Manual. The instructions in the EM Manual shall focus on output parameters such as temperature and pressure. H. Heat source equipment and the associated auxiliary equipment (e.g. burner and water pump) shall be operated, monitored and automatically controlled in response to load fluctuations, which shall be described in the EM Manual. I. If multipe heat-source equipment are provided in heat-source utility for hot-water-supply system, the utility shall be managed in such a way that it improves the overall energy efficiency of the heat-source utilities, which shall be described in the EM Manual. The improvement shall be achieved through adjusting (increasing or decreasing) the numbers of units in operation based on the process load conditions.

(2) Measurement and recording	A. The DC shall monitor and record parameters (e.g. temperature, and humidity) to keep track of air-conditioning in different sections of the industry. The DC shall use online monitors or hand-hold instruments for this purpose, which shall be described in the EM Manual. B. Parameters necessary to improve the efficiency of the overall HVAC system (that include heat source equipment, heat transportation equipment and air conditioner equipment) shall be periodically measured and/or recorded which shall be described in the EM Manual. C. Parameters necessary to improve the efficiency of hot water supply shall be measured and recorded periodically (e.g. quantity, feed water temperature and hot water supply temperature), which shall be described in the EM Manual.
(3) Maintenance and inspection	A. The DC shall undertake periodical inspection and maintenance of air-conditioning equipment to maintain good operating conditions which shall be described in the EM Manual. The improvement shall include both the equipment level and HVAC system level to achieve the overall energy efficiency. B. The DC shall maintain and inspect periodically hot-water supply equipment to keep them in good conditions according to the instructions provided on maintenance and inspection, which shall be described in the EM Manual. C. Automatic control systems or devices used in air conditioning and hot water supply equipment shall be maintained and inspected periodically in order to keep them in a good condition, which shall be described in the EM Manual.
(4) Necessary measures when installing new facilities	A. Air-conditioning equipment While installing a new air conditioning utility, the DC shall ensure the following: a. Select a suitable utility that is capable of responding to changes in heat demands. The DC shall consider installing a dedicated control system for each section of air conditioning to ensure better control. b. The DC shall install a high efficiency system within heat source utility (e.g. heat pumps) as well as heat transport utility of integrated air-conditioning system to accommodate fluctuating load demands. It shall be equipped with split control, flow control, storage system, etc. The heat transport system shall use variable pump head control for efficient operation. c. The DC shall use variable air-volume and flow-rate systems with speed control to respond to load variations. d. The DC shall introduce suitable heat exchanger for reducing air cooling/ heating loads. For example, the DC shall consider options such as outdoor air cooling during winter season and water humidification to reduce air cooling loads. e. The DC shall avoid direct discharge of exhaust heat from production systems close to air-conditioning section to avoid increase in air-conditioning loads. f. The DC shall minimize air-conditioning loads by installing a local air-conditioning system around workers or radiant heating in case the air conditioning of the entire workplace is not essential. g. The DC shall avoid ingression of hot air or exgression of conditioned air by closing gaps and openings as much as possible to reduce the air-conditioning load. h. The location and process of installing an outdoor unit of an air-conditioner should be determined based on both solar radiation and ventilation condition of the installation location, in case the units are installed closely together, which shall be described in EM Manual. i. The air conditioning utility shall be equipped with suitable control and measurement devices to manage operations on its own. The controlling parameters include temperature and humidity of the different sections of air-conditioning. B. Hot water supply equipment The DC shall evaluate load assessment of hot water requirements to select suitable hot water supply utility to achieve overall energy efficiency. It shall consider following before undertaking installation of a new utility. a. Select compatible technology that responds efficiently to load variations. b. Install a dedicated hot water supply system to cater to sections with lower loads. c. Explore use of 'heat pump system' and/or a latent heat recovery system for heat source equipment.

Target Components	
	A. Air conditioning equipment The DC shall focus on the following aspects to ensure efficient use of energy in air-conditioning utility. a. For only air conditioning, the DC shall use heat source equipment with high energy efficiency, such as heat pump and storage system and gas cooling or heating system. For simultaneous air cooling and heating loads within the plant, the DC shall consider using a heat recovery system. Further, in case of the availability of a potential exhaust heat, the use of a heat recovery system, e.g. heat pump and exhaust-heat-driven heat source equipment shall also be considered. b. The DC shall improve thermal insulation of walls and roofs for the air-conditioned areas. It shall include higher thickness of walls and roofs, low thermal conductivity materials, and double-layer thermal insulation. It shall further consider reducing external heat sources through shielding solar radiation through windows using window shades, heat reflecting glasses, heat shield window films and thermal buffer zone with double insulation structure. c. The air-conditioning utility shall be equipped with a carbon dioxide sensor or a similar type of device to minimize the outdoor air-handling load. It shall consider the cooling of air with water from cooling towers during the winter season. d. The air-conditioning utility shall minimize air flow volume and circulation water volume by setting a large temperature difference in the utility. e. The DC shall insulate pipes and ducts to reduce heat losses. B. Hot water supply equipment The DC shall examine the following to enhance the energy efficiency in hot water-supply systems. a. Use of a heat pump or latent heat-recovery system to enhance the efficiency of hot water-supply utilities. b. Use of alternate systems to reduce power consumption in the ventilation system in the workplace, machine rooms, and electric rooms. For example, the air volume controller with suitable sensors.

8. WASTE HEAT RECOVERY AND USAGE

The WHR system is employed to recover and reuse sensible heat available in hot streams, such as exhaust gases from boilers, furnaces, gas turbines, diesel generator (DG) sets, etc. WHRs are used in various applications depending on the quantum of recoverable heat available for extraction. Some of the applications include a WHR boiler, air pre-heater, charge/scrap pre-heating, economiser, etc.

Standards Components	
(1) Management and control	A. Recovery and reuse of waste heat from flue gases for different types of utilities (gas turbine, gas engine, diesel engine, boiler, industrial furnace, TFH, etc.) shall be managed according to the instructions concerning waste gas temperatures or the WHR rates as described in the EM Manual. B. Recovery and reuse of waste heat in condensate return shall be managed according to the instructions concerning parameters, such as the quantity of condensate, temperature, etc., as described in the EM Manual. C. Recovery of sensible heat, latent heat, etc., as available from various sources (gas turbine, gas engine, diesel engine, boiler, industrial furnace, TFH, etc.) shall be managed according to the instructions concerning the rate of recovery as described in the EM Manual. D. Waste heat from exhaust gases shall be utilized suitably according to temperature conditions (e.g. preheating temperature) and operating conditions of equipment.
(2) Measurement and recording	A. The parameters concerning waste heat and its utilization in each utility shall be measured and recorded. These include temperature of waste heat, quantity of waste heat medium and composition, etc. which shall be monitored periodically and the data shall be recorded according to the instructions described in the EM Manual.
(3) Maintenance and inspection	A. Systems such as heat exchangers and waste heat boilers (hereafter, "WHR equipment") shall be periodically maintained and regularly inspected according to the instructions mentioned in the EM Manual.
(4) Necessary measures when installing new facilities	A. The DC shall employ adequate measures while installing a new pipe or system towards the transportation of waste heat with a minimum temperature drop. These measures include preventing air intrusion, enhancing thermal insulation, etc. B. The exhaust gas temperature of boiler shall be reduced by recovering sensible heat by installing waste heat recovery equipment or retrofitting the existing waste heat recovery system considering the reference values as specified in table 8.1. C. The exhaust gas temperature of the industrial furnace shall be reduced by recovering sensible heat by installing a WHR or retrofitting existing waste heat recovery system considering the reference values as specified in table 8.2. D. The DC shall undertake appropriate actions to maximize waste heat recovery while installing a new WHR utility. The actions shall include selection and use of materials with improved properties, shapes and areas of heat transfer (e.g. finned surfaces). E. The DC shall install on-line instrumentation to monitor the temperature of exhaust gases and the waste heat recovery media. F. The DC shall include suitable cleaning systems for the WHR facilities/ heat exchangers to avoid scale formation and to ensure optimum heat transfer as per instructions provided in the EM Manual.

Target Components	
	A. The DC shall put in efforts towards efficient heat recovery from various feasible waste heat sources (gas turbine, gas engine, diesel engine, TFH, etc.), taking into account the type of fluid (e.g. contaminated fluid, corrosive fluid, etc.) so that the waste streams are exhausted at minimum possible temperatures. B. The flue gas temperature of the boiler shall be reduced by recovering sensible heat in the exhaust gases by appropriate measures and methods either on the existing system or installing a new system considering the reference values as specified in table 8.1. C. The flue gas temperature of an industrial furnace shall be reduced by recovering sensible heat in exhaust gases using appropriate WHR either on the existing system or by installing a new system considering the reference values as specified in table 8.2. D. The DC shall also consider other measures for improving overall waste heat recovery. These include an appropriate sizing of duct or pipe, suitable layout, avoidance of leakage, use of efficient insulation materials, regular maintenance, and use of temperature recording systems both at source and usage points. E. The DC shall enhance the WHR system by considering use of materials with better properties, shapes (e.g. fins), and areas of heat transfer. The utility shall also install heat storage facilities. It shall further enhance the recovery of waste heat through by considering new technology options, such as Organic-Rankine Cycle (ORC), vapour absorption systems, etc.

Table 8.1 Flue gas temperature of boilers

Parameter	Boiler capacity (tph)	Flue gas temperature[@]					
		Coal			Biomass fuel[#]	Liquid fuel[+]	Gas fuel[&]
		Pulverised fuel	Fluidized bed[*]	Others[$]			
Standard	> 100	140	140	-	-	-	-
	51 - 100	-	140	140	-	-	-
	11 - 50	-	140	140	180	190	140
	Upto 10	-	220	220	220	220	220
Target	> 100	130	130	-	-	-	-
	51 - 100	-	130	130	-	-	-
	11 - 50	-	130	130	160	180	130
	Upto 10	-	200	200	200	200	220

Source: Boiler performance data from different plants

@ Average temperature at the outlet of the final stage of heat recovery from flue gas or chimney base

* (1) Atmospheric fluidised bed, (2) pressurised fluidised bed and (3) circulating fluidised bed

$ Except pulverized fuel and fluidized bed

Includes wood, briquette, rice husk, bagasse, etc.

\+ Liquid fuels includes light diesel oil, high speed diesel and furnace oil

& Gaseous fuel covers natural gas (NG) only

Table 8.2 Waste heat recovery for industrial furnaces

Exhaust gas temperature (°C)	Standard[α] waste heat recovery rate (%)	Target[β] waste heat recovery rate (%)	Flue gas temperature[#] (°C)
Upto 600	30	38	250-300
600-1000	42	52	200-300
More than 1000	47	56	200-300

Source: Based on data from different industries

α Estimated heat drop based on the upper limit of gas temperatures and net heat transfer with 60% efficiency for heat exchanger

β Estimated heat drop based on the lower limit of gas temperatures and net heat transfer with 65% efficiency for heat exchanger

considering the natural draft systems for higher flue gas temperature and induced draft system for lower temperatures

- The waste heat recovery rate is the ratio of the heat recovered to the sensible heat available in flue gases under rated load operation
- The following formula shall be used for calculating the waste heat recovery rate

$$\text{Waste heat recovery rate (\%)} = \frac{\text{(Exhaust gas temperature-Flue gas temperatue)}}{\text{(Exhaust gas temperature)}} \text{ X } 100$$

Where, temperatures are measured in °C

9. CONVERSION OF HEAT TO ELECTRICITY

The thermal power plants use solid, liquid, and gaseous fuels for generating electricity. The generated electricity is either supplied to the grid or used as captive power. The power generation may be based on steam turbine, gas turbine, diesel engine, gas engine, etc.

9.1 Power-generation Utilities

Standards Components	
(1) Management and control	A. A thermal power plant, which is used either for public distribution or dedicated captive power generation utility, shall be operated efficiently, which shall be described in the EM Manual. Further, multiple power-generation facilities operating in parallel shall be managed to ensure a proper load distribution within the utilities and improve thr overall efficiency which shall be described in the EM Manual. B. The power generation plant shall take into consideration typical characteristics of each generation utility for determining load distribution while ensuring an overall efficient operation.
(2) Measurement and recording	A. The DC shall periodically measure the overall performance of power generation utility and shall record the results according to the instructions, which shall be described in the EM Manual.
(3) Maintenance and inspection	A. The DC shall be periodically inspected and maintained to ensure a trouble-free and smooth operation and achieve the highest possible energy efficiency. Details of maintenance and inspection shall be described in the EM Manual.
(4) Necessary measures when installing new facilities	A. The DC shall select and install a new power-generation utility of optimum capacity taking into account the existing power requirements and considering the future trends of power demands for captive power generation. B. The design net heat rate of the newly installed power-generating utility at the receiving end shall not be significantly higher than the average level of the existing thermal power generation utilities.
Target Components	
	A. The DC shall install state-of-the-art on-line measurements and recording equipment to measure and control key operating parameters.

9.2 Cogeneration Utilities

Standards Components	
(1) Management and control	A. The DC shall manage and operate equipment used in cogenertaion facilities (e.g. boilers, gas turbines, steam turbines, gas engines, and diesel engines) to achieve optimum energy efficiency under variable load conditions, which shall be described in the EM Manual. B. The DC shall take into account characteritics of different facilities to determine an optimum load distribution to respond to load variations for achieving the highest energy efficiency. C. For cogeneration utilities with back pressure or extraction-type turbines, the industry shall control minimum allowable values of back pressure or bleeder pressure according to the instructions concerning the values, which shall be described in the EM Manual.
(2) Measurement and recording	A. The key parameters that influence the overall efficiency of equipment (e.g. boilers, gas turbines, steam turbines, gas engines, and diesel engines) shall be periodically measured and recorded according to the instructions concerning measurements and records of such parameters, which shall be described in the EM Manual. B. In case of cogeneration utilities operated under low pressure, which is close to the minimum allowable limit for back pressure or extraction turbine, the facilities shall periodically measure and record the operating parameters, which shall be described in the EM Manual. These key parameters, which shall be measured and recorded, include operational time, inlet/outlet pressure, back or extraction pressure, and quantity of steam used, etc.
(3) Maintenance and inspection	A. Cogeneration utilities shall be periodically maintained and inspected in a way that maintains the highest level of overall efficiency, which shall be described in the EM Manual.
(4) Necessary measures when installing new facilities	A. The DC shall thoroughly analyse the actual use and future trends of heat and power demands and the availability of exhaust heat while selecting and installing a new cogeneration utility of optimum capacity. Historical data recorded for a period of one year or more shall be used for this purpose.
Target Components	
	A. The DC shall consider installing new cogeneration utility in case of large quantity of steam/ hot water demand and the continuous availability of exhaust heat throughout the year. B. The DC shall explore modifying the existing operating conditions of extraction/ back pressure turbine if it helps in improving the overall performance of the utility while ensuring the services.

10. PREVENTION OF ENERGY LOSS DUE TO HEAT RADIATION AND ELECTRIC RESISTANCE

Thermal energy and electrical energy are commonly used in various industrial processes. Radiation loss takes place in high temperature zones, which is controlled by better insulation on the surface and reducing openings. Electrical losses occur in various distribution lines connecting electrical utilities, such as resistance heating systems, cables, transformers, motors, etc.

10.1 Prevention of Heat Loss Due To Radiation and Conduction

Standards Components	
(1) Management and control	A. The DC shall undertake thermal insulation work on different systems such as steam and condensate pipes, ducts, equipment, etc., which are used for transporting heat media, process fluid for heating, etc. (hereafter, "heat-using equipment") according to the industrial standard practices for thermal insulation works and equivalent standards. B. The existing industrial furnaces shall be thermally insulated to improve the insulation performance to maintain external surface temperature based on the standard value as listed in table 10.1. The external surface temperature for the boiler shall be maintained as per Note (2) provided in table 10.1.
(2) Measurement and recording	A. The DC shall periodically measure all key parameters of surfaces to keep track and reduce heat losses. These parameters include the temperature of external surfaces of furnace, heated object temperature, mass of the object and waste gas temperature, etc. The results shall be analysed, heat losses shall be quantified, and the heat balance shall be prepared, which shall be described in the EM Manual.
(3) Maintenance and inspection	A. Heat-using equipment shall be periodically inspected to maintain proper insulation to reduce heat losses according to the instructions concerning maintenance and inspection of the measures (e.g. insulation work), which shall be described in the EM Manual. B. Steam traps shall be periodically maintained and inspected to prevent steam leaks and clogging caused by the malfunctioning of traps. The maintenance and inspection of the steam traps shall be detailed in the EM Manual.
(4) Necessary measures when installing new facilities	A. While installing a new heat-using utility, actions to improve thermal insulation shall be undertaken. These include employing optimum thickness of insulation, selecting low thermal conductivity material, multi-layer insulation, etc. B. The DC shall minimize heat losses through radiation and air ingression by adopting suitable measures. These include minimum openings, proper sealing, double doors, air curtains, etc. C. The DC shall reduce the heat radiation area by transporting heat media through a streamlined pipe route. D. For a batch operated furnace with an operating temperature more than 1000°C, the utility shall apply veneering on interior surfaces.

Target Components	
	A. The DC shall examine the potential measures such as low thermal mass furniture and better insulation for bodies, bases, fixtures, and equipment used in handling hot materials to minimize heat losses. It includes boilers, furnaces, steam system, condensate recovery system, etc. B. The industrial furnace shall be provided with optimum insulation using compatible material to reduce heat losses from the surfaces. The surface temperature of an industrial furnace shall be maintained as specified in table 10.1 as the target value. C. For batch type furnaces operating with an internal temperature of more than 600°C, the utility shall consider insulation based on the temperatures listed in table 10.1 as the target value. D. The DC shall examine various measures to improve thermal insulation of heat-using facilities. These shall include higher thickness of insulation, selecting low thermal conductivity insulating materials, veneering on internal surfaces, etc. E. The DC shall minimize heat losses through dissipation and air leakage by adopting appropriate measures. These measures include reduced openings, improved sealing, double doors, air curtains, etc. F. The DC shall examine the existing thermal sealing and undertake measures in heat-using facilities to prevent leakage of heat media from locations like rotating parts, joints, etc. G. The DC shall also examine use of improved streamlined pipe route for transporting heat media to reduce heat radiations. H. The DC shall examine methods such as covering of open-type facilities, steam-using facilities and transport facilities which use high-temperature materials to reduce heat losses, except in cases wherein it is required to cool the facilities while transportation.

Table 10.1 Surface temperatures of industrial furnace

Parameter	Furnace design temperature (°C)	Surface temperature (°C)#		
		Ceiling	Side wall	Bottom*
Standard	Up to 600	80	70	75
	600-1,000	100	90	100
	More than 1,000	120	100	120
Target	Up to 600	60	60	60
	600-1,000	90	75	85
	More than 1,000	110	85	100

Source: Based on data from different industries

\# Indicates average skin temperature under steady state operation

* Indicates bottom surfaces not in contact with ground but with open air

Note 1: The surface temperatures of rotary kilns in cement industries are generally observed to be higher than the range provided in the table, which are not included separately in the guidelines.

Note 2: The surface temperatures of a boiler shall be maintained at about 15 to 20 oC above ambient temperature.

10.2 Prevention of Electricity Loss Due To Electric Resistance

Standards Components	
(1) Management and control	A. The DC shall manage and operate electrical systems such as transformers and uninterruptible power supply systems to achieve the highest efficiency and minimise energy losses, which shall be described in the EM Manual. It shall ensure efficient operation even during part-load conditions. The DC shall further adjust the number of units (transformers or uninterruptible power supply systems) in operation for optimum load allocation as per power requirements of various sections. B. The DC shall undertake actions to reduce distribution losses in power-receiving and transforming utilities. These actions shall include shorter distribution lines, proper current-carrying capacity of conductors, and an appropriate distribution voltage, etc., which shall be described in the EM Manual. C. Operating practices to control starting or stopping of capacitors in line with the operation of the equipment in which they are installed shall be described in the EM Manual. D. The DC shall distribute single-phase loads in such a way that there is no current imbalance in the three-phase distribution system, which shall be described in EM Manual. E. The utility shall be equipped with phase-protection relay/ single phasing preventer to avoid motor burn outs. F. The equipment that use electricity (hereafter, electricity-using utility') shall be managed and controlled according to the instructions concerning standard operating practices of the utility, which shall be described in the EM Manual. G. The DC shall manage and control current flow to electricity-using facilities to minimise electrical losses which shall be described in the EM Manual.
(2) Measurement and recording	A. The DC shall periodically measure and record parameters that are required to reduce electricity losses, which shall be described in the EM Manual. Some of the parameters shall include electricity consumption and voltage, current and power factor in power-receiving and transforming equipment etc.
(3) Maintenance and inspection	A. The DC shall undertake preventive maintenance and routine inspection of electrical equipment (power-receiving and transforming equipment, and power distribution equipment), which shall be described in the EM Manual.
(4) Necessary measures when installing new facilities	A. While installing new equipment for power-receiving and distribution equipment, the DC shall select suitable capacity and high efficient equipment to achieve the overall energy efficiency.
Target Components	
	A. The DC shall examine the improvements of the power factor at the receiving end by installing measures, such as automatic power factor controller, capacitor banks, etc., in the distribution facilities as shown as the target value in Table 10.2. B. The DC shall install advanced management systems such as Supervisory Control and Data Acquisition (SCADA), which shall be integrated with each of the electricity-using utility towards automatic monitoring and recording of all key operating parameters.

Table 10.2 Target power factor

Load type	Target power factor
Induction motor#	0.95
Distribution system	0.99
Induction furnace*	0.95
Welding machine	0.90 and above
DC drives	0.90 and above
Fluorescent lamp	0.95 and above

Source: Improving motor and drive system performance- A Sourcebook for industry

Power factor is measured after the correction system

* Capacitors are usually included with induction furnaces

11. CONVERSION OF ELECTRICITY TO MOTIVE POWER, HEAT AND LIGHT

Electric motors are widely used in industries for various loads, such as fans, blowers, pumps, compressors, conveyors, etc. A wide range of capacities of motors are used for these applications. Further, electricity is used for heating and melting applications in furnaces and various types of industrial lighting.

11.1 Facilities Using Motors and Heaters

Standards Components	
(1) Management and control	A. The DC shall stop motor driven equipment when not in use or during idle operation, which shall be described in the EM Manual. It shall take into account the energy losses during idle run period versus energy consumption during intitial start-up. B. Parallel operation of multiple motors shall be managed in a way to achieve high efficiency of the motors as a whole, which shall be described in the EM Manual. Suitable load allocation during parallel operation of multiple motors shall be implemented during partial load conditions to maintain higher efficiency under varying load conditions. C. The DC shall review the current use, end pressure and discharge rate of fluid machines (e.g. pumps, fans, blowers, compressors, etc.), and manage to reduce the load of the connected electric motors according to the instructions which shall be described in the EM Manual. The instructions may include the number of operating units, speed reduction, pipe layout and dimensions, impeller size, etc., to cater to the variable load conditions. D. The DC shall adopt measures in electric heating utilities (e.g. induction furnaces, arc furnaces, and resistance furnaces) to enhance the efficiency, which shall be provided in the EM Manual. The measures include loading pattern, reducing idle operation, better insulation, installation of the WHR system, etc., as applicable. E. The electrolytic facilities shall use electrodes of a suitable size, shape, and characteristics, and shall be managed to attain high efficiency, which shall be described in the EM Manual. The instructions include distance between electrodes, concentration of electrolytes, and contact resistance of conductors. F. The DC shall manage use of electricity in different types of electricity-using utilities (e.g. motor driven utilities, electric heating utilities, etc.) with a view to reduce electrical losses (e.g. voltage or current losses), which shall be described in the EM Manual.
(2) Measurement and recording	A. The DC shall measure such parameters of electricity-using equipment and record the results which will be necessary to reduce electrical losses, which shall be described in the EM Manual.
(3) Maintenance and inspection	A. The motor-driven equipment shall be periodically inspected and maintained to reduce mechanical losses occurring in electric motors, power transmission units, and machines that apply loads to the motors, which shall be described in the EM Manual. B. The motor-driven utility shall be periodically inspected and maintained for different fluid machines (e.g. pumps, fans, blowers, and compressors) to prevent leakages and reduce resistance of pipes and ducts, which shall be described in the EM Manual. C. The DC shall reduce electric resistance losses in electric-heating equipment and electrolytic equipment through periodic maintenance and inspection of wire connections, contacts of switch, etc. which shall be described in the EM Manual.

(4) Necessary measures when installing new facilities	A. The DC shall install and use efficient motors of suitable sizes as provided in table 11.1. B. The DC shall install motors with compatible configurations to meet applications with large fluctuations of loads.
Target Components	
	A. The DC shall install and use high-energy, efficient motors as provided in Table 11.1. B. The industry shall install energy-saving measures such as VFD in a motor-applied utility with large load fluctuations. C. The DC shall examine different heating methods (combustion of fuel, steam, hot air, thermic fluids, electric heating, etc.) for the selection of electric heating. It shall consider parameters, such as heat load, temperature range and energy costs for comparison.

Table 11.1 Energy efficiencies of IE3 motors

Rating (Kw)	Efficiency (%)		
	2-Pole	4-Pole	6-Pole
0.37	75.5	73.0	71.9
0.55	78.1	78.0	75.9
0.75	80.7	82.5	78.9
1.1	82.7	84.1	81.0
1.5	84.2	85.3	82.5
2.2	85.9	86.7	84.3
3.7	87.8	88.4	86.5
5.5	89.2	89.6	88.0
7.5	90.1	90.4	89.1
11	91.2	91.4	90.3
15	91.9	92.1	91.2
18.5	92.4	92.6	91.7
22	92.7	93.0	92.2
30	93.3	93.6	92.9
37	93.7	93.9	93.3
45	94.0	94.2	93.7
55	94.3	94.6	94.1
75	94.7	95.0	94.6
90	95.0	95.2	94.9
110	95.2	95.4	95.1
125	95.3	95.5	95.2
132	95.4	95.6	95.4
160	95.6	95.8	95.6
200	95.8	96.0	95.8
250	95.8	96.0	95.8
315	95.8	96.0	95.8

Source: Is 12615:2011 (three-phase, 50Hz, single-speed and squirrel-cage induction motors)
Note: IE3 motors stand for premium efficiency level; however, high tension and direct current motors are excluded in the table.

11.2 Pumps and Pumping System

Pumps are used for a wide range of applications to transfer fluids through mechanical action. According to the basic operating principle, pumps can be classified as either dynamic pumps or positive displacement pumps. Dynamic pumps are further classified into centrifugal pumps and special-effect pumps. Positive displacement pumps are classified into rotary pumps and reciprocating pumps. Centrifugal pumps account for the major share of electricity consumption in the industrial sector. Some of the centrifugal pumps used by the industry include: (1) mono-block pumps, (2) end-suction pumps, (3) split-case pumps, and (4) multistage pumps. The guideline covers centrifugal pumps, boiler feed water pumps (BFP), and vertical turbine pumps.

Standard Components	
(1) Management and control	A. The DC shall use 'characteristic curves' provided by the manufacturer for the monitoring and control of pump operation. The pump(s) shall be operated close to 'Best Operating Point' (BOP) as specified by the pump manufacturer. B. The DC shall use pumps with highest efficiency to meet the base load when multiple pumps are in operation. C. In case of the DC using multi-pumps, it shall manage and control the loading of pump in such a way that it achieves the highest possible loading near the BOP in respective characteristic curve. D. The DC shall ensure optimum loading of pumps during the entire range of operation both during full load or part load while operating multiple pumps in parallel, which shall be provided in the EM Manual. E. The DC shall manage the piping network of the pumping system and the control operating parameters, such as flow rate, pressure, and temperature, which shall be provided in the EM Manual. F. The DC shall maintain a minimum Net Positive Suction Head (NPSH) of pumps as prescribed by the manufacturer.
(2) Measurement and recording	A. The DC shall measure and record key operating parameters such as the total differential head, flow rate and power consumption to evaluate efficiency of pumps which shall be described in EM Manual. It shall use on-line monitoring for centralized large system and periodical measurement for decentralised smaller pumps.
(3) Maintenance and inspection	A. The DC shall undertake routine/scheduled overhauling of pumps according to the instructions provided by the manufacturers, which shall be described in the EM Manual. B. The DC shall maintain and inspect parameters, such as speed of motor, body temperature in pump ends, and vibration on a periodical basis, which shall be described in the EM Manual. C. The DC shall undertake corrective maintenance in case of a significant drop in the total differential head observed in the pumping system. D. The DC shall ensure a dynamic balancing of pump assembly after each overhauling.
(4) Necessary measures when installing new facilities	A. The DC shall select correct capacity of pump with energy efficient systems such as IE3 motor or permanent magnet synchronous motor, variable frequency drives (VFD), cogged v-belts for belt driven systems, etc., while considering existing demand and immediate future expansion plans. B. The DC shall undertake water balance of the plant to assess the total pumping capacity. C. The DC shall undertake the dynamic balancing of pump assembly during installation. D. The DC shall optimize the number of stages available in a multi-stage pump (e.g. boiler feedwater pump) in case of availability of the head margins. E. The DC shall design and install a pumping network with minimum system resistance using seamless pipes, which shall be described in the EM Manual. F. The DC shall use a booster for small loads requiring higher pressures.
Target Components	
	A. The DC shall select and install most efficient pumps while matching the BOP with system parameters, considering both the existing requirements and the immediate expansion plans. B. The DC shall install a proper size of suction valve as recommended by the manufacturers. C. The DC shall further include measures, such as correct sizing, seamless or fibre-reinforced plastic (FRP) pipe, better layout, plugging off leakages, application of improved insulation (hot and cold media), and the regular maintenance and installation of the appropriate measurement systems for pressure and flow, both at the source and points of usage.

11.3 Air Compressors and Compressed Air Network

Air compressors are used in industries for a variety of applications to meet process requirements, operate pneumatic tools and meet instrumentation needs. These are mechanical devices used to compress and pressurize air. The centralised compressor air network consists of compressor(s), filter, after cooler, dryer, intelligent electronic control system, receiver tank (s), distribution piping, air cylinder, nozzle, ejector, etc. The pressurized air is transferred to various points of usage either directly or through receiver tanks. The compressors can be classified into (1) positive displacement compressor and (2) dynamic compressor.

Standard Components	
(1) Management and control	A. The DC shall ensure the drawing of clean, cool, and dry air by compressors for optimum performance. It shall manage and control operations as per the instructions provided in the EM Manual in the compressed air system. B. The DC shall use a suitable size of air compressors to meet the plant demands. C. The DC shall pre-set a minimum possible generation pressure to optimise system performance, which shall be explained in the EM Manual. D. The DC shall install receiver tanks with sufficient capacities for storing compressed air to cater to load demands and fluctuations. E. The DC shall use dedicated air compressors to meet exclusive high- or low-pressure demands. F. In case of operation of multiple air compressors, the DC shall use the most efficient compressors to meet the base load.
(2) Measurement and recording	A. The DC shall undertake an on-line monitoring of pressure and air flow at the downstream of compressor and the power consumption of individual compressors to assess the performance, i.e. Specific Power Consumption (SPC) which shall be described in the EM Manual.
(3) Maintenance and inspection	A. The DC shall inspect and clean air filters on a weekly basis. The replacement of air filters shall be based on suction air conditions. B. The DC shall undertake an overhauling of air compressors on a periodical basis, as is recommended by the manufacturer. C. The DC shall avoid moisture carryover by compressed air. It shall drain the moisture accumulated on a regular basis. D. The DC shall conduct leakage tests and plug off the compressed air leakages, which shall be described in the EM Manual.
(4) Necessary measures when installing new facilities	A. The DC shall undertake demand assessments of compressed air to select a suitable compressed air system based on the existing requirements as well as considering the immediate expansion plans. This includes energy-efficient systems, such as a inbuilt VFD, motor with permanent magnet, inverter type air compressor, etc. B. The DC shall select and install air compressors with the lowest SPC while meeting the compressed air demands. C. The DC shall install air compressor in a direction that a hermetically closed room or intake of contaminated air (oil, gas, etc.) is avoided. D. The DC shall design and install a compressed air network with a minimum pressure drop. It shall use seamless metallic pipes or 'fibre reinforced plastic' (FRP) pipe for compressed air lines, which shall be described in the EM Manual. E. The DC shall install intelligent electronic control systems to minimise energy consumption and reduce loss of compressed air. It shall also include an auto-drain system for moisture removal. F. The DC shall locate air compressors in such a way that it reduces the piping length and minimises line-pressure losses. G. The DC shall meet fluctuations in compressed air demands using VFD-enabled screw air compressors. In case of a multiple air compressors system, the DC shall use one-inverter type air compressor with a suitable pressure setting to meet the variable load conditions while the other air compressors shall be used in continuous operation to cater to the base load. H. The DC shall use centrifugal compressors for meeting a high volume with low pressure applications, wherever feasible. I. The DC shall install air dryers in the distribution line which supplies to dry air usage points only, e.g. instrumentation air. J. The DC shall ensure the proper location of air compressors and the quality of suction air as per the recommendation of the manufacturers, which shall be described in the EM Manual.

Target Components	
	A. The DC shall undertake demand assessment of compressed air at plant level to select and install a suitable compressed air system. B. The DC shall avoid installing oversized air compressors, which may lead to inefficiencies. C. The DC shall undertake the necessary measures such that the overall leakage from the compressed air network shall remain less than 10% of the total compressed air generation. D. The DC shall optimise a compressed air system using a ring-frame network and avoiding unnecessary bends, redundant pipes, valves, etc.

$$\text{Specific power consumption (SPC)} = \frac{\text{Actual power consumption (kW)}}{\text{Free air discharge (Nm}^3\text{/minute)}}$$

$$\text{Leakage rate (\%)} = \frac{\text{Onload time (sec)}}{\text{Onload time (sec) time+off load time (sec)}} \times 100$$

11.4 Fans and Blowers

Industrial fan and blower systems are employed to generate low-pressure air volumes or gases for transferring against the system resistance caused due to ducts, dampers, or other components. Such systems are used for different applications to transfer air through mechanical action. Based on the operating principle, fans are grouped in two categories, namely, (1) centrifugal fans and (2) axial flow fans. Similarly, industrial blowers are grouped into (1) centrifugal blowers and (2) positive displacement blowers. The selection of a fan or blower depends on the various process requirements, such as air volume, system resistance, output pressure, and working environment.

Standard Components	
(1) Management and control	A. The DC shall use 'characteristic curves' provided by the manufacturer for managing and controlling operations of fans and blowers. It shall operate fans/blowers close to 'best operating point' (BOP) of the characteristic curve, which is the intersection of fan curve and system resistance curve. B. If a DC has multiple blowers, it shall use the blowers in series for high resistance, and in parallel connection for low resistance system. C. The DC shall operate more fans in parallel instead of a single large fan for higher volume requirements.
(2) Measurement and recording	A. The DC shall measure and record key operating parameters such as pressure, temperature, air velocity and power input to assess specific energy consumption (SEC), which shall be described in EM Manual. The DC shall use on-line monitoring for centralized large system and periodical measurement for decentralised smaller blowers.
(3) Maintenance and inspection	A. The DC shall undertake a routine overhauling of fans and blowers according to the instructions provided by the manufacturers, which shall be described in the EM Manual. It shall ensure a dynamic balancing of fans/ blowers assembly after each overhauling. B. The DC shall maintain and inspect parameters, such as the motor speed and vibration on a periodical basis, which shall be described in the EM Manual. C. The DC shall ensure an allowable impeller inlet seal clearances that include axial overlap, radial clearance, back plate clearance, and labyrinth seal clearance. It would further ensure a 'full-open' and 'full-close- conditions of inlet damper positioning for the efficient operation of fans/ blowers. D. The DC shall conduct a periodical inspection for leakages and plug off leakages in distribution lines, which shall be described in the EM Manual. E. The DC shall undertake corrective maintenance in case of a significant drop in pressure head observed in the system.

(4) Necessary measures when installing new facilities	A. The DC shall select and install correct capacity of fan/blower with highest efficiency considering existing requirements, immediate expansion plans, plant layout and routing of pipes as provided in table 11.2. B. The DC shall ensure dynamic balancing of fan/ blower assembly while installing a new system. C. The DC shall use a booster for small loads requiring higher pressures. D. The DC shall undertake demand assessment of air to select suitable fan or blower as applicable, while considering the dust type, its concentration, etc., while handling dust-laden gases. E. The DC shall select fan or blower with energy efficient systems such as IE3/ permanent magnet synchronous motor, VFD, etc., to maintain optimum performance. F. The DC shall install fans and blower in a direction that a hermetically closed room or intake of contaminated air (oil, gas, etc.) is avoided. G. The DC shall design and install fans and blowers network with a minimum system resistance using seamless pipes, which shall be described in the EM Manual. H. The DC shall replace over-sized fans/ blowers with an optimum size system to meet the process requirements for high-load conditions. I. The DC shall retrofit existing fan or blower with a VFD in case of fluctuating load conditions, which shall be described in EM Manual. J. The DC shall install fans/ blowers in the proper location and ensure a suitable quality of suction air, as recommended by the manufacturers, which shall be described in the EM Manual. K. The DC shall ensure a proper belt alignment to minimize side wear and evenly distribute stress on the entire belt for belt-driven system. L. The DC shall replace/trim impeller blades as per the requirements of the process for optimum loading.
Target Components	
	A. The DC shall assess air volume demand of the plant to identify the total system capacity. B. The DC shall select and install the most efficient fans and blowers as shown in table 11.2, while matching the best efficiency point and considering both the existing requirements and immediate expansion plans. C. The DC shall ensure proper sizing of inlet of blower as per design values. D. The DC shall further include measures such as the correct sizing of pipe, appropriate layout, plugging off leakages, application of improved insulation (for hot stream), regular maintenance, recording system, etc. E. The DC shall install multiple systems in parallel to generate a higher volume in place of a single, large system.

Table 11.2 Efficiency of fans

Fan categories		Peak efficiency range (%)
Centrifugal fan	Airfoil backward curved/ inclined	79 – 83
	Modified radial	72 – 79
	Radial	69 – 75
	Pressure blower	58 – 68
	Forward curved	60 – 65
Axial fan	Van-axial	78 – 85
	Tube-axial	67 – 72
	Propeller	45 – 50

Source: Secondary data from websites

$$\text{Specific power consumption (kW/m}^3\text{/min)} = \frac{\text{Actual power consumption (kW)}}{\text{Total air volume (m}^3\text{/minute)}}$$

$$\text{Fan mechanical efficiency (\%)} = \frac{\left(\text{Volume } \left(\frac{\text{m}^3}{\text{hr}}\right) \text{ X Total pressure (mm WC)X 100}\right)/}{\text{(102 X Power input to fan shaft (kW))}}$$

$$\text{Fan static efficiency (\%)} = \frac{\left(\text{Volume } \left(\frac{\text{m}^3}{\text{hr}}\right) \text{ X Static pressure (mm WC)X 100}\right.}{\text{102 X Power input to fan shaft (kW)}}$$

11.5 Lighting System

Standards Components	
(1) Management and control	A. Lighting systems shall be managed according to the instructions based on Energy Conservation Building Code (ECBC), thus ensuring required lighting power density as mentioned in table 11.3 and IS Code of Practice for Industrial Lighting: 6665-1972, or their equivalent standards, which shall be described in the EM Manual. Dimming or turning-off the light shall be managed in a way that eliminates excessive or unnecessary lighting, which shall be described in the EM Manual.
(2) Measurement and recording	A. The DC shall periodically measure the illumination level of lighting systems installed in various sections, which shall be recorded according to the instructions concerning measurements and records of illuminance in different process sections or workplaces to be lit, which shall be described in the EM Manual.
(3) Maintenance and inspection	A. Lighting systems shall be periodically maintained and inspected according to the instructions concerning maintenance and inspection, which shall be described in the EM Manual. The instructions shall include cleaning and replacement of lighting fixtures and lamps.
(4) Necessary measures when installing new facilities	A. While installing a new lighting system, the DC shall optimise energy use in lighting, based on the information concerning lighting systems in the ECBC. These include the following: B. The DC shall replace inefficient lighting with energy-efficient lighting facilities, such as LEDs, induction lamps, etc., maintaining standard illumination with a minimum LPD. The LPD range for a few application areas in industries is shown in Table 11.3. C. The DC shall select suitable lighting fixtures that can be easily maintained and allow for an easy cleaning and replacement of the light source. D. The DC shall provide due consideration to factors affecting the total lighting efficiency while selecting lighting fixtures. The factors include illuminance efficiency of the light sources, efficiency of lighting circuits and lighting fixtures, etc. E. The DC shall install systems that avail natural day light (e.g. use of translucent roofs) to maximize lighting and reduce the electric lighting load. F. The DC shall install appropriate control systems to auto switch off or the dimming of the lighting system. It shall include measures, such as motion sensors, timers, and interlocking with security systems to avoid lighting when not required.
Target Components	
	A. The DC shall use lighting fixture with a dimming function and automatic control devices, when natural lighting can be used. B. The DC shall consider using energy efficient lighting system such as LED and induction lighting along with suitable auto control systems to improve the energy efficiency. C. The DC shall install a natural lighting system e.g. translucent sheets, etc. to maximise the energy saving. D. The DC shall use solar photo voltaic (SPV) based lighting system to use renewable energy sources.

Table 11.3 Lighting power density for industries

Lighting area	Average illumination (Lux)	Lighting power density (w/m^2)
Administrative building	50 - 400	5.0-9.5
Administrative corridor	100	2.3-7.1
Shop floor lighting (process)	150 - 300	6.0-12.0
Workshop	150 - 300	7.1-14.1
Warehouse - storage area	100 - 150	3.5-7.08

Source: Energy Conservation Building Code, Government of India

The lighting power density (LPD) is arrived at by using the following formulae.

$$LPD\ (\frac{W}{m2}) = \frac{Lux}{Efficacy} \qquad LPD\ \left(\frac{W}{m2}\right) = \frac{Lux}{Efficacy} \qquad Efficacy = \frac{lumen}{watt}$$

11.6 Cooling Tower

Cooling tower is used to reduce the temperature of water close to wet bulb temperature of air through evaporation of water. Different types of cooling towers used include (i) natural draft system and (ii) mechanical draft system. Cooling tower is essential auxiliary equipment in process refrigeration and air-conditioning system used in oil refinery, petrochemical industry, thermal power station, etc.

Standard Components	
(1) Management and control	A. The DC shall maintain cycle of concentration (COC) within the limit as provided in table 11.4 to minimize make-up water consumption in cooling water, which shall be described in EM Manual. B. The DC shall describe the minimum set point of cooling water temperature for each process. It shall stop fan operation using automation/controller when the cooling water temperature falls below minimum set temperature. C. The DC shall ensure proper functioning of drift eliminators to control drift losses within limits as provided in table 11.4.
(2) Measurement and recording	A. The DC shall measure and record ambient conditions (e.g. dry bulb temperature, wet bulb temperature, relative humidity) and operating parameters of cooling tower (e.g. inlet and outlet temperatures of water, flow rate of water, etc.) to evaluate effectiveness of cooling tower which shall be described in EM Manual. B. The DC shall measure and record quantity of make-up water addition used towards compensation of water losses such as evaporation loss, drift loss, blowdown loss, etc., which shall be described in EM Manual.
(3) Maintenance and inspection	A. The DC shall carry out visual inspection of fills on a periodical basis to ensure proper distribution of water over surface area. B. The DC shall adopt the suitable mechanism to treat the water used in cooling towers to keep levels of micro-organisms to a minimum, which shall be described in EM Manual.
(4) Necessary measures when installing new facilities	A. The DC shall undertake heat load assessment to select the suitable capacity of cooling tower considering existing requirements, immediate expansion plans, etc. It shall be installed with suitable control mechanism such as variable frequency drive (VFD, thermostatic controller, etc.) to maximise the performance of cooling tower. B. The DC shall install cooling tower having highest performance as provided in table 11.4, while matching plant load requirements. C. The DC shall design and install cooling tower network with minimum system resistance using seamless pipes. D. The DC shall select the cooling tower with moulded FRP fans of aerofoil design. E. The DC shall select and install cooling tower with drift eliminators to reduce drift losses. It shall also use PVC (poly vinyl chloride) fills in place of wooden bars.

Target Components	
	A. The facility shall select and install cooling tower matching load requirement and considering existing requirements as well as immediate expansion plans. B. The DC shall further include measures such as correct sizing and type of pipes, suitable layout, etc. for optimum performance of cooling tower. C. The DC shall install multiple cooling tower systems in parallel in place of a single large system to meet higher volume requirements of cooling water.

The performance of cooling tower can be assessed using following formulae.

$$\text{Range} = A - B$$

A = Entering cooling water temperature (return from process)

B = Cold well water temperature (supply to process)

$$\text{Approach} = B - C$$

B = Cold well water temperature

C = Ambient wet bulb temperature

$$Effectiveness = \frac{Range}{(Range + Approach)}$$

Table 11.4 Performance parameters of cooling tower

Parameter	Unit	Control value
Approach*	^{o}C	4.0-5.0
Cycle of concentration (COC)#	-	8-10
Drift loss	(%)	0.001–0.005% of circulating flow rate

Source: Secondary data

* A minimum approach of 3.8 shall be maintained to have better performance of cooling tower

\# COC of less than 5 would lead to poor performance of cooling tower

11.7 Transformer

A transformer is static electrical equipment which transforms 'alternating current' (AC) electrical power from one circuit to another at constant frequency by step-up or step-down according to the end-use requirement. The transformer is used in various applications of electrical networks e.g. power transmissions and distribution in power generation units, industrial plants, commercial establishment, data centres, railway vehicles, wind turbines, etc. It could be core type or shell type based on placement of primary coil and secondary coil around steel core. Considering the application, transformer could be step-up or step-down, power transformer, distribution transformer, etc.

Standard Components		
(1)	Management and control	A. The DC shall ensure proper electrical compatibilities while operating two or more transformers in parallel. These include voltage ratio, impedance, polarity, etc., which shall describe in EM Manual. B. The DC shall optimise the transformer losses by maintaining suitable loading which depends on "no-load losses" and "load losses" of the transformer. It shall operate the transformer close to the best efficiency loading point. C. The DC shall maintain the power factor close to unity at transformer level to reduce the load losses. D. The DC shall maintain the operating temperature of the transformer within the prescribed limits as specified by the manufacturer to achieve full life span services and reduce losses, which shall be described in EM Manual. E. The DC shall consider switching off the under-loaded transformer used in parallel operation to reduce part-load energy losses. F. The DC shall make necessary tap adjustment in transformer to compensate output voltage drop due to long cable runs.

(2) Measurement and recording	A. The DC shall measure and record the key operating parameters such as voltage, power factor and harmonics on a periodical basis, which shall be described in **EM Manual**. It shall also record the room temperature and moisture level, wherein the transformer is installed.
(3) Maintenance and inspection	A. The DC shall undertake the scheduled preventive maintenance as per manufacturer's instructions to ensure the following: (i) oil and winding temperature, (ii) oil level and leakage, (iii) oil level in OLTC (on-line tap changer) mechanism, (iv) earth resistance, (v) condition of relief diaphragm, (vi) sealing arrangement, etc.
(4) Necessary measures when installing new facilities	A. The DC shall undertake load assessment of the plant to select suitable size and number of transformers, considering best efficiency points for loading and routine/ seasonal operations. B. The DC shall select the transformers with the minimum eddy losses for non-linear load applications. C. The DC shall select the transformer with relatively low no-load losses (e.g. amorphous core type) to maintain the best efficiency at low loads. D. The DC shall consider installing a liquid-filled transformer, which is more efficient and have long life than a dry-type transformer. E. The DC shall ensure installation of the OLTC enabled transformers for new installations to maintain end-use voltage close to the design level.
Target Components	
	A. The DC shall install the best efficiency transformers for the given rating, while matching the plant load requirements. B. The DC shall optimise the transformer loading with respect to the best efficiency point. C. The DC shall maintain unity power factor at the transformer

$$\text{Loading of transformer (\%)} = \frac{\text{Actual Load (kVA)}}{\text{Transformer rating } (kVA)} \times 100$$

$$\text{Transformer loss (kW)} = No\ Load\ Loss + \left(\left(\frac{Average\ Transformer\ Loading\ (\%)}{100}\right)^2 \times Full\ load\ loss\right)$$

$$\text{Optimum loading / best efficiency point (\%)} = \sqrt{\frac{No\ Load\ Loss}{Full\ Load\ Loss}} \times 100$$

12. INDUSTRY ENERGY MANAGEMENT SYSTEM

Industry Energy Management Systems (IEMS) for a DC shall have standing instructions for the following actions to study the efficient use of energy.

Standard components	
	A. The dedicated certified energy manager will be responsible for monitoring and controlling energy use pattern within the industry. B. The energy manager shall ensure periodic monitoring activities for all major energy-consuming equipment or system. The schedule may be yearly, seasonal, monthly, weekly, daily, or hourly, based on the type of requirements of the system or equipment. The performance results of the systems shall be improved, if the performance is lower than the desired value. C. The DC shall review maintenance conditions and compare operating characteristics, performance deterioration, etc., to take remedial actions and improve the energy efficiency.
Target components	
	A. The DC shall undertake appropriate actions to achieve the energy efficiency in individual equipment as well as in the industry as a whole. B. The DC shall implement integrated and centralized automatic controls for various facilities (e.g. combustion, heat-using, WHR, cogeneration, electricity-using, air conditioning, ventilating, and lighting facilities) to improve the energy performance.

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Ministry of Power, Government of India

MARSH

OPERATIONAL RISK SURVEY REPORT

ONGC TRIPURA POWER COMPANY, UDAIPUR, TRIPURA, INDIA

APRIL 2019

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Following: A survey visit to the OTPC, Udaipur, Tripura, India Power Plant on 5th and 6th April 2019 and discussions with the site personnel

REV. OTPC.U.UW.1.0

Revision History

Revision	Date	Comments
OTPC.U.UW.1.0	30 April 2019	Draft issue following April 2019 survey

OTPC, Udaipur, Tripura, India

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Abbreviations

AC	Alternating Current
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
AP	Authorised Person
APH	Air Preheater
ASCE	American Society Of Civil Engineers
APS	Automatic Plant start-up (Shutdown)
CEMS	Continuous Emissions Monitoring System
CO_2	Carbon Dioxide
COD	Commercial Operation Date
CW	Cooling Water
DC	Direct Current
DIN	Deutsches Institut für Normung.
DGA	Dissolved Gas Analysis
DLN	Dry Low NOx
EDG	Emergency Diesel Generator
EPC	Engineering Procurement & Construction
ERP	Emergency Response Plan
ESD	Emergency Shutdown Device
ESP	Electrostatic Precipitator
FD	Forced Draught
FGD	Flue Gas Desulphurisation
FOF	Forced Outage Factor
GCF	Gross Capacity Factor
GSU	Generator Step Up (transformer)
ha	Hectares
HFO	Heavy Fuel Oil
HP	High Pressure
HSE	Health, Safety & Environment
HWP	Hot Work Permit
HV	High Voltage (>1000V)
Hz	Hertz (cycles)
I&C	Instrument & Control
I/O	Input-Output
ID	Induced Draught
IOSH	Institution of Occupational Safety and Health

IPP	Independent Power Producer
IPD	Iso-Phase Bus Duct
ISO	International Standards Organisation
kV	One thousand volts
LDO	Light Diesel Oil
LP	Low Pressure
LV	Low Voltage
Maj	Major
MCR	Maximum Continuous Rating
MFL	Maximum Foreseeable Loss
Min	Minor
MMD	Mechanical Maintenance Department
MPa	Mega (Million) Pascal (pressure)
MV	Medium Voltage
MW	Mega (Million) Watt electrical
NCF	Net Capacity Factor
NFPA	National Fire Protection Association
NOx	Nitrous Oxides
NRV	Non Return Valve
OE	Owners Engineer
OEM	Original Equipment Manufacturer
O&M	Operations & Maintenance
OMA	Operation & Maintenance Agreement
OHSAS	Occupational Health & Safety Assessment System
PCOD	Project Commercial Operation Date
PML	Probable Maximum Loss
PPA	Power Purchase Agreement
ppb	Parts per billion
PPE	Personal Protective Equipment
RC	Reinforced Concrete
SAP	Senior Authorized Person
SWFGD	Sea Water Flue Gas Desulphurisation
tph	tonnes per hour
UBS	Uniform Building Standard
UPS	Uninterruptible Power Supply
VDU	Visual Display Unit
WMS	Work Management System

Company Specific Abbreviations

BHEL	Bharat Heavy Electrical Limited
BIS	Bureau Of Indian Standards
DGM	Deputy General Manager
EHS	Environment Health and Safety
EMD	Electrical Maintenance Department
EOP	Emergency Operating Procedure
FLOP	Fire Loss of Profit
FOLHS	Fibre Optic Linear Heat Sensing Cables
GM	General Manager
IBT	Inter connecting Bus Transformer
IIF- II	India Infrastructure Fund – II
IL&FS	Infrastructure Leasing and Financial Services Limited
INR	Indian National Rupees
IR	Infra-Red
LOTO	Lock Out Tag Out
MLOP	Machinery Breakdown Loss of Profit
OFS	Off site Services
ONGC	Oïl and Natural Gas Company
OTPC	ONGC Tripura Power Company
PTW	Permit To Work
RLA	Residual Life Assessment
SOP	Standard Operating Procedures
TAC	Tariff Advisory Committee
TC	Technical Cell
TMD	Turbine Maintenance Department

CONTENTS

SECTION ONE

INTRODUCTION

This Risk Survey report has been prepared at the request of insurers and reinsurers on behalf of OTPC following a two day survey of OTPC, Udaipur, Tripura Plant on 5th and 6th April, 2019.

Marsh visited OTPC, Udaipur, Tripura previously in November 2015 for the risk engineering survey of the plant.

Objectives and Acknowledgements

The principal objectives of this report are to provide an exposure information update for the projects incumbent operational insurance partners market, and to provide OTPC with the benefit of independent loss control opinion with experience in the specific technology adopted.

Information contained in this report was to an agenda sent to the plant prior to the visit. Discussions with site personnel at the time and following the visit, and observations made during a tour of the plant provided more information of site operations.

There was no physical testing of systems carried out at the time of this visit.

The survey was carried out by Sundeep Pugliya of Global Energy Risk Engineering, Marsh India. The visit was arranged by OTPC in Udaipur Plant and was coordinated by Mr. Sajjan Kumar Sharma (Sr. Manager, Finance and Accounts) and Mr Sital Ray (Manager (EHS).

We gratefully acknowledge the contribution of everyone involved in the survey and in particular the following personnel.

Mr. Bibek Roy	-	DGM (O&M) and Plant In charge
Mr. Sajjan Kumar Sharma	-	Sr. Manager (F&A)
Mr. Narendra Kumar Gupta	-	Sr. Manager (Operation)
Mr. Sital Ray	-	Manager (EHS)
Mr. Premananda Nath Sharma	-	Manager (F&A)
Mr. Souvik Chowdhury	-	Manager (Technical Cell)
Mr. Md. Musa	-	Head C&I Maintenance
Mr. Bhaskar Sen Chowdhury	-	Head Mechanical Maintenance
Mr. S R Das	-	Head Electrical Maintenance
Mr. Raju Singh Parihar	-	Assistant Manager (Fire)

SECTION TWO

EXECUTIVE SUMMARY

Background

Oil & Natural Gas Corporation Ltd. (“ONGC”), a company of the Government of India, owns significant natural gas reserves in the North Eastern state of Tripura. However, these natural gas reserves were not developed commercially due to low industrial demand in the North-Eastern region.

The complexities of logistics and attendant costs limited the economic viability of transportation of gas to other parts of the country where gas is in deficit. In order to optimally utilize the gas available in Tripura and to supply power to the deficit areas of North Eastern States of India, ONGC along with Infrastructure Leasing and Financial Services Limited (IL&FS) and Government of Tripura formed a Special Purpose Vehicle ONGC Tripura Power Company (OTPC) by entering into a Shareholders’ Agreement (SHA) on September 18, 2008 to implement a 726.6 MW Combined Cycle Gas Turbine (CCGT) thermal power plant at Palatana, Tripura.

The first block (363.3 MW) of the power plant was declared under Commercial Operation from 4th January, 2014 and the second block (363.3 MW) of the two blocks was declared under Commercial Operation from 24th March 2015. BHEL was the EPC contractor for setting up of the power plant.

Description Summary

Location

The site co-ordinates are: Longitude 91.4396 (E) and Latitude 23.4992 (N).

The plant is located at Palatana, Udaipur Village at Gomoti District in the Indian state of Tripura.

As per Munich RE Nathan charts, the plant site is located in Zone 2 for earthquakes, Zone 5 for lightning, Zone 2 for tornados and in Zone 3 for flash floods. For the other natural perils including storms, cyclones, tsunami and volcanoes, the site is in “no hazard” or low hazard zones. All the critical structures like chimney, HRSGs, TG buildings, Tall Transfer towers etc. are provided with the lightning protection covering the respective areas.

The area of the plant is approximately 80 ha and the layout of the site provides good spatial separation.

The nearest commercial airport is at Agartala, which is the main airport for the region and is situated around 73 km to the North West of the plant. There was no indication of flight paths over the site during the survey.

The road access to the plant is through State Highway.

Plant

The first block (363.3 MW) of the power plant was declared under Commercial Operation from 4th January, 2014 and the second block (363.3 MW) of the two blocks was declared under Commercial Operation from 24th March 2015. BHEL was the EPC contractor for setting up of the power plant.

The plant comprises two blocks of Combined Cycle Gas Turbine power stations having capacity of 363.3 MW each. Apart from the main plants (Gas Turbines Generators, Steam Turbine Generators and HRSG Units), the plant is equipped with all the balance of plant facilities such as switchyards, Plant Water Treatment facilities, water intake and storage facilities, cooling water systems, hydrogen generation plant and gas receiving, pressure boosting and processing units.

Project zero date or notice to proceed date was 11th August 2008.

EPC contract was awarded to Bharat Heavy Electrical Limited. Make of the major equipment is as mentioned in the below table:

Package Description	Supplier
Gas Turbine Generator	General Electric, India
Steam Turbine Generator	Bharat Heavy Electrical Limited, India
HRSG	Bharat Heavy Electrical Limited, India
Switchyard	Bharat Heavy Electrical Limited, India
HV Transformers	Bharat Heavy Electrical Limited, India
Fire water Pumps	Flow more, India
DM Plant	Ion Exchange, India

Fire Protection

Plant is equipped with fire detection and protection systems. All the detection systems (installed in the different hazardous areas) are connected to the central fire alarm panels and fire stations for better monitoring and control.

Fire alarm and detection system has been supplied by Detectomat, Germany (https://www.detectomat.com).

A basic level of fire detection and protection system was observed in the plant during the survey.

Fire protection and detection system has been supplied by UTC Fire and Security India Limited.

Fire detection systems are installed at Gas Turbine enclosures, Steam Turbine Generator enclosure, main plant control room, DCS panel rooms, station switchgear rooms, Lube oil skids, Generator Step up Transformers, Station Transformers, Auxiliary Transformers and main plant cable cellar rooms.

Fire and gas detection systems at gas receiving and processing stations and gas booster compressor complex are not installed (Recommendation 2019/04/14).

Automatic fixed fire protection systems are installed at Gas Turbine enclosures, Steam Turbine Generator enclosures, Main control and DCS rooms, Lube oil skids, Generator Step up Transformers, Station Transformers, Auxiliary Transformers and main plant cable cellar rooms.

Fixed fire protection and detection systems at Steam Turbine Generator bearings and Gas Turbine Generator Seal oil tank skids are not installed (Recommendation 2019/04/10 and 2019/04/11).

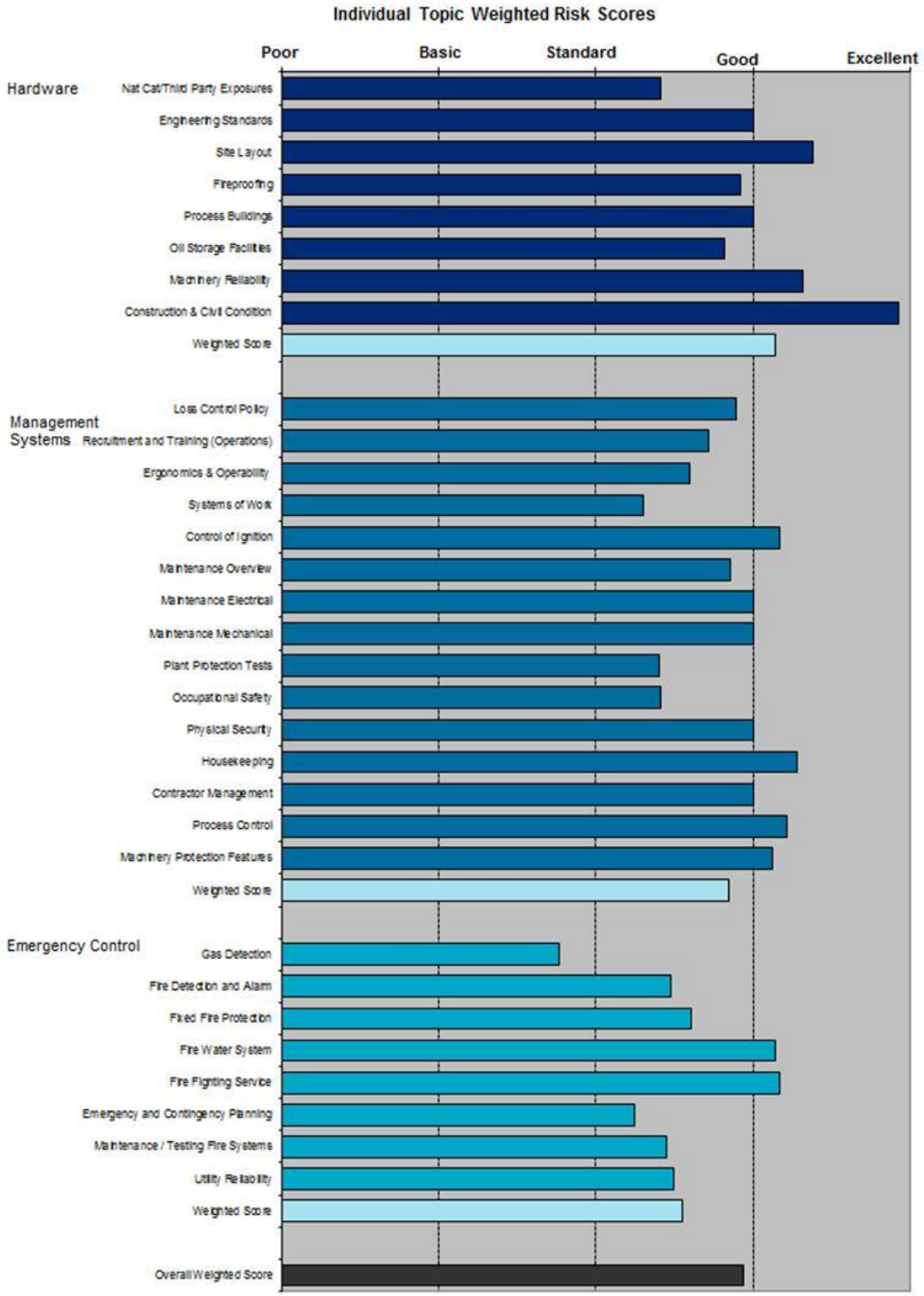
Plant comprises of spray (for fixed fire protection system) and hydrant water reticulation system. These reticulation systems are mostly above ground. Fire water pumps are separate for spray and hydrant fire water system.

Plant is equipped with two numbers of motor driven pumps, one numbers of diesel engine driven pump, two numbers of jockey pumps, two set of compressors and one hydro pneumatic tank for hydrant system and one motor driven pump, one diesel engine driven pump for spray system.

Fire water tank is a concrete tank with a capacity of 3000 cubic meters capacity and is equipped with automatic level control mechanism. The intake to the fire water tank is directly from the clarifiers through gravity with a motorized isolation valve.

Site consists of a raw water reservoir of 1,78,000 cubic meters capacity.

Risk Quality



Recommendations Overview

15 new Risk Improvement Recommendations and eight observations were raised following the survey, which were well received by the site management and are as mentioned below:

2019.04.01	Annual Steam Turbine and Gas Turbine functional overspeed test
2019.04.02	Monthly DC lube oil pump run test on cut in pressure set point
2019.04.03	Monthly Steam Turbine Stop and control Valve exercising
2019.04.04	Annual Emergency shut off valve exercising test
2019.04.05	Implementation of GE upgrade Packages for Gas Turbines
2019.04.06	Gas Turbine door fan test
2019.04.07	Emergency Diesel Generator annual load test
2019.04.08	Fire water testing as per NFPA 25
2019.04.09	Fire detection identification below false flooring in control room
2019.04.10	Fixed fire protection system for Steam Turbine Generator bearings as per NFPA 850
2019.04.11	Gas Turbine seal oil system fixed fire protection system
2019.04.12	Annual foam solution test
2019.04.13	Critical Piping inspection
2019.04.14	Gas detection and interlocking of the gas leak signal with the emergency shut of valve
2019.04.15	STG AC and DC Lube Oil Pump Power Cables

Following Observations also made during the survey

- During the discussions with the site team, it could not be established that the positive fire zoning/isolation in the control and DCS rooms above false sealing has been envisaged effectively.
- Fire signal to respective area equipment trip interlocking is not envisaged.
- Unit 1 steam turbine got jammed during the Turbine costing down after the trip because of station black out scenario.
- Presently, Ware house fire detection system is limited to some of the air conditioned areas only whereas, it needs to be extended to cover the whole covered area as a lot of expensive spare parts are stored.
- Uncontrolled growth of vegetation near critical area like transformer and switchyard area need to be controlled.
- Fault signals were persisting on main and repeater fire alarm panels since last three months, which need to be attended on priority.
- An audit to verify Plant illumination level is required as in some critical area like fire water pump house the illumination level was observed low.
- Standard and Emergency Operating Procedures were last updated in 2015. These should be updated at least once in two years.

Insured Values and Estimates

Following values are considered based on John Foord Paper.

Main Equipment Value	Million US $
Gas Turbine + Generator	81
Transformers	27
Steam Turbine + Generator	40
HRSGs	40
Balance of Plant	80

The loss scenarios have included additional clean-up costs and work on the assumption that equipment will be replaced at the same contract value.

The loss scenarios do not include the potential of third party damage and claims.

Lead Times

Lead times for the critical equipment have been considered as mentioned below (for the loss calculation):

Equipment	Months
Gas Turbine	16
Generators	16
HRSG	13.5
Steam Turbine	13
Transformers	10

In practice OEM's look to improve on standard lead times and will deal with the supply on a case to case basis.

Insured Values

Following are the sum insured values based on the latest policy in place:

- Property Damage Sum Insured: INR 3,822 Cr
- Business Interruption Sum Insured: INR 653 Cr (Annual)
- Business Interruption Indemnity Period: 18 months
- Deductibles:
  - Property Damage: 5% of claim amount subject to minimum of 5,000,000.
  - Deductibles for Mobile / office equipment's – 5% of the claim amount subject to minimum of INR 1,000,000 for each and every loss.
  - Fire Loss Of Profit: 14 days of Gross Profit.
  - Machinery Breakdown Loss Of Profit: 21 days OF Gross Profit.

History

Losses

No losses reported till date.

Upgrades

No upgrades reported.

Technical Issues

Jamming of Unit 1 steam turbine rotor, during the Steam Turbine costing down after the trip due to station black out.

Conclusion

Strengths

- Critical equipment has proven technology.
- Good site layout.
- Good civil construction of various plant and non-plant buildings and structures like chimney.
- Good housekeeping.
- Fire proofing levels are good.
- Good plant firefighting services and good mutual support from the fire stations in the plant vicinity.
- Good record of previous recommendation implementation.

Weaknesses

- Plant safety systems need improvement.
- Testing and inspection of fire water equipment needs improvement.
- Fixed fire protection system for Steam Turbine Generators bearings and seal oil skid (for Gas Turbine Generators).
- Gas detection is not available at gas receiving station and gas booster compressor building.

Opinion

In our opinion, the plant can be considered to be:

- **Better than standard risk** with respect to emergency control, including fire protection.
- **Better than standard risk** with respect to management systems.
- **Good risk** with respect to hardware systems.

Overall, in our opinion, the plant can be considered to be a **Better than standard risk** based on our method of combining the individual risk ranking scores.

SECTION THREE

RISK IMPROVEMENT RECOMMENDATIONS

Prioritisation

The criteria used to prioritise the recommendations are summarised in the following Table.

Code	Description
Critical	Extreme Risk; should be brought to the attention of plant management and immediately progressed.
A	High Priority; requires attention of senior management and an action plan developed as a priority.
B	Moderate Risk; requires action at the earliest opportunity.
C	Low Risk; Opportunity for industry best practice initiatives providing long term benefits.

As a result of this survey 15 new recommendations and eight observations have been made which were well received by the management team.

12 out of 28 previous recommendations were closed and one is superseded, which demonstrates good response.

New Recommendations Summary

Description	Category	Reference
Annual Steam Turbine and Gas Turbine functional overspeed test	Critical	2019.04.01
Monthly DC lube oil and seal oil pump run test on cut in pressure set point	Critical	2019.04.02
Monthly Steam Turbine Stop and control Valve exercising	Critical	2019.04.03
Annual Emergency shut off valve exercising test	Critical	2019.04.04
Implementation of GE upgrade Packages for Gas Turbines	A	2019.04.05
Gas Turbine door fan test	B	2019.04.06
Emergency Diesel Generator annual load test	B	2019.04.07
Fire water testing as per NFPA 25	B	2019.04.08
Fire detection identification below false flooring in control room	C	2019.04.09
Fixed fire protection system for Steam Turbine Generator bearings as per NFPA 850	A	2019.04.10
Gas Turbine seal oil system fixed fire protection system	A	2019.04.11
Annual foam solution test	B	2019.04.12
Critical Piping inspection	B	2019.04.13
Gas detection and interlocking of the gas leak signal with the emergency shut of valve	A	2019.04.14
STG AC and DC Lube Oil Pump Power Cables	B	2019.04.15

Following Observations also made during the survey

- During the discussions with the site team, it could not be established that the positive fire zoning/isolation in the control and DCS rooms above false sealing has been envisaged effectively.
- Fire signal to respective area equipment trip interlocking is not envisaged.
- Unit 1 steam turbine got jammed during the Turbine costing down after the trip because of station black out scenario.

- Presently, Ware house fire detection system is limited to some of the air conditioned areas only whereas, it needs to be extended to cover the whole covered area as a lot of expensive spare parts are stored.
- Uncontrolled growth of vegetation near critical area like transformer and switchyard area need to be controlled.
- Fault signals were persisting on main and repeater fire alarm panels since last three months, which need to be attended on priority.
- An audit to verify Plant illumination level is required as in some critical area like fire water pump house the illumination level was observed low.
- Standard and Emergency Operating Procedures were last updated in 2015. These should be updated at least once in two years.

Previous Outstanding Recommendations Summary

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/1	1. Establish a fire protection impairment system to supervise all fire protection and detection system impairment regardless of the reason or duration of the impairment. The program should also include the reminders to be sent to the respective department that valve(s) are/is closed, the pump is not in “Auto” mode, isolation valves are closed/ partially shut and immediate attention is required to restore the protection. 2. Provide additional protection measures till the impairment is fixed and record the same in the impairment form (e.g. informing the local fire brigade to be on standby in the event of breakdown of fire pumps).	Complete Within 3 months	Impairment procedures need to be prepared	Sample Impairment Procedure copy shared with OTPC.	Under Progress
2015/2	All the isolation valves in the fire protection system i.e. from the fire water tank to the remotest hydrant point, including valves in the sprinkler system and deluge system should be chained and locked in fully open position to prevent malicious or accidental closure of the isolation valve leading to impairment of the fire protection system. Valves in the supply line of the diesel to the fire engine should also be chained in normal operating position.	Complete Within 3 months	All isolation valves of the deluge system kept chain locked. It has been found that 30% of the isolation valves of hydrant line are installed at underground level and there are chances of water accumulation and sometime during heavy rain it got submerged. So, in those cases the locks get rusted/damaged in locking condition and unable to be opened which can lead to major abnormalities.	A Bund of about 200 mm can be constructed around the pit and plastic Ties can be used for the locking of isolation valves.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/4	Carry out weekly property loss prevention rounds to cover the entire power station. The visits should be conducted using check sheet which should typically list down but not limited to the following: 1. Storage of ordinary combustibles below the cable trays in cable gallery, hydrogen manifold room, Diesel generator room etc. 2. Storage of the oil drums in proper containment so that they may not be affected by the knock on damage. 3. The electrical cables are properly laid and terminated. 4. Hot work permit system is being followed in totality as per the hot work policy. 5. “No Smoking” procedure is being followed. 6. Impairment management system is followed. 7. Leakage of oil from level gauges other connections in diesel day tanks to be avoided.	Complete Within 3 months	All completed except Point number 6.	Sample Impairment Procedure copy shared with OTPC.	Under Progress
2015/5	Improve the existing hot work permit by including the following in the precaution list: 1. To check whether the fire protection and detection system in the area is operational. 2. The combustibles within 11 m of the work should be relocated or covered with fire retardant blankets when hot work is carried out at ground level. 3. For elevated hot work, combustible materials should be either relocated a minimum of 50 ft. (15.2 m) from the hot work area or properly protected with fire retardant welding blankets or the hot work operation isolated with welding screens. Suspend fire-resistive welding blankets under hot work conducted near the ceiling. Place noncombustible screens around hot work at the floor to trap sparks. Every elevated hot work operation needs to be evaluated on a case-by-case basis to determine a reasonable safe distance from hot work to combustible occupancies or construction. 4. Seal all floor penetrations and opening on walls in the above mentioned distance using noncombustible materials. 5. Fire watch should be continuously provided during hot work and one hour after the hot work is complete. Furthermore, the watch period should be extended three hours after the continuous watch period. This could be intermittent watch and the fire alarm system can be used in this period for monitoring. Finally, the permit should be closed by the fire watch. 6. Ensure all personals involved in hot works are using all personal protective equipment.	Complete Within 3 months	All completed except Point 4.	Sealing of cable openings below false floor at Battery charger room is balance. Moreover, intumescent paint should be applied to the cables near to the sealing area.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/7	Inspection and Testing: 1. Conduct weekly system inspections to see that nozzles are clear and in proper position, that all operating controls are properly set, and that system components have not been damaged 2. Check the agent quantity and pressure of clean agent containers semi-annually. Refill or replace halocarbon clean agent containers if they show a loss in agent quantity of more than 5% or loss in pressure (adjusted for temperature) of more than 10%. Refill or replace inert gas clean agent containers if they show a loss in pressure (adjusted for temperature) of more than 5% 3. Inspect thoroughly inspect clean agent systems for proper operation exclusive of a discharge test every year. Inspect and test all actuating and operating devices in accordance with the system manufacturer's recommendations as outlined in the appropriate system design, installation, operation and maintenance manual. Regular service contracts with the system manufacturer's authorized representative are advised. 4. Inspect thoroughly the clean agent system protected enclosure every year. Determine if penetrations or other changes have occurred that could adversely affect agent leakage or change the volume of the hazard or both. Correct any conditions discovered during the inspection that could result in inability to maintain the clean agent concentration. If uncertainty still exists with regard to the enclosure integrity, conduct an enclosure integrity test of the enclosure. Maintenance: 5. Maintain clean agent systems in operating condition at all times and restore to service promptly after any impairment or operation. 6. Seal any penetrations made through the clean agent system protected enclosure immediately.	Complete Within 3 months	Completed	Checklist for the inspection and test of Argonite system to be prepared and preserved as records for verification.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/12	1. Pre-plan with the local fire brigade by inviting them for the annual mock fire drills. During their visit, they should be appraised on the various hazards prevailing at the location and providing them with the details of the firefighting capabilities of the plant. 2. Alternatively, the plot plan of the plant displayed at the entrance gate should be revised to indicate the number and the capacity of the fire pumps, fire water storage and the locations of the electrical panel rooms.	Complete Within 3 months	Under Progress		Under Progress
2015/13	1. Provide a copy of business continuity plan to Marsh Risk Consultancy for review. 2. Meanwhile, verify whether the existing Business Continuity plan includes a scenario where-in the main transformers, steam generators and the cooling towers are damaged due to fire. If these scenarios are not included then the plan should be revised to include the time required to procure, install and commission the equipment and the back up plans to ensure continuous production. 3. It is also recommended to keep a copy of business continuity plan at site along with corporate office.	Complete Within 3 months	Business Continuity Plan is to be obtained from Delhi Office.	Please provide the Business Continuity Plan.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/15	1. Verify if the containment provided for the main lube oil tank and emergency/drain lube oil tank is designed to contain the largest expected lube oil spill and water spray system discharge and is designed and installed as per NFPA/FM Global standards. 2. Close all the openings in the existing containment made for the lube oil system area of steam turbine. 3. Provide approved flange guards over the flanges of the lube oil pipeline available at the level of the solid turbo-generator operating floor, flanges on the cooling canister and the flanges at the level of the main lube oil tank that fall outside the secondary containment along with adequate drainage leading to outside the building. 4. Extend spray system on flanges, lube oil coolers, lube oil filters and also above and below main oil tank. 5. Provide Sprinkler system for turbine operating floor, under the turbine floor, on mezzanine floors as per the guidance in FMDS 7-101. 6. Provide the layout drawings and hydraulic calculation for the water spray system being installed for the main lube oil tank and emergency/drain lube oil tank to verify whether the discharge density of the system is 12 mm/min over the exposed area of the main lube oil tank. The verification will be based on the guidance provided in FM Global Property Loss Prevention Data Sheet, 7-101. 7. Test the Lube oil pumps every month as per FMDS 13-3 to ensure the reliability of the lube oil system.	Complete Within 6 months	Completed	Flange guards on oil piping flanges near Steam Turbine to be provided and extension of fixed fire spray system till lube oil coolers and filters to be provided.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/18	1. Maintain the Argonite flooding system in auto mode. Automatic detection system should be integrated with the Argonite flooding system to activate in case of fire. It should always be ensure that Argonite flooding system is always maintained in the auto mode. 2. Install Argonite nozzles below raised floorings as required in FMDS 5-32 for combustible false floorings. 3. Conduct an enclosure integrity test for the control room in guidance provided in NFPA 2001. 4. Acknowledge the alarms/troubles in the fire alarm panel. Maintain a log book of all the alarms and trouble. 5. Wire the fire detection system to the air conditioning units/air handling units and cut-off the air supply when the fire detection system is activated. 6. Provide self-closing mechanism for doors of the control room to avoid open doors at the time of release of extinguishing agent. 7. Provide design calculation of Argonite flooding system to Marsh Risk consulting for review to ensure the adequacy of the system.	Complete Within 3 months	Under Progress	Interfacing of fire signals with the HVAC equipment for tripping and enclose integrity test is to be carried out.	Under Progress
2015/20	1. Ensure all the filled and empty cylinders are chained properly. 2. Provide automatic fire detection and protection systems in hydrogen generation plant as per FMDS 7-91 section 2.4.3. 3. Route the signal from hydrogen analyser installed in the hydrogen generation plant to the unit control room.	Immediate Action	Under Progress	Automatic fire detection and protection system in hydrogen generation plant to be provided.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/21	1. Seal the opening between the hydrogen manifold room and the gas turbine hall on the ground floor. 2. Provide ventilation in the room at ceiling level at a minimum of ten air changes per hour. The ventilation rate should increase to 25 air changes per hour upon operation of the hydrogen gas analyser at not more than a 2% level (50% of LEL). 3. Provide approved hydrogen gas analysers to sound an alarm and increase ventilation at a 2% hydrogen concentration in room. At present hand held hydrogen detector is used to monitor the hydrogen concentration. 4. Chain all the filled and empty hydrogen cylinders. 5. Avoid any loose connections/tapings on the electrical wires	Immediate Action	Under Progress	Under Progress	Under Progress
2015/22	1. Provide adequate containment and drainage for the maintenance oil tank located in BFP (Boiler Feed Pump) room. Containment was provided for maintenance oil tank in the BFP room but it was open from one end. 2. Provide adequate containment for the lube oil tank of Gas booster compressors. 3. Install Automatic fire detection and protection system on the lube oil tank area of the Gas booster compressor area at ground floor. 4. Provide automatic shutdown of oil pumps of Lube oil tanks of GBC (Gas Booster Compressor) actuated by heat detectors located at ceiling level or by activation of sprinklers.	Complete within 3 months	Under Progress	Point number 3 and 4 are superseded by new recommendation 2019/04/14	Under Progress
2015/23	1. Provide Continuous ventilation that is provided at a rate of not less than 1 ft3/min/ft2 (5.1 L/sec/m2) of floor area of the room or cabinet as per NFPA 70E. 2. Provide Hydrogen detector in the battery bank room with alarm in control room. 3. Smoke detector in battery charging room was observed to be capped. 4. Install Argonite system considering the openings in the false ceiling, main access door etc. 5. Provide design calculation of Argonite flooding system. 6. Conduct enclosure integrity test for battery rooms and battery charging area after installing Argonite system.	Complete within 3 months	Under Progress	Under Progress	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/24	Provide sprinkler protection for the inside of the cooling towers as per the guidelines available in FM Global datasheet 1-6.	Complete within 3 months	Under Progress	Under Progress	Under Progress
2015/25	1. Provide proper bolting/grouting of the control panels in the CER room to prevent shake damage due to shaking of ground during earthquake. 2. Install Argonite nozzles below raised floorings as required in FMDS 5-32 for combustible false floorings.	Complete within 3 months	Completed	Argonite nozzles have been provided but the Sealing of cable openings below false floor at Battery charger room is balance.	Under Progress

Previous Completed Recommendations Summary

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/3	Create a valve supervision program for all the valves in the fire protection network. Following should be include in the program: 1. Create a valve list which lists down all the valves with each having a unique number. 2. Carry out weekly visual valve inspection to inspect whether the chain and the locks are in place. 3. Once every month, carry out physical inspection of the non-indicating gate valves which means opening the valve in fully open position, then closing the valve three turns and then re-opening the valve in fully open position and finally chain and lock the valve. 4. Once every month fully operate the butter fly valves by closing and then re-opening them. Chain and lock the valve in close position after testing. 5. Operate each valve fully once every year to ensure reliable operation of the control valves. 6. Document the status of each valve.	Complete Within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/6	1. Maintain all electrical driven firefighting pumps in auto mode to operate as per the signal given by installed pressure switches for initiation. 2. Plan and do an annual pump test according to NFPA 25 to compare the achieved flow and pressure against the design pump curve. 3. Maintain fire pumps at regular intervals (daily, weekly, annually) to deliver rated pressure at rated flow. Note all the pump parameters i.e. pressure, flow rate (if possible), water level etc. during every test. (Checklist for the fire pump system maintenance is included in the Appendix) 4. Train pump room operators to put all systems in Auto/ safe mode post testing/ at all times. 5. Verify the level of the fire water in fire water tanks and diesel level in diesel day tanks respectively. The water level should be at least 90% of that of the normal water level and the diesel should be at least 75% full. 6. Verify the manual operation of the fire pumps in the weekly tests	Complete Within 3 months	Completed	Completed	Completed - Closed
2015/8	Develop a preventive maintenance program for testing of the safety interlocks, automatic starting of the emergency lube oil pumps and over speed trip tests for gas turbines and steam turbine as per the guidance provided in FMDS 13-17 and FMDS 13-3 respectively for gas turbine and steam turbine.	Complete Within 3 months	This recommendation is superseded by Recommendation 2019/04/01, 2019/04/02, 2019/04/03 and 2019/04/04		Superseded
2015/9	Augment existing electrical inspection program to include regular inspection of all the electrical fittings such as junction boxes, electrical cables and other electrical and illumination fittings at high hazard areas and other sections throughout the site. Following points can be incorporated in the inspection schedule: 1. Eliminate usage of temporary wiring (such as extension cords) within the facilities. Temporary or loose wiring and connections in electrical cables should be avoided at the site. 2. All electrical bulbs should be provided with enclosures and mechanical guards to prevent hot filament from falling and acting as potential ignition source. 3. All electrical fittings should be properly clamped and protected from any knock on damage.	Complete Within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/10	Following recommendation are made to improve the existing emergency response plan (ERP): 1. Include following in the ERP: - Sprinkler control valve operator: A person who knows where all valves are located and is responsible for operating them in the event of a fire. - Fire pump operator: A person who checks the automatic starting pump when the fire alarm sounds - Salvage team: Team that gets the facility back in operation as soon as possible after an emergency. 2. Since site is exposed to 50 years EQ zone , 60 m/s wind zone and close to 500 year flood zone. It is recommended to include natural hazard such as Earthquake, Flood, and Wind in the ERP as per the recommendation made below. 3. Each type of emergency event has specific characteristics that must be anticipated and prepared for. Hence it is recommended to include specific control measures as per each event considered in ERP. 4. Frequently, back-shifts will have a reduced staff. This may require that personnel be assigned to perform multiple functions. Hence it is required to conduct mock drill at night time also. 5. Provide alternate for each key position. Ensure that people from emergency response team is available in all shift and during holidays also.	Complete Within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/11	Formalize an earthquake emergency plan and include the following in the earthquake emergency response plan: 1. Examine all fuel-fired equipment for leaks. 2. Consider shutdown of gas supplies as appropriate. 3. Examine fire protection water supplies to determine if they are impaired. 4. Examine all fire protection systems to determine if they are damaged. 5. Initiate repairs to all fire protection equipment as needed to have them restored to service. 6. Examine production equipment for damage and make necessary repairs before starting up. 7. Control ignition sources including hot work, smoking, etc., particularly if fire protection systems are impaired. 8. Use the FM Global Hot Work Permit System for any hot work to be performed in and around the facility. 9. Examine all electrical equipment and conduct necessary repairs. 10. Examine building structures and facades for damage and take necessary steps to repair and/or stabilize. 11. Examine exterior structures, equipment, and storage and take appropriate action. 12. Other site-specific activities as outlined in the Emergency response Plan.	Complete Within 3 months	Completed	Completed	Completed - Closed
2015/14	1. Avoid storage of combustible materials in the hydrogen manifold room. 2. Prevent storage of unused cables in the fire pump room. 3. Arrest oil leakage in the lube oil system area of the steam turbine. Source of leakage should be identified and proper measures should be taken to prevent such occurrence.	Immediate Action	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/16	1. Provide secondary containment to hold the entire contents of the Lube oil tank of gas turbine plus 50 mm of freeboard. 2. Make the CO2 flooding system operational for lube oil system enclosure of gas turbine. 3. Close all the doors of the lube oil enclosure to ensure proper operation of CO2 flooding system. Supervisory alarm should be triggered in control room if the gate is opened. 4. Conduct enclosure integrity test (i.e. door fan test) of Lub oil enclosure in guidance with NFPA 2001. 5. Provide a metal hood of at least 0.5 mm thickness over the seal oil tank and provide sprinkler or deluge system along with adequate drainage & containment designed and installed as per NFPA/FM global standards with a discharge rate of 12 mm/min over the exposed area of the seal oil tank. Wire the sprinkler/deluge system to cut-off the seal oil pumping action in the event of a spray fire. 6. Test the Lube oil pumps every month as per FMDS 13-17 to ensure the reliability of the lube oil system of gas turbines.	Complete within 6 months	Completed	Completed	Completed - Closed
2015/17	Following recommendations are made to improve the reliability of the fire pumps: 1. Detect leakages in the fire protection line and normalise the jockey pump operation. 2. Maintain all the fire pumps in auto mode. 3. Arrest the leakages from the discharge side control valve of diesel engine driven fire pump. 4. Provide individual pressure sensing to test each fire pump and test them as per the recommendation made earlier. 5. Provide containment for diesel day tank to prevent the spillage of oil from diesel day tank. 6. Seal all the cable penetrations in the fire pump rooms. Remove unused electrical cables from the fire pump room. 7. Provide easy identification of all the fire control panels by painting them red and providing identification tag. 8. Install the fire pump control panel for electrical panel near the pumps. As informed, at present the control panel for electrical fire pump is located away from the fire pump house in the cooling water pump house electrical room.	Complete within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/19	1. Provide emergency oil spillage containment below the diesel day tanks of emergency diesel generator installed in fire Pump room and DG room respectively, to contain emergency oil spillage from the day tanks. The minimum height of the curb should be 100 mm. As per NFPA 20, standard for the Installation of Stationary Pumps for Fire Protection, 2013 Edition, 11.4.1.2.4 Single wall fuel tanks shall be enclosed with a wall, curb, or dike sufficient to hold the entire capacity of the tank plus 50mm free board or 110% of the tank capacity. 2. Provide level transmitter or magnetic type level indicator or protected glass type level indicator instead of plastic sight tube for diesel day tank measurement. 3. Provide regular checks for possible diesel leakage from flange joints, level gauges etc. 4. Provide spray nozzles on the HVWS (High Velocity Water Spray System) pipeline installed on the diesel day tank of the emergency diesel generator. 5. Remove the covers provided on the Quartzite bulb type heat detector line installed on diesel day tank. 6. Provide hood on the vent of the diesel day tank. Check for the provision of providing the vent outside the diesel generator room.	Immediate Action	Completed	Completed	Completed - Closed
2015/26	1. Repair the existing fire detection system installed in the electrical panel room. Caps on the smoke detectors should be removed to make it operational. 2. Arrest the leakages observed on the MVWS (Medium velocity spray system) line installed on the cable galleries in cable vault located at 0m elevation. 3. Seal all the cable openings present in the cable vault. Some openings were due to the drain pipes installed in the cable vault room. Same should also be sealed properly. 4. Provide adequate fire extinguishers in the cable vault room. Carry a weekly loss prevention round to ensure that all the fire extinguishers are properly placed and easily accessible. 5. Provide design calculation for the spray system provided in the cable vault room to Marsh risk consultancy for review and verify adequacy of the system.	Complete within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/27	Provide the following engineering information in order to verify the adequacy of the metal roof sheet of main power block and metal wall cladding attachments of the GBC (Gas booster compressor area): - Linear dimensions of the building. - Peak and eaves height of the building. - Thickness of roof sheet. - Distance between the purlins. - Linear distance of the fasteners on the purlins. - Diameter of the metal fasteners head.	Complete within 3 months	Completed	Completed	Completed - Closed
2015/28	1. Provide earthquake protection for fixed fire protection system as per FMDS 2-8. Following recommendation should be followed in this regards: - Brace fire protection piping to minimize uncontrolled differential movement between the equipment and the structure(s) to which they are attached. - Provide flexibility on piping systems and on other equipment where differential movement between portions of those piping systems or equipment is expected. Except where large differential movement occurs over a short distance, flexible couplings provide sufficient flexibility between portions of sprinkler piping systems where needed. - Provide clearance between piping or equipment and structural members, walls, floors, or other objects so that potential damage from impact is minimized. - Provide anchorage to minimize potential sliding and/or overturning. - Use appropriate types of pipe hangers and sway bracing, properly located and attached to the structure to minimize the potential for pullout. - Use appropriate types of piping and pipe-joining methods to minimize potential pipe breaks 2. Provide seismic safety shut off valves on the natural gas pipelines as per guidance in FMDS 1-11. 3. Properly bolt/grout all the electrical panels, control panels, racks in maintenance store room to prevent over toppling of equipment during earthquake.	Complete within 6 months	Completed	Completed	Completed - Closed

New Recommendations Details

Annual Steam Turbine and Gas Turbine functional overspeed test	Critical	2019/04/01
Date Raised / Revised	April 2019	
Risk Exposure	Machinery Breakdown	
Description	Steam Turbines and Gas Turbines are equipped with electronic over speed protection devices. Physical overspeed test was carried out during the commissioning stage and there after overspeed protection tests were not conducted. It is imperative to conduct the steam turbine and Gas Turbine overspeed tests on regular basis to ensure the integrity of the protection devices. Huge losses have occurred around the world because of the steam turbine/Gas Turbine overspeeding as the protection devices didn't work.	
Recommendation	It is recommended to carry out the functional steam turbine and Gas Turbine overspeed test on annual basis. This functional test can be carried out at reduced speed set point.	
Client Response	Client agreed to carry out the test as recommended.	
Status	***April 2019: New***	

Monthly DC lube oil and seal oil pump run test on cut in pressure set point	Critical	2019/04/02
Date Raised / Revised	April 2019	
Risk Exposure	Machinery Breakdown	
Description	During the discussions with operation department, it was informed that DC emergency lube oil and generator seal oil pump auto start at lube oil header pressure low set point is not being tested though the weekly push button start test is carried out. Testing of DC emergency lube oil and eal il Pumps should include activation of the pressure switch to verify functionality of the system. In the event that main and standby lube oil pumps were to fail, the DC Emergency Lube Oil Pump is required to ensure that the bearings are supplied with oil whilst the turbine generator runs down. Failure of DC lube oil pump systems has resulted in insurance losses due to journal damage.	
Recommendation	It is recommended to test the auto operation of DC lube oil and seal oil pumps at least on monthly basis to ensure the availability of these pumps in need.	
Client Response	Client agreed to carry out the test as recommended.	
Status	***April 2019: New***	

Monthly Steam Turbine Stop and Control Valve exercising	Critical	2019/04/03
Date Raised / Revised	April 2019	
Risk Exposure	Machinery Breakdown	
Description	Load demand from the grid is varying on continuous basis and so is the control valves' position. In view of the above, control valves are exercised on daily basis. Moreover, it was noted during the discussion with site team that there is no routine to check the freeness/smooth movement of Steam Turbine stop valves. Free movement of stop and control valves is a must in order to ensure the full closure of the valves (without any sticking of valve stems inside gland) when the steam turbine trip command initiates. Closure of the valves reduces risk of Steam Turbine overspeed to a great extent.	
Recommendation	It is recommended to test the free movement/floating of steam Turbine stop valve on monthly basis.	
Client Response	Client agreed to carry out the test as recommended.	

Monthly Steam Turbine Stop and Control Valve exercising		Critical	2019/04/03
Status	***April 2019: New***		

Annual Emergency shut off Valve test		Critical	2019/04/04
Date Raised / Revised	April 2019		
Risk Exposure	Fire		
Description	Site is equipped with the Emergency Shut off valve at the plant gas receiving station. Upstream of the plant gas receiving station, ONGC (the gas supplier) has its gas receiving and processing station, which is just besides the OTPC gas receiving station. Client informed that currently there is no routine of Emergency Shut off valve testing however, the shut off valve installed at ONGC side is tested annually. Each GT has a double block and bleed valve arrangement on its gas supply line. It was further noted during the discussion that currently the plant gas leak detection is not wired for the closure of Emergency Shutoff device.		
Recommendation	It is recommended to wire the plant gas leak detection signals for the Emergency Shut off valve closure and that the Emergency Shut off valve should be tested on annual basis.		
Client Response	May trip the unit in the event of false/spurious signal. May require further discussion before implementation.		
Status	***April 2019: New***		

Implementation of GE upgrade Packages for Gas Turbines		A	2019/04/05
Date Raised / Revised	April 2019		
Risk Exposure	Machinery Breakdown		
Description	Site is equipped with GE's 9FA machines. GE has issued upgrade packages one to five for the Gas Turbines. Site has implemented package one and two only till date.		
Recommendation	It is recommended to implement the upgrade packages suitably.		
Client Response	It requires significant investment which may not get approved by CERC outside O&M expense. Hence this point needs further discussion before implementation.		
Status	***April 2019: New***		

Gas Turbine door fan test		B	2019/04/06
Date Raised / Revised	April 2019		
Risk Exposure	Fire		
Description	The top sections of the gas turbine enclosures are generally dismantled during a major overhaul. Following reassembly after overhaul, the enclosures are not tested to verify the integrity of its seals. It is important to ensure that in the event of a fire, the discharged CO2 would be able to maintain the required concentration for the required amount of time, generally accepted as 30 minutes, to extinguish the fire. If the fire is not extinguished due to leaks in the enclosure, thereby compromising the CO2 concentration, the fire may reignite, causing significant property damage and generation downtime.		
Recommendation	It is recommended that enclosure air tightness tests are performed either through Door Fan Testing – this test involves the use of a fan to pressurise the enclosure and measuring the air leakage rate from the enclosure over a period of time. (or) CO2 Discharge Testing – this test involves an actual CO2 discharge in the enclosure and measuring the resulting CO2 concentration over a period of time.		
Client Response	Client agreed to carry out the recommendation.		
Status	***April 2019: New***		

Emergency Diesel Generator annual load test	B	2019/04/07
Date Raised / Revised	April 2019	
Risk Exposure	Fire	
Description	Emergency Diesel Generators are push button started on weekly basis. Currently auto synchronization and load test is not being carried out. When a diesel generator is run unloaded very little fuel is injected into the cylinders. As a result, the combustion is not robust and incomplete combustion products can collect behind the compression rings of the piston and prevent them from sealing properly. Over time this will cause the engine to run poorly and lose power.	
Recommendation	It is recommended to carry out the load test on Emergency Diesel Generator as per NFPA 110.	
Client Response	Client agreed to carry out the recommendation.	
Status	***April 2019: New***	

Fire water testing as per NFPA 25	B	2019/04/08
Date Raised / Revised	April 2019	
Risk Exposure	Fire	
Description	The site has electric and diesel firewater pumps. These are understood to be run weekly however these are not performance tested in accordance with NFPA 25 standard. Monthly and Annual testing of fire pumps comes under NFPA 25, '*Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, and 2008 Edition*'. Note: There is an updated version 2014 Edition The standard annual flow test requires testing the pump at minimum, rated and peak flows by controlling the quantity of water discharged through an approved test device. A full set of performance readings should be taken at each flow condition including; electrical motor current and voltage, pump speed in rpm, pump suction and discharge pressure, and discharge flow. Pump performance should be compared with the pump design curve and with previous annual flow test reports. Degradation in excess of 5% of the pressure of the initial unadjusted acceptance test curve or nameplate shall require an investigation to reveal the cause of degraded performance and restorative maintenance. The standard monthly no flow test requires testing of motor driven pumps for 10 minutes and testing of diesel engine driven pumps for 30 minutes as per NFPA 25. Reference should be made to NFPA 25, which also makes other recommendations and precautions to be taken, and gives full details of the test requirements.	
Recommendation	It is recommended that monthly no flow and annual flow tests of fire pumps should be carried out in accordance with NFPA 25 standard. The results should be plotted and compared to the pump design curves to check for degradation.	
Client Response	Client agreed to carry out the same.	
Status	***April 2019: New***	

Fire detector identification below control room false flooring	C	2019/04/09
Date Raised / Revised	April 2019	
Risk Exposure	Fire	
Description	During the control room visit, it was observed that below the false flooring, smoke detectors were installed for the fire detection. On the false floor tiles, however, there were no identification marks to locate the smoke detectors, which are installed below.	
Recommendation	It is recommended to put the identification marks at the respective false floor tile for the ease of identification of smoke detectors.	
Client Response	Client agreed to carry out the recommendation.	
Status	***April 2019: New***	

Fixed fire protection system for Steam Turbine Generator bearings and diesel engine for fire water pump as per NFPA 850	A	2019/04/10
Date Raised / Revised	April 2019	
Risk Exposure	Fire.	
Description	The main steam turbine generator bearings have no fixed fire protection as per NFPA 850. If a major failure occurs followed by fire the entire plant will be shut down for an extended period of time. Steam turbine generator lubricating oil fires do occur and these events are among the most severe of loss incidents resulting in extensive damage and long durations to repair. Within the insurance industry a steam turbine generator lubricating oil fire is considered as an MFL (Maximum Foreseeable Loss) event.	
Recommendation	It is recommended that fixed fire protection system should be provided for the main steam turbine generator bearings in accordance with NFPA 850 'Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations', 2015 Edition.	
Client Response	Client shall discuss internally and revert.	
Status	***April 2019: New***	

Gas Turbine seal oil system fixed fire protection system as per NFPA 850	A	2019/04/11
Date Raised / Revised	April 2019	
Risk Exposure	Fire.	
Description	The Gas Turbine Generator seal oil system has no fixed fire protection. Gas Turbine seal oil system is a mineral oil and very critical as it seals generator hydrogen. In the event of fire, the seal oil system may be out of operation and this may cause hydrogen leak from the generator.	
Recommendation	It is recommended to provide fixed fire protection system on the Gas Turbine generator seal oil system in line with NFPA 850.	
Client Response	Client shall discuss internally and revert.	
Status	***April 2019: New***	

Annual foam solution test	B	2019/04/12
Date Raised / Revised	April 2019	
Risk Exposure	Fire	
Description	It was observed and discussed during the site visit that the fire-fighting foam solution (Aqueous Film Forming Foam for fuel oil tanks) is not tested on regular basis. Foam concentrate can deteriorate and is affected by high ambient temperature conditions	
Recommendation	As per NFPA 25, fire-fighting foam solution should be tested annually.	
Client Response	Client agreed to comply with this recommendation.	
Status	***April 2019: New***	

Critical Piping Inspection	B	2019/04/13
Date Raised / Revised	April 2019	
Risk Exposure	Machinery Breakdown	

Critical Piping Inspection		B	2019/04/13
Description	During the discussion with Mechanical maintenance team it was noted that critical piping like Main steam, Hot Reheat, Cold Reheat, Feed water piping etc. are not inspected periodically. Critical piping have many critical welds, bends and pipe support system (including variable and constant spring hanger supports), which need periodic inspection and maintenance. Critical Pipe supports need to be inspected in both hot and cold condition and should be subject to adjustments or replacements based on the inspection outcome.		
Recommendation	It is recommended to inspect critical piping and inspection should cover critical bends, welds and piping supporting system.		
Client Response	Client informed that the critical weld inspection will be difficult to perform as the arrangement of resources and spares will be difficult because of the remoteness of site but client agreed to perform the support inspections as recommended.		
Status	***April 2019: New***		

Gas detection and interlocking of the gas leak signal with the emergency shut of valve.		A	2019/04/14
Date Raised / Revised	April 2019		
Risk Exposure	Fire		
Description	It was observed during the site tour and discussions with the site team that currently, gas detection system is not installed at gas booster compressors. Gas leakage is an extreme fire and explosion hazard and needs to be monitored on continuous basis. Moreover, the gas leak detectors should be interlocked with the closure of emergency shutdown valve, installed at gas receiving station.		
Recommendation	It is recommended to install the gas detection system at gas booster compressors and to interlock/wire the gas leak signal with the Emergency shut off valves.		
Client Response	Client agreed to comply with the recommendation.		
Status	***April 2019: New***		

STG AC and DC Lube Oil Pump Power Cables		B	2019/04/15
Date Raised / Revised	April 2019		
Risk Exposure	Fire		
Description	Steam Turbine Lube oil tank is cited at “0” meter TG building. The power cables to the STG AC and DC oil pump motors are running together in the proximity of the main lube oil tank. A fire in this area could quickly burn out both cables and starve the bearings of oil before the STG has been brought to rest. The following extract is taken from the 2010 edition of NFPA 850: 7.7.3.8 “cable for operation of lube oil pumps should be protected from the fire exposure. Protection can consist of separation of cable AC and DC oil pump or 1- Hr fire resistive coating (derating of cable should be considered)”.		
Recommendation	It is recommended that fire proof paint (intumescent paint) to be applied to the power cables from the STG AC and DC lube oil pump motors terminals up to the conduit portion.		
Client Response	Client agreed to comply with the recommendation.		
Status	***April 2019: New***		

SECTION FOUR

SITE DESCRIPTION

Power Plant is located at Village Palatana, Udaipur in Gomoti district in the Indian state of Tripura. The plant comprises two blocks of Combined Cycle Power plants i.e. power block 1 and block 2.

The first block (363.3 MW) of the power plant was declared under Commercial Operation from 4th January, 2014 and the second block (363.3 MW) of the two blocks was declared under Commercial Operation from 24th March 2015.

Owners

Shareholding pattern of the company is as mentioned below:

Company Name	Percentage Shareholding
Oil and Natural Gas Company Limited (ONGC)	50
Infrastructure Leasing and Financial Services Limited (IL&FS)	26
India Infrastructure Fund – II (IIF- II)	23.5
Government of Tripura	0.5

Operator

Plant Operation and Maintenance contract has been awarded to STEAG Energy Services since 3rd January 2017 for three years.

STEAG GmbH operates power plants using fossil fuels and renewable energy sources.It produces and supplies electricity and thermal energy worldwide. It also provides district heating for households, utilizing residues from coal fired power plants in concrete industry, and large scale battery systems to secure electricity supply.

It serves to energy utilities, municipal enterprises, and industrial and commercial businesses; and customers ranging from private individuals to large consumers and property companies.

STEAG GmbH was formerly known as Evonik STEAG GmbH and changed its name to STEAG GmbH in June 2011.

The company was founded in 1937 and is based in Essen, Germany.

Business Model

Currently OTPC have long term power purchase agreement for 726 MW with the following state electricity boards:

State	Capacity (MW)
Assam	240
Meghalaya	79
Manipur	42
Nagaland	27
Arunachal Pradesh	22
Mizoram	22
Tripura	196
Balance on Merchant Sales	98

State	Capacity (MW)
Total	**726**

Site Description

Location

The grid coordinates for the sites are:

Co-ordinates:	Longitude	Latitude
OTPC, Udaipur, Tripura	91.4396° (E)	23.4992° (N)

The plant is located at Palatana, Udaipur Village at Gomoti District in the Indian state of Tripura.

As per Munich RE Nathan charts, the plant site is located in Zone 2 for earthquakes, Zone 5 for lightning, Zone 2 for tornados and in Zone 3 for flash floods. For the other natural perils including storms, cyclones, tsunami and volcanoes, the site is in “no hazard” or low hazard zones. All the critical structures like chimney, HRSGs, GTT buildings, etc. are provided with the lightning protection covering the respective areas.

The area of the plant is approximately 80 ha and the layout of the site provides good spatial separation.

The nearest commercial airport is at Agartala, which is the main airport for the region and is situated around 73 km to the North West of the plant. There was no indication of flight paths over the site during the survey.

The road access to the plant is through State highway.

Natural Perils

The most recent Nathan Single Risk Assessment Report is shown in the following chart.

Hazard Score Rating

Hazard zoning values for significant natural hazards

	low	high	hazard rating
Earthquake			Zone 2
Volcanoes			No hazard
Tsunami			No hazard
Tropical cyclone			Zone 1
Extratropical storm			No hazard
Hail			Zone 2
Tornado			Zone 2
Lightning			Zone 5
Wildfire			Zone 2
River flood			Zone 0
Flash flood			Zone 3
Storm surge			No hazard

Overall the risk is considered as high due to higher storm/cyclone and lightening exposure.

Third Party Risks

Plant is surrounded by agricultural land from three sides and Udaipur town from the forth side. There are no third party hazards in the locality.

Layout

The plant occupies a large area and is well laid out.

Both the Gas Turbines are housed at “0” meter TG building with a separation of around 70 meters in parallel configuration.

Both the Steam turbines are housed in the turbine building at TG floor with an axial configuration having separation of around 75 meters.

HRSGs are outdoor installations located within their own steel frame support structures to the West of the Turbine Hall with approximately 70 m separation. The flue gas from each HRSG is released via steel stake located to the West of the HRSGs. The Plant Gas receiving and conditioning facilities are located to the North East of the main plant with about 350 meters of separation and can be considered as separate risk.

Hydrogen Generation Plant is located in the South East of Turbine hall with a separation of around 550 meters and can be considered as a separate risk as well.

Steam Turbine Generator lubricating oil tanks and pumps are located at Turbine hall “0” meter floor and the tanks are bunded with oil drainage facility in place. Lubricating oil tanks are equipped with fixed fire protection system. Fixed fire protection system is not extended up to the lube oil filters and coolers. Fixed fire protection system for steam turbine generator bearings and lube oil piping is not installed (Recommendation 2019/04/10).

Gas Turbine lube oil system is located just besides respective Gas Turbine enclosure at “0” meter floor and in a separate enclosure. The enclosure is equipped with CO_2 based compressed gas fire protection system.

The seal oil skids/tanks for Gas Turbine are located in a pit at the ground floor of the Turbine Hall (besides Gas Turbine Enclosures). These tanks are not equipped with fixed fire protection system (Recommendation 2019/04/11).

The Station transformers, Generator Step up (GSU) Transformers (for Gas Turbine Generators and Steam Turbine Generators) and Unit Auxiliary transformers are located to the East of the turbine hall.

A blast/ fire wall and containment (filled with stone chips) has been provided between each GSU transformer, Unit Auxiliary transformer and station transformer suitably as per NFPA 850.

GSUs, Station transformers and Unit Auxiliary Transformers are equipped with fixed fire protection systems.

Chemical house is located around 170 meters south east of TG building.

Cooling towers are located around 250 meters south west of TG building.

Construction

All the major buildings like turbine hall, ware house building, admin building, Fire water pump house, switchyard control building, DM Plant and other water treatment buildings are constructed of non-combustible material.

Details of various plant and non-plant buildings are as mentioned below:

Description	Roof material	Walls material	Remarks
Turbine Generator hall	Non-combustible Unprotected	RCC walls	
Unit Control Room	Combustible	RCC walls with wooden interior decoration on partition walls	False floorings tiles are also combustible in nature (made up of wooden dust)
Fire Pump Room	Non-combustible Unprotected	RCC walls	
Fire Station	Non-combustible Unprotected	RCC Walls	
Gas receiving station and GBC (Gas Booster Compressor) area	Non-combustible Unprotected	Steel structure	

SECTION FIVE

PROCESS DESCRIPTION

Gas Turbines

Gas turbines (model MS 9001FA+e) is supplied by General electric.

This is single fuel fired machine which can only run on natural gas. This machine has 18 stages compressor with 1:16.5 compression ratio. Gas Turbines are equipped with Dry Low Nox type (DLN 2.0) combustors.

Gas turbine is a three stage impulse type turbine with shaft rated speed at 3000 rpm. The various interlocks on the gas turbine includes but not limited to low lube oil pressure (alarm and trip), generator trip lockout, exhaust pressure high (trip), excessive vibrations (alarm and trip), control system fault (trip) etc.

Pre-ignition trips includes DC lube oil DC pump under voltage (trip), failure to ignite on gas (trip), shutdown gas leak test failed (trip), start-up gas leak test failed (trip), gas purge fault (trip), natural gas level Hi Hi level (trip), seal oil DC motor under voltage (trip) etc.

Post ignition trip on gas turbines includes loss of flame, high exhaust temperature, load tunnel temperature high, exhaust over temperature, exhaust thermocouple open, compressor bleed valve position trouble etc.

Master protective trip on gas turbine includes protective status trip, pre-ignition trip, post-ignition trip, starting device trip, inlet guide vane control trouble, gas purge fault trip etc. Compressor degradation program is in place which includes online and offline water washing of the compressors.

Online water washing is done for 15 min. every 48 hours. Offline water washing is done during shutdown of the unit or every six months whichever is earlier.

Cross section view of the 9FA machine is as shown below:

Cross sectional view of DLN 2.0 combustor is as shown below:

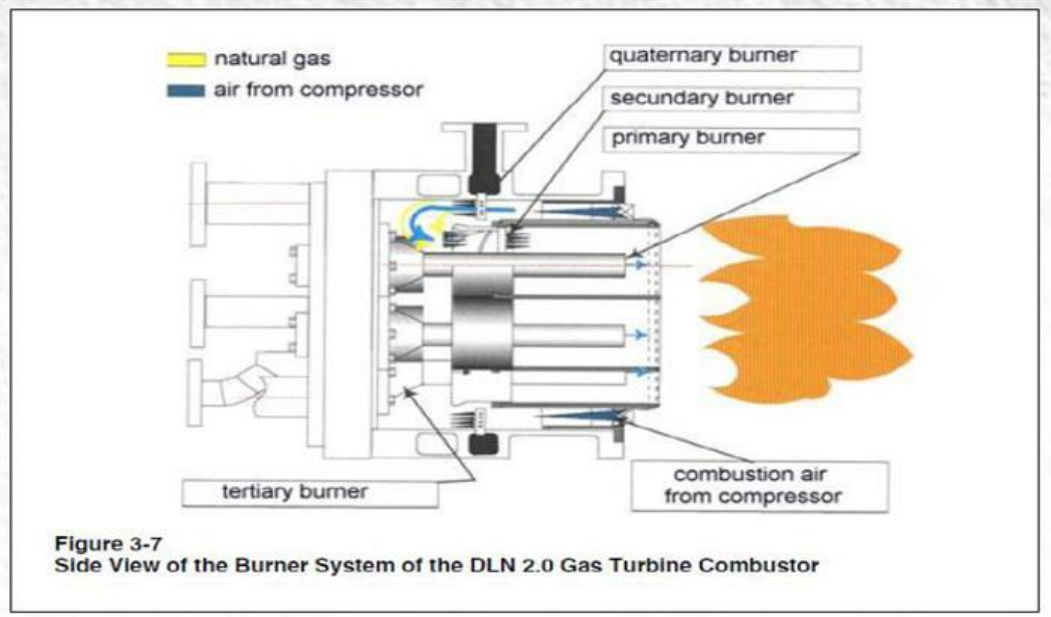


Figure 3-7
Side View of the Burner System of the DLN 2.0 Gas Turbine Combustor

Gas Turbine Specifications are as mentioned in the below table:

Designation	GT1 and GT2
General	
Service Status	Base Load
Spacing	50 meters
Turbine	
Designer	GE
Commissioning Year	For Block 1 it is 2014 and for Block 2 it is 2015
Model Number	9FA
Compressor stages	18
Compression Ratio	16.5:1
Compressor extraction stages	9th and 13th stages
Turbine stages	03
Type of Gas Turbine	Impulse Type
Combustor Chamber	Annular arrangement
No. of Combustors	18
Type of Combustors	Reverse Flow, Can annular
Type of burners	DLN 2+
Rating (MW)	232 (at site condition)
Fuels	Natural Gas
Liquid fuel NOx control type	No provision for liquid fuel injection. No use of water for Nox control.
Exhaust Temp (°C)	700
Speed RPM	3000
On line vibration analysers	Seismic velocity type (12 mm/sec alarm and 25 mm/sec Trip)

Lubricating Oil/Seal Oil	
System/Type	Mineral Oil ISO VG32
Piping	Welded
Containment	Yes

Steam Turbines

Details of the Steam Turbines are outlined in the following Table.

STEAM TURBINE - General Specifications	
Designation	**ST 1 and 2**
Spacing	50 meters
GENERAL	
Service Status	Continuous
Number of units	2
TURBINE	
Designer	Bharat Heavy Electrical Limited, India
Type & N° of cylinders & reheat	Two cylinder reheat condensing turbine
PCOD / Year	Unit 1 in 2014 and Unit 2 in 2015
Rating (MW)	131
Speed (RPM)	3,000
Online vibration monitoring system	Available (Alarm: 7 mm/sec, Trip: 11 mm/sec)
Online relative shaft vibrations	Alarm value 22 µm
LUBRICATING OIL/SEAL OIL	
Type	Mineral Oil
Piping	Stainless steel, Welded
Containment	Provided
Reservoir location	Lube Oil Tank at “0” meter TG Building
VIBRATION MONITORING	
HP/ IP/LP Steam Temperature and Pressure	
Pressure (MPa)	13.4/3.46/.44
Temperature (°C)	540/330/230

HRSG

The Heat Recovery Steam Generator (HRSG) is of horizontal, natural circulation, unfired, triple pressure reheat type.

The HRSG is designed to generate steam at 134 Kg/cm^2 & 540ºC (+/- 5ºC) at Main Steam Stop valve outlet at GT (gas turbine) base load in designed ambient temperature of 27ºC with natural gas firing in GT.

The HP steam is generated from HRSG at a pressure of 134 Kg/cm^2 and temperature of 540ºC with a flow rate of 289.6TPH (Tonnes per hour).

The IP steam is generated from HRSG at a pressure of 34.6 Kg/cm^2 and temperature of 330ºC with a flow rate of 35.6 TPH.

The LP (Low Pressure) steam is generated from HRSG at a pressure of 4.4 Kg/cm^2 and temperature of 230ºC with a flow rate of 36.7 TPH.
Safety relief valves are installed on IP economizer and water pre heater. As informed they are tested every year as per statuary law.

All the parameters of HRSG are continuously monitored using BHEL make MAXDNA DCS controllers in the unit control room.

Details of the HRSGs are outlined in the following table.

Designation	HRSG 1 and 2
Service Status	Continuous
Spacing	50 meters
GENERAL	
Number of units	2
Designer	BHEL (Bharat Heavy Electrical Limited), India
PCOD / Year	Block 1 in 2014 and Block 2 in 2015
Type	Horizontal, Natural Circulation, Water tube, top supported, fully drainable, modular design, Triple Pressure with Reheat type waste heat boiler.
Steam flow (t/h) HP / IP/LP	289.6/35.6/36.7
Steam pressure (MPa) HP/IP/LP	13.4/3.46/.44
Steam temperature (°C) HP /IP/LP	540/330/230
Boiler Fuels	NA
MISCELLANEOUS	
Water Chemistry Testing/Controls	Ammonia and Hydrazine as low pressure and Tri Sodium Phosphate as high pressure Dosing.
Boiler Feed water Pumps	2X100% HP BFP and 2x100 LP BFP (motor driven)

Gas Turbine Generators

Details of Generators are outlined in the following table.

Generator	
Designation	**Generator Unit 1 and 2**
Make	Bharat Heavy Electrical Limited
PCOD / Year	Unit 1 in 2014 and Unit 2 in 2015
Rated voltage (kV)	15.75
Rated output	232.39 MW (at site conditions)
Phase	3 Phase
Frequency (Hz)	50
Power Factor lagging / leading	0.85 Lagging
Rotor cooling	Hydrogen
Stator cooling	Hydrogen
Insulation Class	F

Plant comprises two Emergency Diesel Generator sets of 750 kVA each and has been supplied by Jackson, India.

Steam Turbine Generators

Generator	
Designation	**Generator Unit 1 and 2**
Make	Bharat Heavy Electrical Limited
PCOD / Year	Unit 1 in 2014 and Unit 2 in 2015
Rated voltage (kV)	15.75
Rated output	131 MW
Phase	3 Phase
Frequency (Hz)	50
Power Factor lagging / leading	0.85 Lagging
Rotor cooling	Air
Stator cooling	Air
Insulation Class	F

Transformers

Details for Transformers are as mentioned in below table.

Transformers	Gas Turbine Generator Transformer	Steam Turbine Generator Transformer	Station Transformer	Unit Auxiliary Transformer
Number	02	02	02	02
PCOD Year	Unit 1 in 2014 and Unit 2 in 2015	Unit 1 in 2014 and Unit 2 in 2015	Unit 1 in 2014 and Unit 2 in 2015	Unit 1 in 2014 and Unit 2 in 2015
Rating (MVA)	287 (@27ºC)	150	20/25	16
Serial Voltage (kV)	15.75 – 420	15.75 - 420	132 – 6.9	15.75 – 6.9
# Phases	3	3	3	3
Frequency (Hz)	50	50	50	50
Cooling	OFAF	ONAF	ONAN/ONAF	ONAF
Oil type	Mineral	Mineral	Mineral	Mineral
Drainage/Containment	Available	Available	Available	Available
Blast wall to NFPA 850	Available	Available	Available	Available
Protection Relays	Available	Available	Available	Available
Vector Group	YNd1	YNd1	YNyn0	Dyn11
Tap Changing equipment type	OLTC +/- 10% IN 1.25% Steps in HV side	OLTC +/- 10% IN 1.25% Steps in HV side	OLTC – 12.5% to +7.5% IN 1.25% Steps in HV side	OLTC +/- 05% IN 2.5% Steps in HV side

Switchyard

Plant comprises of air insulated switchyard of 400 kV and 132 kV.

All the generators are connected to 400 kV switchyard through generator transformers and 132 KV switchyard through Inter connecting transformers. Two overhead 400 kV outgoing overhead transmission lines supply the power grid sub stations and two overhead 132 KV lines are connected to state sub stations.

Generator circuit breakers are installed in the 400 kV switchyard side. They are supplied by ABB.

Station transformers are connected to the 132 kV switchyard.

Fuel Supply Systems

Natural Gas receiving station

ONGC supplies natural gas to the plant from the wells, which are located around 10 km to 57 km from plant.

Gas from ONGC side is supplied at a pressure of 14-15 Kg/cm^2 at a temperature of 27-28ºC. Upstream of the OTPC gas conditioning skid, ONGC also has gas conditioning skid, which is just besides the OTPC skid and is being operated by ONGC personnel.

There are two streams, one running and one standby present in Initial Gas Conditioning Skid (IGCS), each having scrubber and Filter-Separator.

There are 3 Gas Booster Compressors (GBCs) in the Gas Boosting Compressor Station (2 running, 1 standby for 2 Units).

From the IGCS, the gas flows to GBCs where the pressure of the gas increases to 32-34 Kg/cm^2 and temperature increases to 130ºC.

From IGCS the gas flows to Final Gas Conditioning Skid (FGCS), separate for both Units, where the temperature of gas is increased to 185ºC.

There is a gas flow Measure Control Room in the IGCS.

There was no gas detection and alarm system provided in the said Control Room in the event of any leakage of natural gas (Recommendation 2019/04/14).

Online Chromatography is done at the site near the gas metering station.

There are two redundant lines for chromatography. Helium is used as the carrier gas for gas chromatography.

Site is located in 50 years earthquake zone (as per FMDS 1-2), seismic shutoff valves were not installed on the natural gas pipelines to shut off the gas supply automatically in case of earthquake.

River Water Supplies

The source of plant raw water is river Gomati and the water intake point is only 2 km away from the project site.

There are four numbers of vertical pumps of capacity 1100 m^3/h installed to supply water to the project through a GRP pipeline of 900 mm diameter, which is stored in a reservoir of capacity 1, 78,000 cubic meters.

Raw water is clarified in the pre water treatment plant and then stored in the clarified water tank and fire water tank.

Water from clarifiers is directly routed to clarified water tank and fire water storage tanks through gravity with a motorized isolation valve.

From clarified water tanks, water is either used as service water, make up water for condenser cooling water system, or at Demineralised plant.

Plant comprises two raw water clarifiers.

There is a chemical house for chemical treatment of raw water. Alum, biodispersent and Flocculent are added in the raw water before it is clarified in clarifiers.

Compressed Air

Plant comprises of two screw air compressors (of 100% capacity each), supplied by Atlas Copco

Out of the two compressors, one is in service for service and instrumentation air requirements and the other one is in standby.

Cooling Towers

The cooling towers employed at site are counter flow induced draft parabolic masonry cooling towers with plastic fills (Each unit have one cooling tower with 8 cells out of which 7 are in running mode while one is redundant).

The condenser cooling system is water cooled with vacuum extraction pumps.

Cooling water cycle can only run in closed cycle mode. It is not designed to be operated in once through cycle.

Plant Protection Systems

Gas Turbine Protection systems

Gas Turbine Protection and control Systems are implemented through the Distributed Control System (DCS).

DCS for Gas turbine protection and control systems has been supplied by GE (MARK VI).

Gas Turbine major protections include (but not limited to):

- Over speed protection (electronic protection systems are in place).
- Lube/control oil pressure low.
- Vibration high (12 mm/sec alarm and 25 mm/sec Trip).
- Loss of flame.
- Over Temperature.
- Combustion monitoring.

HRSG Protection Systems

Plant HRSG Protection System is implemented through the Distributed Control System (DCS).

HRSG is equipped with BHEL make (MAXDNA 4.2.2 – SP4) DCS systems. This is (Safety Instrumented Level) SIL 2 rated system.

HRSGs are not equipped with duct burners and have three pressure drums i.e. High pressure, Intermediate pressure and Low pressure drums.

Each drum is equipped with three level transmitters and one hydrastep. These level transmitters are used for HRSG protection and control based on 2oo3 voting. These level transmitters are calibrated on annual basis by C&I maintenance during annual shutdown.

There are 2X100% High pressure Boiler Feedwater pumps and 2X100% Low Pressure Boiler feed water pumps, which feed HRSG.

Steam Turbine Protection System

Plant Steam Turbine Protection System (TPS) and Steam Turbine Control system (TCS) are implemented through the Distributed Control System (DCS).

DCS for Steam turbine protection and control systems has been supplied by BHEL (MAXDNA 4.2.2 SP4) only.

Steam Turbine protections include (but not limited to):

- Turbine over speed protection (both mechanical and electronic protection systems are in place).
- Turbine lube/control oil pressure low.
- Turbine vibration high (200µm is Alarm and 320 µm is Trip).
- Turbine shaft and Casing differential expansion.
- Turbine eccentricity high.
- Turbines exhaust pressure high.
- Lube oil level low in Main Lube oil Tank.

Generator and Transformer Protection System

Generators have following (but not limited to) digital protections installed:

- Generator protection trip, where in the electrical tripping is getting initiated by the various differential protection relays installed.
- Generator vibration high.
- Generators lube oil pressure low.
- Generator seal oil pressure low.

Transformers (for both the blocks) have different type of differential protection relays, and Buchholz relays, installed for all the electrical protections.

Control Systems

There is a control room for the plant. Control room is located on the steam turbine floor, overlooking the Steam Turbine floor.

Plant comprises of following DCS/control system:

- BHEL's MAXDNA 4.2.2 SP4 for HRSG and Steam Turbine control systems.
- GE's MARK VI for Gas Turbine control and protection.
- Other Balance of plant systems like DM Plant, Hydrogen generation plant, cooling water systems are equipped with GE make PLC systems.
- Fire water system is equipped with Rockwell Make PLC.

UPS / DC Power Supplies

Plant is equipped with 220V DC system comprises of Ni-Cd battery banks and battery chargers (one working and one stand by) for critical drives operation, switchgear control supply and emergency lighting.

For gas turbine control systems (GE make MARK VI), 125 V DC systems have been installed (1 Working and 1 standby per Block)

For HRSG and Steam Turbine control systems following UPSs are installed.

- 230V (50Hz) AC UPS (one working and one standby) have been installed in each unit.
- 230V AC supply is directly fed to DCS as a power supply.

The 230V UPS is installed to cater the power requirements of HMIs (Human Machine Interfaces), SCADA and power supply for some critical valves and actuators like actuator for boiler feed water pump scoop coupling actuator.

Projects

No new projects reported.

Insurance Loss History

No Losses reported till date.

SECTION SIX

PLANT STATUS

Operational Performance

System Control and Dispatch

Plant receives load demand from a Load dispatch centre located in Shillong, Meghalaya.

On the day of the survey, only Block 2 was operational with the gross output as 328 MW.

Block 1 was out of operation due to the jamming of the steam turbine post a steam turbine trip initiated due to plant black out.

Performance Data

Station Performance

Year	Availability Factor	Plant Heat Rate (Kcal/KWh)
2016 - 2017	67%	1805
2017 - 2018	64%	1834
2018-2019	85.15	1790

Fired and Outage Hours

Year	Unit 1fired Hours	Unit 2 Fired Hours	Plant Planned outage Hours	Plant Forced outage hours
2016 - 2017	7591	7726	1428	797
2017 - 2018	8026	8083	944	485
2018-2019	8223	8401	384	479

Warranties

All the warranties are expired.

Technical Issues

Steam Turbine

During the survey, Block 1 steam turbine was out of operation due to jamming, post a trip on account of station black out.

After the Steam Turbine trip, while coasting down, both the AC and DC jacking oil pumps didn't come into operation in auto at the RPM set point and finally AC jacking oil pump was started in manual mode locally.

By the time AC Jacking oil pump started in manual mode, steam turbine got jammed.

As informed by the site team, this issue has occurred many times earlier as well. Historically, after cooling down (to around 170ºC), the steam turbine gets free and then rolled again.

It was understood that OTPC has discussed the issue with OEM (Bharat Heavy Electrical Limited) and carried out steam turbine inspections (Based on the OEM's recommendations) like checking internal clearances, bearings etc. and found the same in order.

Further, site informed that same issue is there in the similar steam turbines installed for the other clients as well.

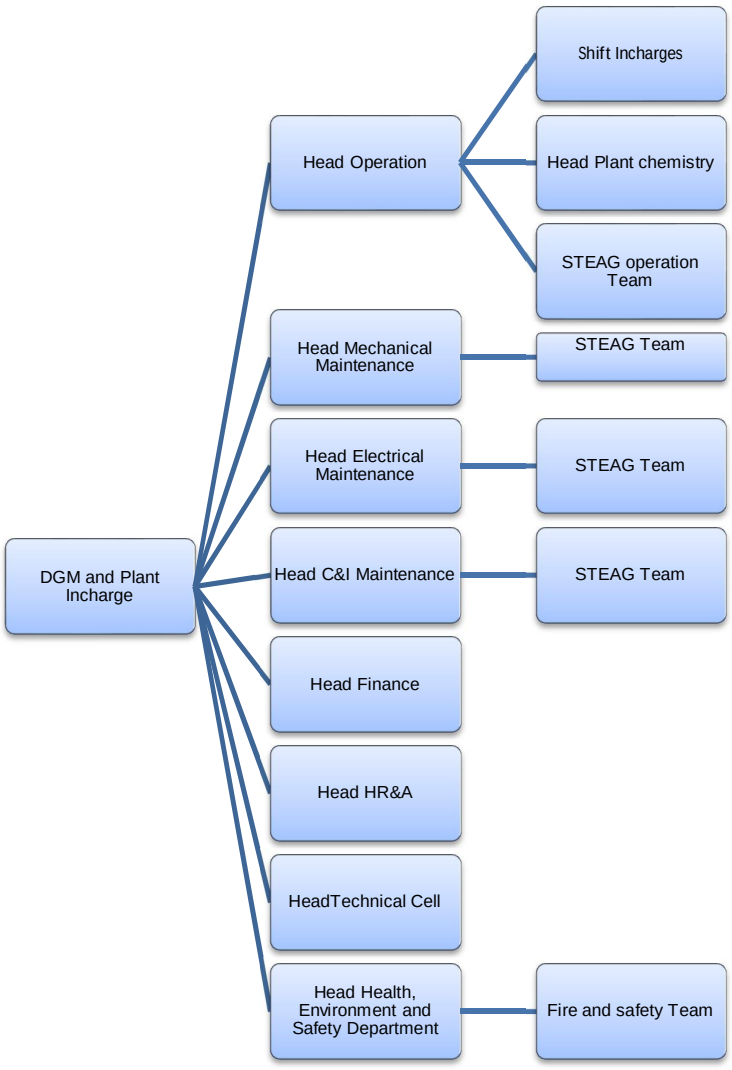
Site is in discussion with BHEL on this issue and awaiting the response.

SECTION SEVEN

MANAGEMENT SYSTEMS

Site Organisation

The Owner's management team at site includes:



Accreditations

OTPC has acquired following accreditations:

- ISO 9001:2015.
- ISO 14001:2015.
- BS OHSAS 18001:2007.

Management of Change (MOC)

During the control room visit it was observed that OTPC has a good system of trip bypass control.

OTPC has divided the protection / permissive bypass control into two groups for better monitoring. First group is for equipment protection bypass control. This bypass request is initiated by unit control room operators. This request is then approved by shift charge engineers.

Second group pertains to the unit protection / trip bypass control. In this, further approval of Plant In charge is also sought.

In Plant daily O&M meetings, each bypass is discussed in detail. Any trip/protection bypass getting extended beyond the approved time period is brought to the higher management's notice and plan to expedite the normalization is also prepared and followed up.

Document Management

Standard and Emergency Operating Procedures are being managed in electronic as well as physical form.

Physical copies of the procedures are kept at control room but these are not updated on regular basis. These procedures were last updated in 2015.

Individual maintenance departments hold records of their respective maintenance reports.

During the control room visit, various documents like start-up procedures, permissive and protection documents, pre start check list and pre start check list for electrical operations observed in paper form and operators informed that the above mentioned procedures were used extensively.

Operations

Organisation

Plant Operation and Maintenance contract has been awarded to STEAG Energy Services since 3rd January 2017 for three years.

There are four shift groups, which rotates in three shifts. Morning shift runs from 7AM to 2PM, evening shift from 2 PM to 10PM and night shift from 10PM to 7AM.

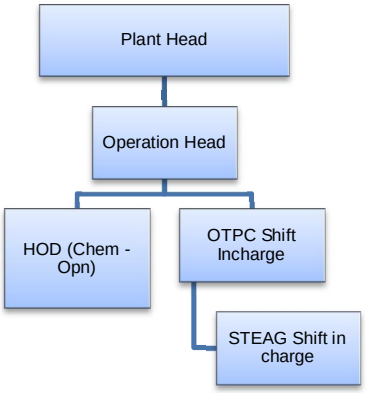
STEAG is currently deploying three desk engineers and one shift in charge engineer at control room and four operators and two helpers at site, per shift.

OTPC deploys one control room shift in charge in each shift. STEAG team reports into OTPC shift in charge and OTPC shift in charge further reports into plant operation head.

In view of the above, STEAG deploys 35 persons in plant operation.

Desk operators report into shift in charge and shift in charge reports into Operation head.

Organogram of the operation team is as mentioned below:



Operations Staffing

The operation staff level currently seems to be sufficient.

Shift Handover Procedure

Three levels of shift handover are there as mentioned below:

- Shift handover at desk operator (STEAG) level: This happens face to face with an overlap of 30 Minutes. Desk operators maintain manual logbooks.
- Shift handover at shift charge (STEAG) Level: This also happens face to face with an overlap of 40 -50 Minutes. Shift Charge Engineers maintain manual log books.
- Shift handover at shift charge (OTPC) level: This also happens face to face with an overlap of 40 -50 Minutes. Shift Charge Engineers maintain manual log books

Operating Procedures

Standard Operating Procedure documents are being managed in physical as well as electronic form and are not updated on regular basis (captured in observations).

During the control room visit, various documents like start-up procedures, permissive and protection documents, pre start check list and pre start check list for electrical operations observed in paper form and operators informed that the above mentioned procedures were used extensively.

Training and Competence Assurance

Selection procedure for trainee engineers at OTPC includes rounds of technical and personal interviews.

After the selections candidates are designated as Trainees and are going through one year rigorous training programme. This training programme comprises of class room sessions and site visits.

After completion of the training, candidates are absorbed into various OTPC departments for different roles.

Regular refresher trainings are also conducted for operation and maintenance staff.

Simulator trainings have not been planned till now.

Safe System of Work

Equipment isolation

This subject has been covered in standard operating procedures described above. This system involves all the departments, sections, individuals and contractor working at the plants and pipelines.

Prior to issuance of any permit to work, requisitioner needs to submit the duly approved job safety analysis form (JSA) by safety department. JSA form enlists the type of work, requirement of PPEs, lifting tackles to be deployed and health of this equipment, requirement of scaffolding and health of this etc.

There is a lock out tag out (LOTO) system in place for equipment isolation and support the production of Isolation Certificates by the Authorised Persons. Authorised person is a competent person adequately trained and appointed in writing by OTPC, after testing, to carry out specific work on any system, apparatus or plant. The certificate of appointment shall state the type of work the person is authorised to carry out, and the apparatus, plant or section to which it applies. The authorised person can receive, clear and suspend his Permit to Work (PTW).

Hot Permits are issued for a day only. It was observed that this is followed rigorously and the hot PTWs are cancelled on the same day and if required these are issued the next day.

Types of permits based on work are as mentioned below:

1. PTW: Permit to work where electrical isolations are required.
2. LWC: Permits where no electrical isolations are required but the area of work is limited.
3. SFF: Sanction for test permit.
4. Auxiliary PTW: For any hot work.

Control of Work

Permission for the execution of work is controlled through Permits issued by the Authorised Person and based on Isolation Certificates. There are a range of different permits in use depending on the result of the risk assessment carried out by the AP, permits used includes:

- Permit to Work.
- Hot Work Permit.
- Confined Space Permit.
- Working at Height Permit.
- Permit for Excavations.

Operational Testing Routines

Steam Turbines and gas turbines are equipped with electronic overspeed protection devices. Functional overspeed test at reduced RPM is not conducted annually (Recommendation 2019.04.01). Presently actual overspeed test are planned during major shutdowns.

Control Valves of the Steam Turbines are subjected to continuous exercising as the load set point is changed based on the demand however; stop valves are not subject to exercising (Recommendation 2019.04.03). Quick closing NRVs' are checked for freedom of movement on monthly basis.

Stop and control valve tightness test is conducted on opportunity or at least on annual basis, which is good practice.

DC Oil Pumps for lube and seal oil are operated on daily basis by push button start but the starting of the pumps on low oil pressure is not simulated on regular basis (Recommendation 2019/04/02).

Annual emergency shut off valve (installed at gas receiving station) testing is not carried out (Recommendation 2019/04/04).

The Emergency Diesel Generator (EDG) is push button started on weekly basis but synchronization and full load test is not conducted during annually (2019/04/07).

Capacity test for DC batteries (full discharge) is carried out on annual basis.

In HRSG annual Trevi test (online) is being carried out on annual basis by third party.

HRSG drum level transmitters are tested and calibrated on annual basis.

Changeover of UPS is carried out on regular basis.

Water / Steam Chemistry Controls

All volatile treatment (Reducing) is being carried out presently where in both ammonia and hydrazine is dosed after the condensate polishing units.

Tri sodium Phosphate (TSP) is dosed directly into the HRSG drums.

Cation Conductivity meters is installed at all the strategic location to detect any tube leakages in condenser.

Grab samples are collected per shift to cross check the correctness of online analysers.

Off Load Preservation

Following off load preservation practices are being followed for different equipment:

- HRSGs are preserved by wet preservation and regular monitoring and correction of water quality.
- Steam Turbines are preserved by hot air circulation and periodic barring.
- For generators, hydrogen is charged all the time.

Ergonomics & Operability

Control Rooms were observed to provide good spatial separation between unitized control desks and well laid out. The majority of the critical equipment was observed with labels and good access all around.

Lighting levels in the plant need an audit (captured in observations) and access to all the critical equipment and valves is provided.

Standard and emergency Operating Procedures are maintained both in electronic and physical form in control room but the same are not updated on regular basis. It was last updated in 2015 (captured in observations).

During the control room visit, various documents like start-up procedures, permissive and protection documents, pre start check list and pre start check list for electrical operations observed in paper form and operators informed that the above mentioned procedures were used extensively.

Alarm Management

During the discussions with the site team, it was observed that currently alarms are managed based on the priority with colour coding however, number of alarms per operator per shift is currently not monitored.

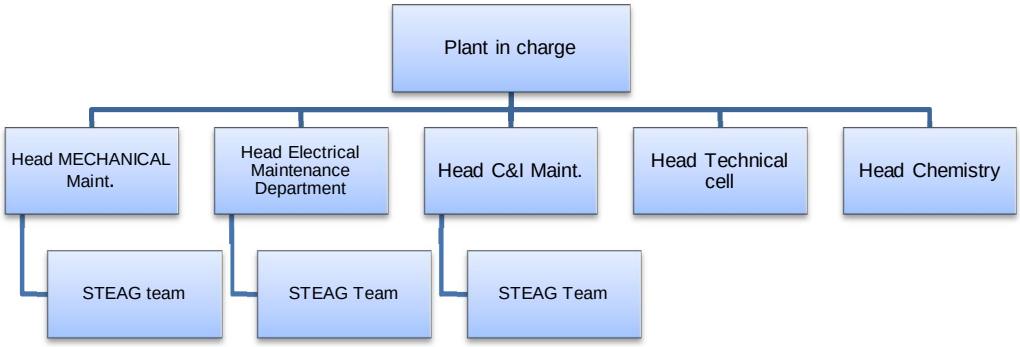
For Fire detection system, Fire alarm reporting system has been installed in the control room. The repeater Fire alarm reporting system has been installed in the fire control building as well. All the fire alarms are displayed both at control room and fire control building simultaneously.

Maintenance

Organisation

Plant Operation and Maintenance contract has been awarded to STEAG Energy Services since 3rd January 2017 for three years.

The maintenance organisation (OTPC) is shown in the following chart.



OTPC persons are deployed only at the key positions to supervise the O&M contractor and for spare part management.

In all there are around 65 persons in maintenance department (including STEAG).

Work Identification, Planning and Control

The Maintenance Philosophy is based on a blend of Preventive, Predictive, Pro-active and Corrective Maintenance activities.

Maintenance management module of SAP is currently in place for planning all types of routine maintenance activities, spare part management, capturing and monitoring regular defects and managing store activities like material issue, stock maintenance, material receipt etc.

Any abnormality, defects etc. are also captured in the SAP. While capturing the defects, concerned departments are assigned and notified with the maintenance jobs.

Regular follow up on the pending defects is being carried out during daily O&M Meetings.

Currently, for Gas Turbines Hot Gas Path Inspection (HGPI) is carried out every 32000 factored fired hours and Major Inspection (MI) is planned every 64000 effective burning hours (i.e. 32000 hrs, after the HGPI).

Block 1 GT HGPI was carried out in Aug 2017 and Major Inspection is planned in Aug 2021. Block 2 GT HGPI is planned in Aug 2019 and Major Inspection is planned in March 2023.

Steam Turbine Minor Shutdown is planned every 25000 Hrs and major shutdown is planned in every 1,00000 hrs.

Condition Monitoring Tools used for Predictive Maintenance include:

- Online Vibration Monitoring.
- Portable Vibration Monitoring by portable instrument.
- Temperature Monitoring.
- Thermography.
- Ultrasonic thickness gauging (UT).

- Material Identification.
- Dye penetrant test (DPT).

Gas Turbines

OTPC has entered a long term service agreement with GE.

This LTSA is in force till 2026 and covers HGPI and Major inspection and supply of all the required spares, which need replacement. Moreover, two GE persons are deputed at site for coordination.

During HGPI Following activities are carried out:

- Boroscope inspection of compressor.
- IGV calibration.
- Bell mouth cleaning.
- Replacement of all (three stages) gas turbine buckets, shrouds and nozzles.
- Replacement of combustor fuel nozzles, transition piece, liners and end cap.

During Major inspection other than the above activities, compressor is thoroughly inspected after opening the compressor casing.

Steam Turbines

Minor Steam Turbine overhauls are scheduled to be carried out every 25,000 effective running hours and the scope of the work includes:

- Bearing inspection.
- Alignment checks.
- Stop valves and governor valves are inspected and overhauled.
- Inspections of last stage blades.

In Major Steam Turbine overhauls (scheduled every 1,00000 effective running hours), in addition to the work carried out during minor overhauls, the scope of work for the major overhauls includes:

- Casing removal and full strip down of the Turbine.
- Rotor removal, cleaning and inspection.
- Magnetic particle inspection and ultrasonic inspection on Turbine rotor, blades, piping and flanges.
- Metallurgical replication on welded joints.

Steam Turbine Lube oil analysis is carried out on monthly basis where in Lube oil viscosity, colour, moisture and acidity is analysed and trended.

OEM is contracted for the Steam Turbine overhauling. This subcontract is both for spares and service.

Generators

Minor overhaul are scheduled to be carried out on the Generators every 25,000 effective running hours.

The scope of work for a minor overhaul includes:

- Visual inspections and cleaning.
- Excitation system overhaul.
- Bearing inspections.
- Cleaning and inspection of coolers.
- Replacement of all consumables and gaskets.

- Inspection of all connections.
- Hydrogen seal clearance inspection.

Testing during minor overhauls includes Insulation Resistance (IR), Polarisation Index (PI) and testing of current transformers and voltage transformers. Generators protection testing is performed and includes both secondary and primary injection.

The scope of work for a major overhaul (scheduled every 100,000 effective running hours) also includes:

- Generator rotor removal.
- Full inspection of all Generators.
- Wedge tightness checks- the wedged are of the spring type.
- Tan Delta testing of the windings.
- Dye Penetrant.
- Ultrasonic testing for flaws / cracks.

Testing during major overhauls includes IR, PI, testing of current Transformers and voltage transformers, off line partial discharge monitoring and a high voltage tests.

OEM team members are contracted for supervision of Generator overhauling.

HRSGs

The scope of overhauls includes:

- Full visual inspection of all tube banks, headers, steam drum and deaerator.
- Ultrasonic thickness checks in critical areas on tubes, headers and piping.
- Hydro tests are performed after repairs have been carried out. Final hydro tests (at 1.25 times the design pressure) are witnesses by a boiler inspector (Represents Statutory Body under the constitution of India; Boiler Regulation Act 1950).
- Dismantle pressure safety relief valves; inspect components including the use of dye penetrant inspection and recalibrate.
- Flanged pressure safety relief valves are removed, overhauled by a specialist company and bench tested in the presence of an OTPC representative.
- All rotating equipment is internally inspected, bearings are inspected and alignment is checked.
- All the headers are subjected to Ultrasonic tests and die penetrant tests to check any defects.

HRSG safety valves are Trevi tested on Annual basis.

High Energy Pipework

High energy piping inspection is not being carried out currently (Recommendation 2019/04/13).

Transformers

Transformer insulation oil is sampled from all the transformers biannually and sent to CPRI, Guwahati labs or STEAG Labs, Noida for DGA. The STEAG lab for DGA oil analysis is NABL accredited.

Tests for Furans and corrosive sulphur are also performed on transformer oil.
Results for last DGA analysis were observed and TDGC levels were observed satisfactory with respect to the levels as per IEEE C57.104 -2008.

Major Transformer maintenance is scheduled to be carried out every 2 to 3 years. The scope of work includes:

- Visual inspection including High Voltage and Low Voltage bushings.

- Cleaning.
- Cooling system maintenance.
- Protection testing.
- The tap changer is cycled through its full range.
- Tan Delta test on Bushing and winding.
- Turn ratio test.
- Magnetic balance test.
- Magnetising current test.
- Trips interlock tests.

Balance of Plant

Motors

Large High Voltage motors are scheduled every six months for maintenance. During this maintenance, vibration analysis, current and temperature trend monitoring is done during running.

The overhaul of large motors is carried out on annual basis where in rotors are threaded out for full electrical test.

Generator Circuit Breaker

During the annual overhauls following activities are carried out on Generator circuit breakers:

- Contact Resistance test.
- Time elapse in make or break of the contact.
- Open-close- open test.
- Dynamic Contact resistance

DC Power System

Routines have been established for maintenance of batteries and inverters. Batteries are of Nickle cadmium type.

Following activities are done on DC system as a preventive maintenance:

- Voltage Monitoring.
- Terminal tightness.
- Insulation resistance test for chargers.
- Earth Fault monitoring.

Battery full discharge / capacity tests are carried out on annual basis.

I&C Systems

Maintenance routines have been established for instrumentation and control equipment on a weekly, monthly, annual, minor overhaul and major overhaul basis.

Critical transmitters are inspected, calibrated and certified every year. Non critical transmitters are tested once in every 2 years.

DCS loop testing is carried out in every minor overhaul. One static IP (with firewalls) has been assigned to the DCS OEM for online fault diagnosis.

Predictive Maintenance

Vibration Monitoring

Gas Turbine Generators, Steam Turbine Generators and large motors (High Voltage Motors like Condensate extraction pumps, boiler feed water pumps and CW pumps) are equipped with fixed vibration monitoring system.

Vibration readings are displayed in the control rooms and are being monitored.

Vibration checks on the other rotating equipment are carried out, using a portable device on quarterly basis.

Vibration data is downloaded analysed and equipment vibration levels are trended.

Thermographic Surveys

Thermographic surveys on electrical equipment such as transformers, large motors, Switch gear etc. are carried out on regular basis.

Site is equipped with Thermographic cameras.

Lube Oil Analysis

Quarterly Steam Turbine Lube oil analysis is carried out where in colour, viscosity, acidity and moisture is analysed and trended.

Metal particles analysis is carried out on request or after equipment overhaul.

Spares

SAP is deployed for spare part management.

Optimum spare part inventory levels are defined in the SAP system for all the equipment. Material issue, new arrival is also captured into the SAP system. Notifications are generated and sent to the concerned maintenance team member if inventory falls below a certain levels.

Moreover, existing spare parts are categorized as per criticality and Usage.

Different type of storage facilities like Open yards, closed and semi closed, air-conditioned etc. are there for different materials.

Currently gas turbine spares, which are envisaged to be replaced during HGPI and MI, are available but the compressor spares are not available. This was discussed with the site team and it is understood that OTPC has connections with GE and other clients having similar GT sets for the arrangement of compressor spares if required.

Safety

Tripura State Rifles, a security force of government of Tripura is deployed in the plant for security of the plant whereas fire and safety is being taken care by STEAG and OTPC staff.

All contractors' staff and new staff have initial safety induction (orientation) training. Safety procedures follow Occupational Safety and Health Administration System (OSHAS) guidelines. New recruits initially work under a foreman and an individual work specific training plan includes safety training.

Near Miss, first aid, reportable and fatal incidents are monitored.

Smoking is not allowed in the plant.

There is a procedure for investigating accidents including determining root cause. The investigation team members are dependent on the severity. Action from the investigation is reviewed quarterly for progress. Near misses are reported.

For contract labours, prior to issuance of gate passes safety training and medical examination is a must.

A full-fledged executive training program on fire and safety is mandatory along with the annual refresher training.

Plant safety parameters are as mentioned in the below table:

Parameter	Units	2015	2016	2017	2018
Loss Time Injury	Nos.	0	0	0	1
First- aid cases	Nos.	26	97	34	12
Occupational Diseases	Nos	0	0	0	0
Safety Training Hours	Man-hours	283	657	2460	2596

Environment

The plant emission limits are outlined in the following Table (measured in March 2019):

Parameter	Unit of Measurement	Limit	Typical
Particulates(PM10)	PPM	50	44
SOx	PPM	200	0.94
NOx	PPM	50	19 - 20
Effluent PH	PH	6.5 – 8.5	6.92 – 7.79
ETP Effluent - TSS	Mg/l	NA	16.19

Physical Security

Tripura State Rifles, a security force of government of Tripura is deployed for the Plant security.

Access to the site is through a gatehouse that is continuously manned by armed guards.

Visitors require prior approval for issue of a Gate Pass and are accompanied from the gatehouse by a member of the plant staff.

The site is surrounded by approximately 2 m high brick and RCC Wall (topped with strands of barbed wire).

Cyber Security

Good cyber security measures observed at site.

Site intranet is completely isolated from the internet through firewalls.

All Units have independent LAN systems.

External memory device ports have been disabled in all the laptops and PCs.

SECTION EIGHT

EMERGENCY CONTROL

Fire Protection Features

Plant is equipped with fire detection and protection systems. All the detection systems (installed in the different hazardous areas) are connected to the central fire alarm panels and fire stations for better monitoring and control.

Fire alarm and detection system has been supplied by Detectomat, Germany (https://www.detectomat.com).

A basic level of fire detection and protection system was observed in the plant during the survey.

Fire protection and detection system has been supplied by UTC Fire and Security India Limited.

Fire detection systems are installed at Gas Turbine Enclosures, Steam Turbine Generator enclosure, main plant control room, DCS panel rooms, station switchgear rooms, Lube oil skids, Generator Step up Transformers, Station Transformers, Auxiliary Transformers and main plant cable cellar rooms.

Fire and gas detection systems at gas receiving and processing stations and gas booster compressor complex are not installed (Recommendation 2019/04/14).

Automatic fixed fire protection systems are installed at Gas Turbine enclosures, Steam Turbine Generator enclosures, Main control and DCS rooms, Lube oil skids, Generator Step up Transformers, Station Transformers, Auxiliary Transformers and main plant cable cellar rooms.

Fixed fire protection and detection systems at Steam Turbine Generator bearings and Gas Turbine Generator Seal oil tank skids are not installed (Recommendation 2019/04/10 and 2019/04/11).

Plant comprises of spray (for fixed fire protection system) and hydrant water reticulation system. These reticulation systems are mostly above ground. Fire water pumps are separate for spray and hydrant fire water system.

Plant is equipped with two numbers of motor driven pumps, one numbers of diesel engine driven pump, two numbers of jockey pumps, two set of compressors and one hydro pneumatic tank for hydrant system and one motor driven pump, one diesel engine driven pump for spray system.

Fire water tank is a concrete tank with a capacity of 3000 cubic meters capacity and is equipped with automatic level control mechanism. The intake to the fire water tank is directly from the clarifiers through gravity with a motorized isolation valve.

Site consists of a raw water reservoir of 178,000 cubic meters capacity.

Plant fire water system comprises of following pumps:

Pumps	Quantity	Flow (m^3/hr)	Head (m)	Supplier	Type
Main Hydrant Pumps (Electrical)	02	273	88	Flow more, India	Vertical Centrifugal
Stand by hydrant Pump (Diesel Engine driven)	01	273	88	Flow more, India	Vertical Centrifugal
Main Spray Pumps (Motor driven)	01	273	88	Flow more, India	Vertical Centrifugal

Pumps	Quantity	Flow (m^3/hr)	Head (m)	Supplier	Type
Stand by Spray pump (Diesel Engine driven)	01	273	88	Flow more, India	Vertical Centrifugal
Jockey Pump	02	20	95	Flow more, India	Vertical Centrifugal
Air Compressors	2	30	NA		
Hydro pneumatic tanks	1	80 M^3	NA		

Standards

As informed by the site team fire protection and detection systems have been designed based on respective NFPA standards.

Critical areas like Steam Turbine Generator bearings lube oil piping and GT Generator seal oil system as per NFPA 850 (Recommendation 2019.04.10 and 2019.04.11).

Passive Fire Protection

Separate Fire Compartments and Other Aspects

The plant occupies a large area and is well laid out.

Both the Gas Turbines are housed at “0” meter TG building with a separation of around 70 meters in parallel configuration.

Both the Steam turbines are housed in the turbine building at TG floor with an axial configuration having separation of around 75 meters.

HRSGs are outdoor installations located within their own steel frame support structures to the West of the Turbine Hall with approximately 70 m separation. The flue gas from each HRSG is released via steel stake located to the West of the HRSGs. The Plant Gas receiving and conditioning facilities are located to the North East of the main plant with about 350 meters of separation and can be considered as separate risk.

Hydrogen Generation Plant is located in the South East of Turbine hall with a separation of around 550 meters and can be considered as a separate risk as well.

Steam Turbine Generator lubricating oil tanks and pumps are located at Turbine hall “0” meter floor and the tanks are bunded with oil drainage facility in place. Lubricating oil tanks are equipped with fixed fire protection system. Fixed fire protection system is not extended up to the lube oil filters and coolers. Fixed fire protection system for steam turbine generator bearings and lube oil piping is not installed (Recommendation 2019/04/10).

Gas Turbine lube oil system is located just besides respective Gas Turbine enclosure at “0” meter floor and in a separate enclosure. The enclosure is equipped with CO_2 based compressed gas fire protection system.

The seal oil skids/tanks for Gas Turbine are located in a pit at the ground floor of the Turbine Hall (besides Gas Turbine Enclosures). These tanks are not equipped with fixed fire protection system (Recommendation 2019/04/11).

The Station transformers, Generator Step up (GSU) Transformers (for Gas Turbine Generators and Steam Turbine Generators) and Unit Auxiliary transformers are located to the East of the turbine hall.

A blast/ fire wall and containment (filled with stone chips) has been provided between each GSU transformer, Unit Auxiliary transformer and station transformer suitably as per NFPA 850.

GSUs, Station transformers and Unit Auxiliary Transformers are equipped with fixed fire protection systems.

Good cable sealing arrangements were observed in cable rooms and switchgear rooms.

AC and DC lube oil pump, power and control cables are running through the same route but are not painted with intumescent paint (Recommendation 2019/04/15).

Fire and Gas Detection

Detection Systems

Fire detectors installed include:

- Photoelectric smoke detectors.
- Probe type conventional heat detectors.
- Multi sensor.
- Linear Heat Sensing (LHS) cables.

Detection is installed in the following areas:

- Gas Turbines enclosure.
- Control Room (including floor voids).
- All switch rooms and cable rooms.
- DCS room.
- Transformers.
- Cable raceways.
- Lube oil tanks for Gas and Steam Turbines.
- Stores (Air conditioned area only).

Fire and Gas Alarm Systems

Plant is divided into different fire zones as per design. Each zone is equipped with the various types of fire detectors.

These fire detectors are connected to the fire alarm panels located in control rooms and fire station building.

Fire alarm and detection system has been supplied by Detectomat, Germany (https://www.detectomat.com).

Hydrogen Gas detection system is installed in hydrogen generation plant and wired to the local PLC system.

Natural Gas detection system is installed in Gas Turbine enclosures. The signals are wired to DCS for alarm and tripping as mentioned below:

- 5% LEL for high alarm.
- 12% LEL for High- High Alarm.
- 25% LEL for tripping.

Fire Water Systems

Design

Fire water systems are designed based on TAC (Tariff Advisor Committee) guidelines.

Fire water system is equipped with one fire water tank (of 3000 m^3). This is an RCC tank and receives water directly from clarifiers through gravity.

Fire water tank is equipped with level transmitters, which controls the water level in the tank automatically.

Pumps for hydrant and spray fire water systems are separate and has been sized sufficiently as informed by site team.

Fire Main

All the critical areas in the plant such as mentioned below are equipped with dedicated hydrant and spray ring mains:

- TG Building & HRSGs.
- ESP/ESP Control Room.
- Transformer yard & 400 kV/132 kV switch yard/control room.
- DM Plant.
- Fire Station.
- Hydrogen Plant.
- CT MCC Room.
- Plant Air Compressor Building.
- Air washer room.
- Stores.
- Chemical Storage.

Fire water spray and hydrant pipes are mostly laid over ground except some areas like switchyard, which is currently being changed to over ground.

Fire hydrants are installed as per TAC (Tariff Advisory Committee) guidelines and the details are as mentioned below:

- Outdoor hydrants.
- Internal hydrants.
- Double headed hydrants.
- Water monitors.
- Total number of equivalent hydrants.

Fixed Protection

Fixed Fire Protection Summary

A summary of the fixed fire protection systems installed are shown the following Table.

Zone	Activation	Fire Protection
Gas Turbine enclosure	2 Number Gas detectors and 6 Numbers of heat detectors	CO_2 gas system
GTG Lube oil tanks	Heat	Automatic Deluge
STG Lube Oil Tanks	Heat	Automatic Deluge
Gas Turbine Generator step up Transformers	Q B detectors	Automatic Deluge
Steam Turbine Generator step up Transformers	Q B detectors	Automatic Deluge
Station and Unit aux. Transformer	Q B detectors	Automatic Deluge
Control rooms	smoke	Argonite system
DCS and computer rooms	Smoke	Argonite system
Cable cellar rooms	LHS and smoke detectors	Automatic Deluge
Switchgear Rooms	Smoke detectors	None
Gas booster compressor building	None	None
Hydrogen Generation Plant	Hydrogen gas leak detection	None

Mobile Equipment

Fire Appliances

Following fire extinguishers are installed in the plant at different locations:

Type of Fire Extinguisher	Quantity
Water (9 Litre)	40
Mech Foam(9 Litre)	5
ABC 2kg	2
ABC 5 kg	6
ABC 6kg	20
CO_2 4.5 kg	37
CO_2 6.5 kg	3
CO_2 9 kg	10
CO_2 22.5 kg	8
DCP 5 kg	163
DCP 25 kg	7
DCP 50 kg	2
Total	303

Plant is equipped with two numbers of fire tenders of 3000 Litres water capacity each and two numbers of 200 Litre foam trolleys.

Plant consists of following firefighting installations:

Description	Quantity
Fire Hydrant	102
Fire escape hydrant	40
Water monitor	3
Deluge valves (MVWS:12 and HVWS:22)	34
Hose boxes	142
Area isolation gate valves	31

Emergency Plans

There is a disaster management Plan in place which takes care of the various emergency scenarios. As discussed with the site safety team, regular emergency drills are also carried out for the intended spontaneous action from all the employees in case of any emergency.

Based on the various emergency scenarios / situations mentioned in the disaster management plans, following emergency drills are performed at site:

- Annually once involving external agency.
- Mock drill fortnightly internally.

Disaster management plans are updated every two years/ (or) whenever the change is there and these plans are also approved by factory inspectorate office.

Fire Response

Site Fire Response

Deployment of firefighting team is in STEAG's scope as a part of O&M contract.

Firefighting cover is provided on a 24 hour basis on a three 8 hour shift pattern using four shift teams with each team lead by a shift supervisor.

Following persons are deployed per shift:

- Two Fire tender drivers.
- Two Firemen.
- One supervisor.

Around 05 persons are deployed in each shift, as mentioned above. In view of the same the total manpower of the fire team is around 21 persons.

Moreover, fire team has around 14 dedicated persons for the maintenance purpose which is a good practice.

Mutual aid

OTPC has the mutual aid arrangement with the following:

- Udaipur fire service department, Udaipur which is around 10 km from site.
- Kakraban Fire service, which is around 06 kmfrom site.

Mock drills were conducted recently to see the response time for the arrival of fire tender and team from Udaipur and Kakraban fire service department. Both the teams arrived within 10 to 15 minutes at site.

The mutual aid arrangement is for sharing ambulance facilities also.

Site is equipped with one of ambulances also.

Fire Systems Inspection, Maintenance & Testing

Inspection testing and maintenance of the fire water pumps and fire detection and protection system is carried out by fire and safety department.

All the fire extinguishers are inspected on monthly basis and refilled if found empty or with less weight. Fire extinguishers observed with the tags, which show that monthly inspections are carried out.

All the fire hydrants are also monthly inspected. During inspection, correctness of local pressure gauges with respect to actual water pressure, freeness of hydrant valves, availability of water etc. are checked and corrected if found with the problem.

Testing of Fixed fire protection system of transformers, Main Lube oil tanks and cable cellar rooms is carried out on annual basis.

Fire water pumps are tested but as informed by site, these are not tested as per NFPA 25 guidelines (Recommendation 2019/04/08).

Housekeeping

Housekeeping in the plant was generally in order.

Cleaning of dry vegetation in the areas like switchyard and transformer yard is required on immediate basis.

Fire System Impairment Procedure

Formal fire impairment procedure is not available (Recommendation 2015/01).

Ignition Source Control

Hot work is controlled through the Permit to Work system. A fire watch post hot work completion is provided by the fire department.

Vehicle access to the site is strictly controlled by site Security and only essential vehicles are allowed onto the Power Plant area.

Smoking is not allowed in the plant.

SECTION NINE

LOSS SCENARIOS

Loss Definition

In this section of the report, a review is presented of the probable principal Material Damage loss exposures relating to the plant, indicating a Probable Maximum Loss (PML) and Maximum Foreseeable Loss (MFL) for each scenario.

The scenarios considered are those related from physical damage perils conventionally insured and from machinery breakdown.

The definition of PML is as follows:

"The Probable Maximum Loss in respect of Property Damage and Business Interruption from an insured event that is considered to be limited to the initiating object or area and occurs at a time when normal protection is in service and functions correctly."

The definition of the MFL is:

"The Maximum Foreseeable Loss where severely adverse conditions are present. A loss resulting from an event that is considered to be of a major magnitude that causes damage not only to the initiating equipment or area but also to surrounding equipment, buildings and infrastructure and occurs when normal protection is out of service. This includes the consequences of a fire or explosion in the most critical area of the property assuming the loss or failure of all existing fixed fire protection systems but assumes passive fire protection works and emergency response works. It also includes the highly unlikely catastrophic incidents such as earthquake, hurricane etc."

Plant and equipment for the OTPC, Udaipur Plant is those typically associated with the production of electrical energy from Gas fired Turbine Generators, HRSGs and steam turbine generators. Consequently, the losses are those expected from the operation of heavy industrial equipment, large rotating plant, steam pressure vessels, piping, lubricating oil systems, together with transformers, power and control cabling necessary for the operation of the plant.

Property Values

Following values are considered based on John Foord Paper.

Main Equipment Value	Million US $
Gas Turbine + Generator	81
Transformers	27
Steam Turbine + Generator	40
HRSG	40
Balance of Plant	80

The loss scenarios have included additional clean-up costs and work on the assumption that equipment will be replaced at the same contract value.

The loss scenarios do not include the potential of third party damage and claims.

Lead Times

Lead times for the critical equipment have been considered as mentioned below (for the loss calculation):

Equipment	Months
Gas Turbine	16
Generators	16
HRSG	13.5
Steam Turbine	13
Transformers	10

In practice OEMs look to improve on standard lead times and will deal with the supply on a case to case basis.

Insured Values

Following are the sum insured values based on the latest policy in place:

- Property Damage Sum Insured: INR 3,822 Cr.
- Business Interruption Sum Insured: INR 653 Cr (Annual).
- Business Interruption Indemnity Period: 18 months.
- Deductibles:
  - Property Damage: 5% of claim amount subject to minimum of 5,000,000.
  - Deductibles for Mobile / office equipment's – 5% of the claim amount subject to minimum of INR 1,000,000 for each and every loss.
  - Fire Loss Of Profit: 14 days of Gross Profit.
  - Machinery Breakdown Loss Of Profit: 21 days OF Gross Profit.

Probable Maximum Loss

Loss Event	Property Damage Mn US$	BI Estimate MW x Months	Description of Loss
Severe DOD due to combustor failure or compressor blade failure resulting in loss of turbine section	32	363 MW for 12 Months	Assumes loss because of the DOD in either combustor or compressor and damages the hot gas path. Considering 60% damage.
Generator Transformer explosion	3	363 MW for 10 Months	Assumes explosion in Gas Turbine Generator transformer by some electrical fault. Assumes complete replacement of the transformer.
Steam Turbine Generator Fire	8	131 MW for 7 Months	An oil leak in the generator side causes a fire. The fire team responds and damage is minimized. Specialists are required to repair the damage to the Generator. Estimate 20% of STG value.
Loss of HRSG pressure parts requiring replacement during over-pressurization	16	363 MW for 8 Months	Pressure part losses resulting from over pressurization in case safety valves fail to open. Estimate 40% of HRSG value

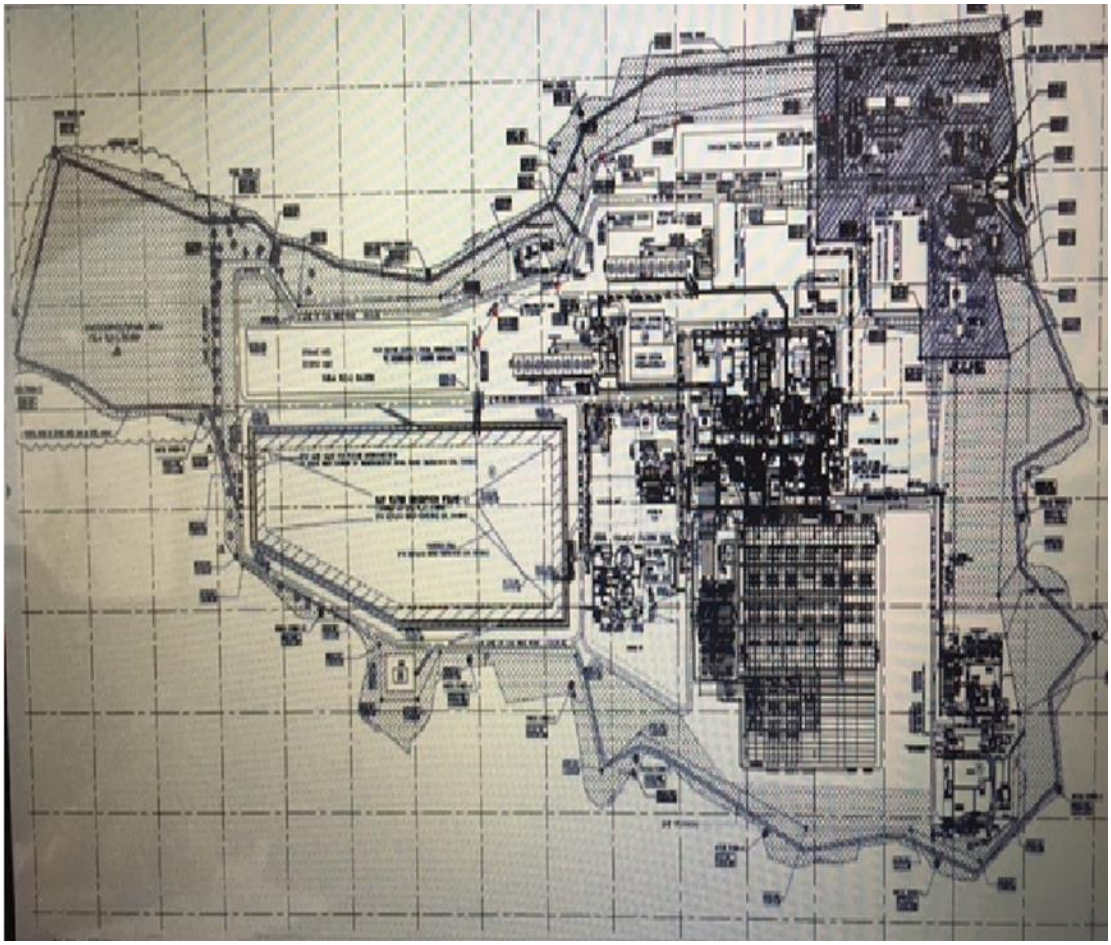
Loss Event	Property Damage Mn US$	BI Estimate MW x Months	Description of Loss
Inundation of ground floor TG Building and GT enclosure where in all the ground floor TG equipment got damaged and need replacement.	10	363 MW for 8 Months	Assuming all the" 0 "meter TG and GT auxiliary equipment got damaged and need replacement. Considered this loss as the area is in high river flood zone (Zone 500) as per Munich re.

Maximum Foreseeable Loss

Loss Event	Property Damage Mn US$	BI Estimate MW x Months	Description of Loss
Earthquake	14	363 MW for 16 Months	An overall damage level equivalent to 5% of the total plant value is suggested for the loss resulting from earthquake event. This represents direct earthquake damage and the following fire damage. Estimate to be 5% of Plant value.
Major GT loss	105	363 MW for 24 Months	Explosion in GT and severe damage to GT and Generator followed by Hydrogen explosion in generator. Assumes total loss of Gas turbine and generator requiring complete replacement + 12% Debris removal+20% damage to the adjacent unit.
Major ST uncontrolled Lube oil fire	53	363 MW for 20 Months	Assumes catastrophic loss of ST, with significant building damage and partial collapse. Assumes most of the major equipment suffers external damage only and can be salvaged. Estimate full replacement cost of 1 STG + debris removal, clean up and minor damage to adjacent STGs.
ST over speed without following fire	53	363 MW for 20 Months	Assumes total loss of turbine and generator requiring complete replacement + 12% Debris removal+20% damage to the adjacent unit.
Major HRSG pressure part loss	15	363 MW for 10 Months	Assumed considerable loss of pressure parts including drum .

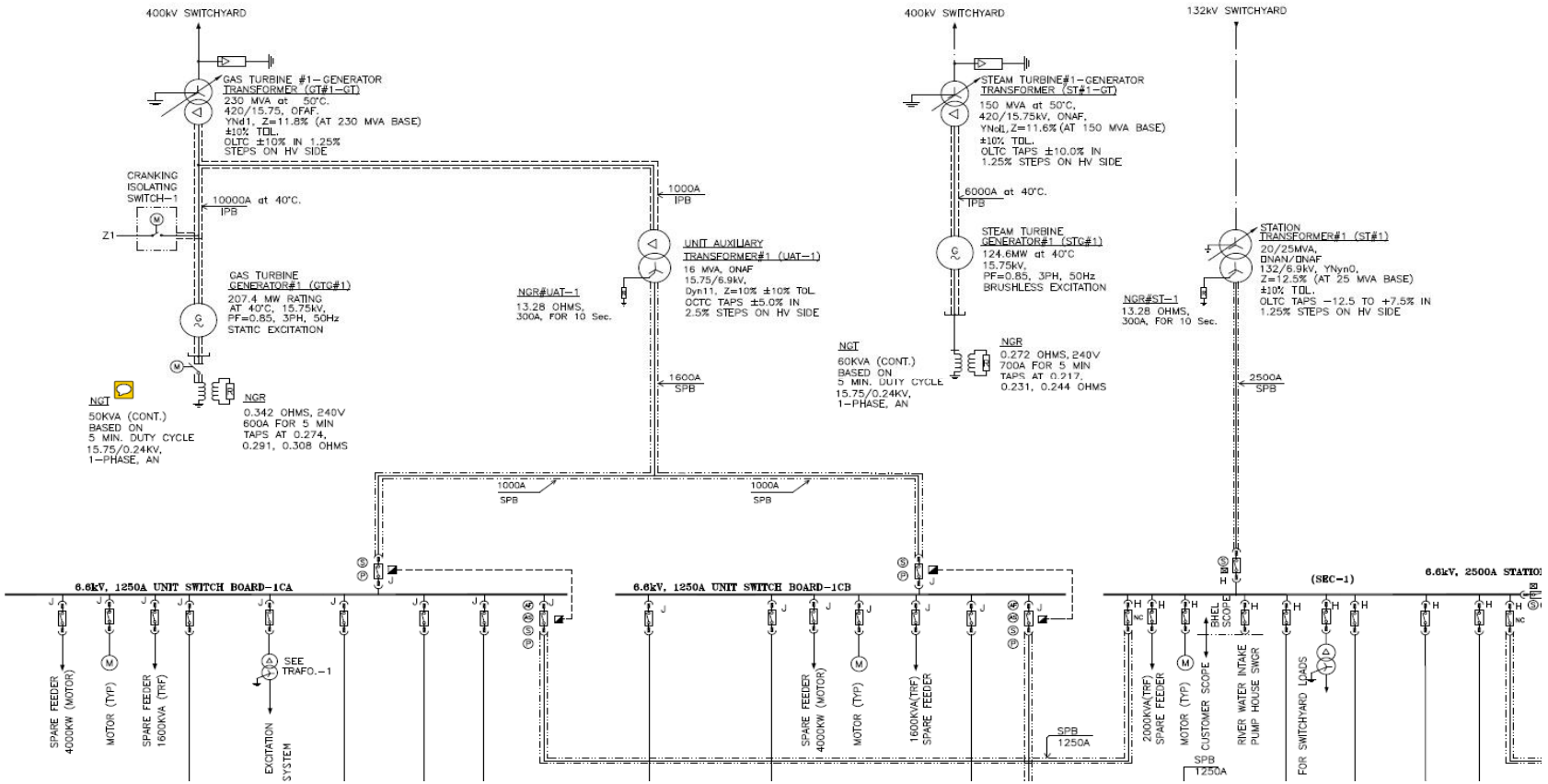
APPENDIX A

PLOT PLAN



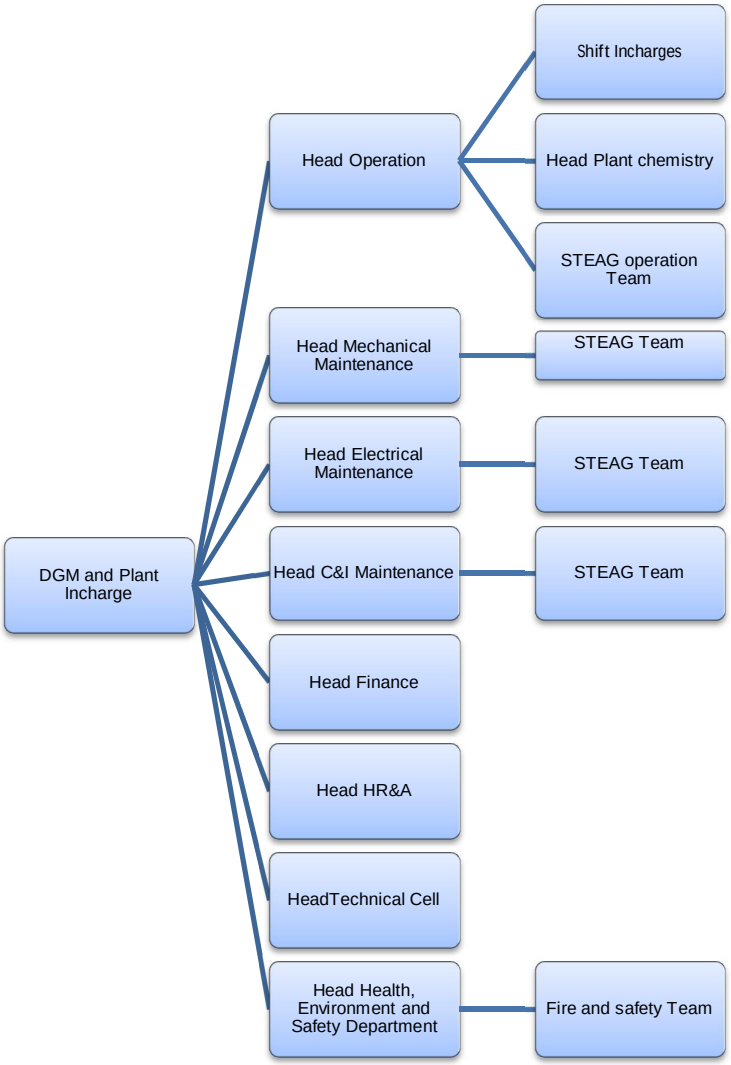
APPENDIX B

SINGLE LINE ELECTRICAL DIAGRAM (FOR ONE BLOCK)



APPENDIX C

ORGANISATION STRUCTURE



Click here to enter text.

Marsh Ltd.
1 Tower Place West, Tower Place
London EC3R 5BU

F. No. 1/6/2011-IT-IV (236746)
Government of India
Ministry of Power

Shram Shakti Bhawan, Rafi Marg,
New Delhi, Dated: 9th October, 2018

To

Additional Chief Secretary, Principal Secretary, Secretary (Energy) of States/UTs

Subject : Guidelines for Mitigation of Cyber Secuirty Threats in Power Sector .

Sir,

I am directed to convey that National Critical Information Infrastructure Protection Centre (NCIIPC) has found following vulnerabilities while conducting cyber security assessment at two Discoms in the country:

(i) Due to lack of patch/update management, the Operating Systems of servers are prone to multiple critical security vulnerabilities such as "Shell Shock", " Remote Code Execution" and are open to various kinds of attacks.

(ii) Applications installed over servers are not being patched to the latest patches/updates and are prone to multiple security critical vulnerabilities and susceptible to different kind of cyber attacks (eg. Oracle Database used in server is having unsupported patches level).

(iii) The team was able to access the Oracle Database remotely over Internet by Exploiting SQL Injection vulnerabilities.

(iv) Telnet services have been configured over services, which provides remote login for administration. As Telnet transmits traffic in clear text, attackers may sniff into the traffic and steal Telnet credentials.

(v) Server is configured with SNMP (Simple Network Management Protocol) community string. An attacker could leverage knowledge of a SNMP community string to collect sensitive information such as device configuration, installed software, running processes, installed patches, network configuration, network connections etc.

(vi) Windows firewall was found disabled on the NMS (Network Management System) server.

(vii) Web and Directory Servers are having high web vulnerabilities such as SQL Injection, Cross Site Scripting. etc.

(viii) Servers have not been hardened, and contain unnecessary services, which increase attack surface sustainability.

(ix) VNC (Virtual Network Computing) Application, third party application, was running on Human Machine Interface (HMI) Workstations which allow remote logon to the systems, hence usage of VNC exposes large attack surface.

(x) Operating systems of Workstations do not have windows security polices such as Password Policy, Account Lockout etc.

(xi) No active Anti-Virus application was found on the workstation. This is a critical vulnerability and a serious threat.

(xii) The switch/Router was configured with the default credential. Default credential may allow attacker to compromise the entire network at ease.

(xiii) There is no end to end communication between RTUs and FEP Server. The communication between RTUs and LDMS is in plain text. This may allow attackers to inject commands, sniff and modify traffic.

(xiv) Definition database of Cyberoam Firewall was found to be un-updated, which leave the entire network prone to various kinds of cyber attacks.

(xv) Many of the Passwords were weak and the team could easily crack the hashes to retrieve the password in plain text.

2. National Critical Information Infrastructure Protection Centre (NCIIPC) has issued following guidelines regarding Cyber Security threats in Power Sector and are conveyed for further necessary action and compliance:

(i) Deploy only those critical software application such as Anti-Virus applications, whose technical support and version control are verifiable publically.

(ii) Deploy product releases and firmware update and technical support details which are not available in the open domain.

(iii) Evolve procedural controls such as Security Level SLA which mandates the OEM/System-Integrator & makes him liable to provide/support security patches and firmware updates for longer duration on equipment life cycle.

(iv) Avoid Internet connectivity directly or indirectly (over firewall) to OT/SCADA networks.

(v) Update all Operating Systems, Applications and Firmware as a basic cyber hygiene practice.

(vi) Nominate CISO (Chief Information Security Officer), ISOs' (Information Security Officer) to establish ISD (Information Security Department) for implementing and managing information security at different location of the organisation.

(vii) Accelerate the process of CII identification and notification as Protected Systems, steered by Power Sector CERTs.

Yours faithfully,

(Praveen Kumar)
Under Secretary to Government of India
Telefax; 23715507 extn. 370
it-mop@nic.in

Copy to:

1. MDs of All DISCOMs
2. CISO-MoP for Necessary compliance

ಭಾರತ್ ಹೆವಿ ಎಲೆಕ್ಟ್ರಿಕಲ್ಸ್ ಲಿಮಿಟೆಡ್
भारत हेवी इलेक्ट्रिकल्स लिमिटेड
Bharat Heavy Electricals Limited
(A Government of India Undertaking)
ELECTRONICS DIVISION
P.B. No. 2606, Mysore Road, Bangalore - 560 026

Gram : BHARATELEC
Telex : 0845-2436 BHCE IN
0845-8151 BHCE IN
Fax : 080-6740137
RABMN : 4041[illegible]4
PHONE : 6998
(EPABX NO.)

To

Mr. Mohammed Musa
Head (C&I)
ONGC Tripura Power Company Ltd
Palatana,
Tripura
Mobile : 7085458310
E-mail : mohammad.musa@otpcindia.in

Ref: CE-MKTG/804/OTPC/OC

Dear Sir,

Sub : Upgradation of maxDNA based HMI based on Windows XP suppled by BHEL to Windows 10.
Ref : PO No. OTPC/PO/PLT/20-21/BHEL/SSBG-EDN/001 dated 23rd December, 2020.

BHEL had supplied and installed maxDNA system for STG and BOP with Windows XP Operating System at OTPC, Palatana during the year 2013-14.

M/s Microsoft has announced the end of support for Windows XP Operating system including security updates from April, 2014.

Although, BHEL continues to support Windows XP installations for maintenance until there are major issues in the hardware, all our supplies after 2014 are based on Windows10 professional OS.

In line with general industry practice, all maxDNA releases are backward compatible. Mimics that are created in maxDNA version on Windows XP will run in maxDNA version on Windows 10. Both maxDNA version on Windows XP and maxDNA version on Windows 10 can exist concurrently.

However, due to the obsolescence of Microsoft XP, the HMIs at Palatana were facing issues. Hence, BHEL advised upgradation of HMI workstations from Windows XP to Windows 10 OS for trouble free operation.

In view of the above situation, the HMI based on Windows XP were changed by BHEL under the PO referred above.

Thanking you,

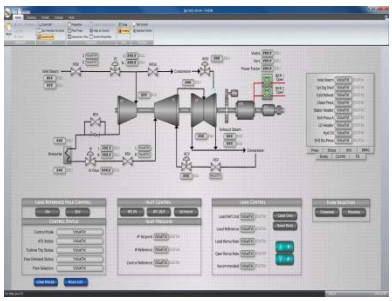
Yours faithfully

ಕೆ. ಪ್ರದೀಪ್ ಕುಮಾರ್, ಅತಿರಿಕ್ತ ಪ್ರಧಾನ ವ್ಯವಸ್ಥಾಪಕರು/ಎ.ಜಿ.ಎಂ.-ಮಾರ್ಕೆಟಿಂಗ್
के. प्रदीप कुमार, अपर महाप्रबंधक/सी.ई.-विपणन
K. PRADEEP KUMAR, ADDL. GENERAL MANAGER/CE MARKETING
BHEL-EDN, MYSURU ROAD, BENGALURU-560026

K. Pradeep Kumar
AGM (CE-Marketing)
BHEL, Electronics Division,
Bangalore

GE
Measurement &
Control

June 07, 2013



Product Life Cycle Support Notice - Update

Control Solutions

Windows XP – End of Microsoft Support Notification

The Product Life Cycle Support Policy, **(see Life Cycle Overview)** can help you plan the maintenance and ultimate evolution of your GE control system. Notices such as this one are issued at distinct life cycle milestones to inform you of pending changes and provide recommendations on how to move forward. This is the first LCN on this subject.

This notice is to inform you that Microsoft† has announced intention to end extended support of the Windows XP operating system, effective April 8, 2014. If you are still using the Windows XP operating system after that date, you may no longer receive all security updates. GE is advising users to upgrade affected systems to the Windows 7 Server 2008R2. The operator and engineering workstation used with GE's turbine, generator, and power plant control systems is based on the Windows operating system. These HMIs include Mark IV, V, Ve, VI, and VIe control systems.

Based on our commitment to provide our customers with timely updates, GE introduced an upgrade from the Windows XP operating system to the Windows 7 operating system in September 2011. The Windows 7 operating system uses 64-bit Windows 7 Ultimate (SP1) with CIMPLICITY* Advanced Viewer/Server (V08.02) and WorkstationST* applications. The first ControlST version for Windows 7 was 4.03.

Microsoft extended support for Windows 7 is currently scheduled to end in January 2020. These extended support dates are important for GE controls users who must maintain the latest applicable patches on their HMIs and software upgrades for installed HMIs.

Recommendations

The ControlST software suite is continually enhanced with new features. It is recommended that any existing systems be upgraded to the Windows 7 environment. As part of the upgrade proposal, the existing HMI system, including hardware and peripherals, should be evaluated for compatibility with the 64-bit Windows 7 operating system. Items such as printers and monitors should be evaluated to make sure drivers are available for the 64 bit environment.

For more information, please go to GE Controls Connect at www.GE-ControlsConnect.com or contact your local GE representative to obtain a proposal specific to your site requirements.

Additional Email Support - ControlsConnect@GE.com

Additional Phone Support –

North America: 1-888-943-2272 or 1-540-387-8726
Latin America (Brazil): +55-11-3958-0098
Europe (France): +33-2-72-249901
Asia/China (Singapore): +65-6622 1623
Africa/India/Middle East (U.A.E.): +971-2-699 7119

Life Cycle Overview

The life cycle of any GE control system has three main phases:

- Phase 1 – Current Production - Product has been released to market with full support including enhancements, custom modifications, new spare parts and repairs.
- Phase 2 – Post Production - Mature product that is no longer available for new installations. New spare parts are still available, and repair, exchange, and remanufacture services are available through designated Control Solutions repair centers. Standard modkits and upgrades are available. Notice of last time buy of new spare parts issued approximately one year before transitioning to Phase 3.
- Phase 3 – Legacy – The product is no longer fully supported. New spare parts are no longer manufactured. The parts & support for the product will be limited to the available resources and available components. Parts repair, exchange and remanufacturing support will be offered on a best effort basis. Customers are advised to review the potential risks of ongoing operation of the control system and consider options for supporting or upgrading to the current technology. The **GE ControlsCare** offerings are designed to provide a solution to many of these options.

Enclosure: GEZ-2019

Revision(s):

Revision #	Originator	Description	Date
-	M. Hammer	Initial Release	2013-Jun-07

The Managing Director,
ONGC Tripura Power Company Ltd
10th Floor, Core-4 and Central, Scope Minar,
Laxmi Nagar, Delhi-110092

Subject:Upgradation of Mark-VI Control System to Mark-VIe and Upgradation of HMI of Mark-VI at Palatana Plants

Dear Sir,

a. As part of the contract arrangement with BHEL under EPC Contract for Palatana Project, GE had supplied latest available version of MARK-VI control systems for gas turbines. MARK-VI control system included DCS (hardware and software), network switches, and Human Machine Interface (HMI). At the time of supply Windows-XP was the compatible software for MARK-VI and the system was delivered with the same operating system.
b. GE had issued a Product Life Cycle Support Notice to OTPC in 2014 inferring that MARK-VI had entered Post-Production phase and GE was transitioning to MARK-VIe which was in phase-1 (current production). Also, while sharing a presentation regarding MARK-VIe, it was submitted to OTPC that MARK-VI would soon enter legacy phase.
c. In legacy phase the product is no longer fully supported. New spare parts are no longer manufactured. The parts & support for the product is limited to the available resources and available components. Parts repair, exchange and remanufacturing support is offered on a best effort basis. Customers are advised to review the potential risks of ongoing operation of the control system and consider options for supporting or upgrading to the current technology.
d. Considering that Mark-VI had entered legacy phase, we had submitted to OTPC in 2018, a proposal for upgradation of Mark-VI to MARK-VIe and upgradation of HMIs. The proposal had detailed that the HMIs should be upgraded to Windows 10 platform as Microsoft had ended support for Windows XP operating system in 2014 (OS in existing HMIs).
e. OTPC had informed GE about problem being faced by them in HMI which included:
    1. HMIs hanging while in operation making operator unable to control the equipment, and
    2. No virus definition update was taking place. To protect the desktop from cyber threats, OTPC had disabled all drives (USB / CD / DVD) on the HMI.
f. After detailed review of the problem at Palatana, GE recommended upgrade of the MARK-VI control system to MARK-VIe and the HMIs due to the following reasons:
    1. MARK-VI had become obsolete and it was no longer fully supported i.e. new spare parts were not manufactured and the parts & support were limited to the available resources and available components. Without upgrading to the current technology and without successful migration to Mark Vie there were potential risks to ongoing operation of the control system which could not be predicted.
    2. The HMIs had been in use for over 10 years since synchronization of the first unit in 2012. Even after the COD of first unit in January 2014, the system had been in continual use for nearly 8 years without any upgrades and has outlived its normal life of 4-5 years.
    3. Antivirus system was outdated and unable to update due to obsolete operating system (Windows XP). Out dated anti-virus was exposing crucial plant control system to cyber threats.
    4. Windows XP operating system of HMIs had become obsolete and Microsoft had ended its support in 2014.

g. The following upgrades were hence undertaken by GE at Palatana:

1. Upgrade of hardware/software of DCS for Gas Turbines and upgrade of Network Switches
   i. In order to control user access and reduce risk, Domain control system was installed.
   ii. Normal life of network switch hardware is around 5 years. As network switches are important network components, responsible for smooth flow of data/instruction between controller and client application of the MARK-VI control system, network switches were upgraded.

2. Upgradation of MARK-VI to MARK-VIe (Phase-1) hardware and software was performed. OTPC had decided to upgrade remaining component which mainly included field instrument as part of phase-2 upgrade.

3. Upgrade of associated HMIs, which included:
   i. Upgrade of old HMIs with new HMIs (compatible with Windows 10)
   ii. Upgrade of Operating System (Windows XP to Windows 10)
   iii. Upgradation of Antivirus
   iv. Upgradation of Mark-VI to Mark-VIe HMI latest control software
4. It may also be kindly noted that many other customers in India have also opted for such upgrades and have been successfully implemented.

As already evidenced above, the complete upgrade of the DCS, HMIs and Network switches was required at Palatana. In the event of any failure of any component of MARK-VI system, the plant could have been exposed to huge generation losses.

Thanking you.

Yours faithfully

For GE

Jagdish Rao
Senior Service Director - IN/SL/MAU
GE Gas Power South Asia

Annexure – III

WARRANTY PERIOD OF DCITI & WARRANTY EXTENSION

1.0 **Initial Warranty** - Initial warranty coverage period of DCITI was for 5 years.

2.0 **Warranty Extension** - To ensure OEM support and availability of spares, OTPC renewed warranty of DCITI till FY 2022-23. Further warranty extension shall be initiated for a period of 1 year i.e. till FY 2023-24 to ensure uninterrupted availability of DCITI.

3.0 **Cost of Warranty Extension** - Total cost of warranty extension of DCITI till FY 2023-24 is Rs. 6,62,20,228.

OEM / Product	**FY 2020-21**	**FY 2021-22**	**FY 2022-23**	**FY 2023-24**
IBM	27,71,255	27,71,255	27,71,255	35,84,837
Juniper	6,14,308	3,35,009	10,62,000	25,21,417
Palo Alto	17,70,000	24,19,000	22,53,800	36,28,500
DLP	4,40,801	8,01,220	8,73,342	9,15,000
LLB (Array)	4,73,180	5,89,504	16,52,000	17,41,433
SUSE Linux	15,64,000	20,34,014	22,83,739	37,84,260
Microsoft	30,60,153	34,12,206	**Support not Taken**	**Support not Taken**
SSL Certificates	21,240	22,420	24,780	27,140
Veritas	10,23,120	12,42,324	12,81,036	15,35,599
CA	11,26,561	10,93,860	12,82,424	14,52,875
Email Gateway	94,700	1,11,746	1,32,656	1,75,324
Antivirus	82,765	86,305	1,33,370	1,54,698
Non-IT Plant	11,52,270	12,67,497	14,14,917	16,26,000
TOTAL	**1,37,21,273**	**1,61,86,460**	**1,51,65,412**	**2,11,47,083**
% increase on FY 2022-23				**39.40%**

Figures are in INR.

Following may be noted:

a. It may be noted that the cost of warranty extension (till FY 2023-24) after expiry of initial warranty period of 5 years is 63.50% of the total cost of supply of DCITI and this cost is increasing year over year.
b. Cost of maintaining Juniper products is rising exorbitantly on account of non-availability of spares.
c. Support for Microsoft was discontinued from FY 2022-23 onwards considering number of issues raised. These services are being reasonably managed with lot of effort by in-house IT team.
d. Cost of maintaining Palo Alto, Array, SUSE Linux, Non-IT Plant etc. is rising exorbitantly as compared to previous year maintenance cost considering ageing of systems and on account of non-availability of spares.

India
Ransomware Report
2022

certin
Enhancing Cyber Security in India

At a Glance

The prevalence of Ransomware threats continued its upward trajectory in the year 2022. In 2022, Ransomware gangs broadened their attacks across critical sectors with increased frequency and complexity. New ransomware variants emerged last year, as several profit-driven cyber criminals started their own campaigns aided by leaked source codes of established groups and the availability of readymade tool kits. Ransomware As A Service (RAAS) ecosystem with financial motive is becoming prominent with double and triple extortion tactics to cause successful business disruption, thereby forcing the victim to the pay ransom. Not only money, but Geo political conflicts also influenced ransomware attacks this year. This trend may continue further when Ransomware broadens its spectrum beyond financial aspects and becomes an arsenal for cyberwarfare's.

With phishing being the major pivot point for network initial access, attackers are continuing to exploit known vulnerabilities of public exposed applications and also focusing on acquiring valid credentials / session cookies of remote access services mainly through infostealer logs available in the dark web and underground forums. In addition, system misconfigurations, brute force attacks, unmanaged devices, insider threats and supply chain attacks are becoming concerning risk factors.

Much emphasis is required on ransomware prevention as the time, cost and efforts involved may become quite significant in responding and recovering from ransomware incidents. It is crucial to develop cyber resiliency with well-prepared & tested disaster recovery (DR) and business continuity plans (BCP) to avoid major business operational disruption in ransomware crisis times.

This report is focused on presenting the latest ransomware trends and attack methodologies pertaining to Indian cyberspace, which CERT-In has observed in the year 2022. The actionable preventive measures are discussed to improve ransomware resiliency and avoid significant business risks.

We hope, this report helps in reassessing the ransomware resiliency capabilities with a focus on defense in depth.

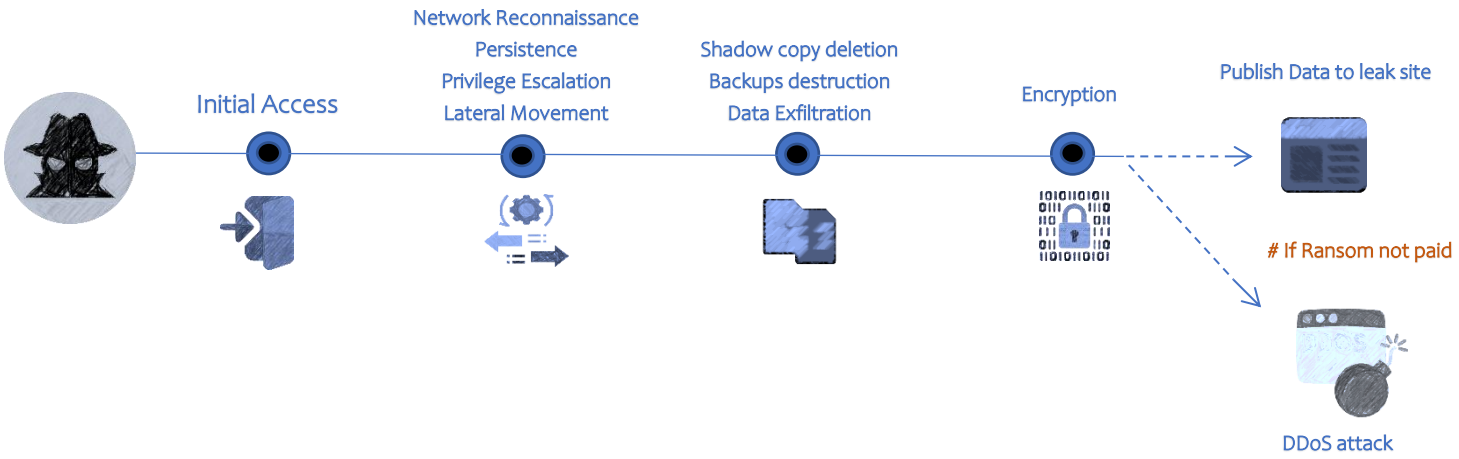
Ransomware - Introduction

Ransomware is a category of malware that gains access to systems and makes them unusable to its legitimate users, either by encrypting different files on targeted systems or locking the system's screen unless a ransom is paid. Ransomware actors also threaten to sell or leak any exfiltrated data, if the ransom is not paid.

Although there are countless strains of ransomware, they mainly fall into two main categories.

- *Crypto Ransomware* encrypts files on a computer so that they become unusable.
- *Locker Ransomware* blocks standard computer functions from being accessed.

Advanced Ransomware attacks follow several stages –



Initial Infection methods

For Organisations

- ⚠ Exploiting vulnerabilities in Internet-facing systems [Ex: VPN, Firewalls, Mail & Web servers]
- ⚠ Compromised credentials/Cookies
- ⚠ Phishing campaigns
- ⚠ Supply chain attacks
- ⚠ Insider Threats

For Individuals

- ⚠ Drive by Download, particularly from pirated/crack software advertising websites
- ⚠ Phishing/Spam Emails

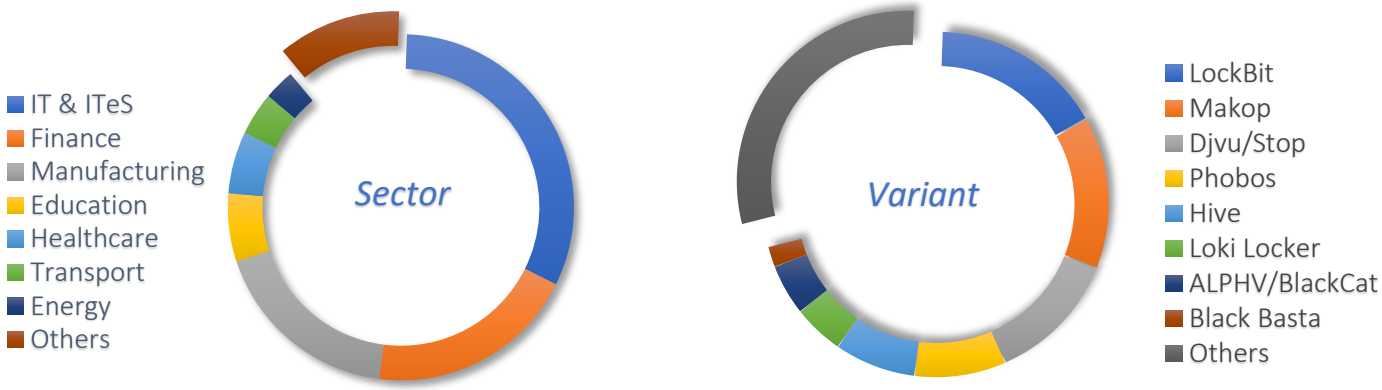
Ransomware -Trends

Sectors & Variants

Overall, there is **53%** increase in Ransomware incidents reported in 2022 Year over Year.

IT & ITeS was majorly impacted sector followed by Finance and Manufacturing. Ransomware players targeted critical infrastructure organisations and disrupted critical services in order to pressurise and extract ransom payments.

Variant wise, Lockbit was majorly seen variant in the Indian context followed by Makop and DJVU/Stop ransomware. Many new variants were observed in 2022 such as Vice society, BlueSky etc. Leaked Ransomware source codes are getting forked to launch new Ransomware brands.



At large enterprise level, Lockbit, Hive and ALPHV/BlackCat, Black Basta variants became major threats, whereas Conti which was very active in the year 2021 became extinct in the first half of the year 2022. Makop and Phobos Ransomware families mainly targeted medium and small organisations. At individual level, Djvu/Stop variants continued dominance in attacks over the past few years.

Ransomware -Trends

Vulnerabilities exploited

Most of the Ransomware groups are exploiting known vulnerabilities for which patches are available. Some of the product wise vulnerabilities being exploited are:

Microsoft Exchange:

CVE-2021 -34523: Proxyshell
CVE-2021 -34473: Proxyshell
CVE-2021 -31207: Proxyshell
CVE-2021 -26855: ProxyLogon

Citrix:

CVE-2020-8195: Unauthenticated Authorization Bypass
CVE-2020-8196: Improper access control
CVE-2019-19781: Directory Traversal
CVE-2019-11634: Incorrect Access Control

Fortinet:

CVE-2020-12812: Improper authentication
CVE-2019-5591: Information Disclosure
CVE-2018-13379: Directory traversal

SonicWall:

CVE-2021-20016: SQL injection
CVE-2020-5135: Buffer Overflow
CVE-2019-7481: SQL injection

Sophos:

CVE-2020-12271: SQL injection

Zoho:

CVE-2021-40539: Authentication bypass

Pulse Secure VPN:

CVE-2021 -22893: Authentication bypass
CVE-2020-8260: Remote Code Execution
CVE-2020-8243: Arbitrary Code Execution
CVE-2019-11539: Code Execution
CVE-2021 -11510: Arbitrary File Reading

Palo Alto:

CVE-2020-2021: Authentication Bypass
CVE-2019-1579: Remote Code Execution

Ransomware -Trends

Restoration & Recovery time

Ransomware restoration & recovery time is dependent upon multiple factors like level of infection, affected applications, availability of backups & images, and Business Continuity preparedness. Time, efforts and cost involved are very much significant even with the availability of safe backups. It is essential to have tested Business Continuity Plan (BCP) to avoid major operational disruption. When Ransomware strikes, many organisations are clueless about scope of infection/blast radius. Lack of an updated IT inventory list, improper network segmentation and visibility gaps are the main reasons for ascertaining the level at which the infection has spread across the organisation, leading to enormous efforts in sanitisation of each and every system in the affected network. Also, rebuilding the applications may take considerable time, if golden images/backups are unavailable or inaccessible.

On an average, the restoration time is about 10 days for infections in reasonably large infrastructure networks. For smaller network/ infrastructure, the restoration time is around 3 days and for individual systems it is 1 day.

As Ransomware incident is a business risk, organisations must prepare themselves to face this havoc in an efficient manner-

1. Maintain current asset inventory to assist in determining components and devices that support critical operations
2. Plan how to continue operations if a critical system gets compromised
3. Develop work arounds or manual controls to ensure business operations
4. Regularly test Business Continuity Plans (BCP) including Disaster Recovery (DR) & backup procedures.
5. Incorporate automation in BCP and Recovery phases.

Ransomware -Trends

Ransomware gangs are becoming innovative in their approach to improve attack operational efficiency. Ransomware builders are focusing on speed and performance. Instead of encrypting entire file, a portion of file is getting targeted for encryption to save time. Multithreading is getting leveraged for faster encryption and decryption of files.

Attackers are using already existing Living Off the Land Binaries (LOLBINS) and legitimate tools available in sources like Github during the infection phases. In this way, they are successfully able to blind security solutions and disable the anti-malware applications, which makes their life easy for deployment and execution of encryptors. Safe boot restart is another technique adopted by Ransomware gangs in this context. Also, data exfiltration is getting destinated to reputed cloud storage to avoid flagging by firewall devices.

Prominent RAAS groups like LockBit are using novel methods such as launching bug bounty programs, to improve the quality of the malware. These groups are releasing new toolkit versions on regular basis with enhanced capabilities. Malware authors are using heavy obfuscation techniques to bypass static signature detections and hinder reverse engineering. Notable techniques include command line-based Ransomware execution using unique string argument for each victim entity. Ransomware authors are choosing light weight cryptographic algorithms to make the encryption process faster and efficient. Some Ransomware authors are switching to “Rust”, a cross platform language to evade AV detections and enhance concurrency for encryption process.

Some groups are rebranding themselves and some are carrying out only low-profile attacks to avoid the attention of law enforcement.

As threat actors become sophisticated and swift in the attack process, organisations must level up their capabilities for monitoring and early detection of Ransomware infection.

As prevention is better than cure, it is desirable to understand the attack surface and ensure hardening of all internet-exposed assets and improve security posture to minimize the Ransomware attack probability. Targeted Ransomware attacks may not immediately disrupt the systems. Threat actors take time during attack phases for activities such as network enumeration, lateral movement. So, it gives the targeted entities an opportunity for threat hunting and detection of the intrusion at early stages. Early detection and mitigation of the Ransomware threat can minimize the impact and avert a crisis situation.

Rasomware –Trends

Legitimate tools & LOLBINs

Most of the Ransomware groups are trying to leverage already available legitimate tools and Living Off the Land Binaries (LOLBins) during the attack phases. This way, they are able to blind the security controls in the victim environment. After disabling end point Antivirus/EDR functionality, in later stages Ransomware custom encryptor is being dropped for execution.

Attack phases of network enumeration, persistence, lateral movement are mainly through already available tools in the operating system or via legitimate / open-source applications sourced from code repositories such as Github.

In many cases, Usage of post exploitation tool "Cobalt Strike" has become a common practice. Brute Ratel is also becoming a favourite choice apart from Cobalt Strike.

Ransomware gangs are commonly using Microsoft Sysinternals utilities such as PsExec for lateral movements.

Threat actors also started using tools like "Non Sucking Service Manager (nssm)" to install an executable as a service. nssm monitors the running service and will restart it if it dies.

Some of the observed LoLBINs and Legitimate tools were:

- Network enumeration
  Commands - net, ping, whoami, systeminfo
  Light weight tools - Advanced IP scanner, Netscan, Adfind, PinginfoView
- Persistence
  AnyDesk, ngrok, FRP (fast reverse proxy)
- Credential Dumping
  Mimikatz, quarks pwdump

It is recommended to refer to the following website for a list of "Living Off The Land Binaries, Scripts and Libraries"

- https://lolbas-project.github.io/

Defence -Active Directory

Active Directory is a directory service developed by Microsoft for Windows domain networks, which contains critical information about all users, endpoints, applications, and servers. Active directory sits at the heart of most organisations and would be considered a crown jewel information system. Threat actors always focus on reaching Active Directory (AD) after the initial compromise. Once privileged access is achieved in the domain controller, ransomware can easily target and attack the AD controlled assets through methods like logon scripts via a Group Policy Object (GPO), by leveraging WMI. Attackers generally try to leverage Active Directory database "ntds.dit" and SYSVOL for further attacks.

It is very important to protect Active Directory to the greatest extent possible. It helps in deterring Ransomware lateral movements and reduce the scope of infection.

Some of the hardening measures:

- Implement Principles of Least Privilege in AD Roles and Groups
- Restrict the use of privileged AD accounts and consider Multi Factor Authentication (MFA) for privileged AD accounts
- Disable the Local Administrator Account on all systems
- Consider using Local Administrator Password Solution (LAPS), if required
- Regularly audit security changes across Active Directory and Azure AD environments
- Implement Active Directory tiered administration model
- Use dedicated work station with secured configuration for Active directory
- Clean-Up Inactive User Accounts in AD
- Limit the software and roles installed on domain controllers

Refer:

https://learn.microsoft.com/en-us/windows-server/identity/ad-ds/plan/security-best-practices/best-practices-for-securing-active-directory

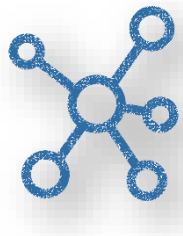
May explore free AD security assessment tools like Ping castle, Purple Knight etc. to analyse the AD risks and for further closure of the security gaps.

- https://www.pingcastle.com/
- https://www.purple-knight.com/

But make sure to completely remove these tools and related files post assessment, as in the future these may become weapons for use by threat actors, if somehow they get access to the Active directory.

Defence -Network

It is very important to have organisation network level visibility to monitor and detect any malicious or suspicious network connections. Appropriate controls must be deployed to monitor perimeter level network traffic as well as within the internal networks.



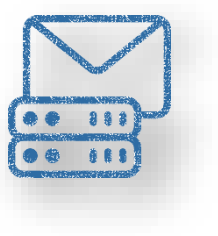
- Maintain perimeter level security controls firewall/IDS/IPS with latest versions, updated signatures and fine-tuned rules
- Implement Geo-based traffic filtering, if feasible
- Ensure firewall configurations with features like Botnet filter, DPI-TLS inspection and sandboxing
- Block or restrict RDP and other non-essential ports, protocols & services at the network level
- Review and revamp the network architecture from a security preceptive:
- Segment the network using appropriate controls such as VLANs, internal firewalls, ACLs, SDN. Segment wireless LAN to separate internal network from guest users.
- Define zone to zone interaction so that only specific traffic allowed to pass between the zones.
- Ensure to implement secured remote access as per business requirement
- Maintain the network logs and monitor for alerts for any malicious or dark web traffic or unusual data egress traffic. Especially, keep a watch on network sessions involving newly registered domains
- Ensure restricted access to network level routers, switches, firewalls and other elements with strong authentication policy
- Based on the threat intel feeds, monitor or block malicious domains and IP addresses at appropriate levels of firewall, proxy server, DNS server etc. In case of identification of historical connections towards any malicious IP or domain, immediately trace out the possibly compromised host and investigate
- Deploy Anti-DDoS controls as some ransomware incidents may get associated with DDoS attack

May explore free tools like Real Intelligence Threat Analytics (R-I-T-A) to identify any suspicious network beacons, long connections and DNS tunnelling for further investigations. Threat actors generally attempt to initiate outbound connectivity from the compromised hosts to evade detection by security controls such as firewall. In such cases, usage of tools like R-I-T-A can be handy for network level threat hunting.

RITA framework ingests Zeek logs or PCAPs converted to Zeek logs for analysis.

- https://www.activecountermeasures.com/free-tools/rita/

Defence -Email



Email based phishing is one of the most prominent initial infection vectors in ransomware infections. Ransomware threat actors frequently engage in spear-phishing and Business Email Compromise (BEC) to harvest user & application credentials for obtaining access to organisation's network infrastructure. Also, visiting email embedded malicious domains or accessing malware attachments in emails may lead to ransomware infection.

Email security controls play crucial role in stopping malicious inbound emails.

- Implement Email security protocols:
  - Sender Policy Framework (SPF)
  - DomainKeys Identified Mail (DKIM)
  - Domain-Based Message Authentication, Reporting & Conformance (DMARC)
- Enable Multi Factor Authentication (MFA) for email access to deter Business Email Compromise (BEC)
- Configure native security settings, when using Microsoft 365 Exchange or Google Workspace
- Implement security features in Email gateway applications such as:
  - Anti-phishing
  - Anti-spam
  - Email content & attachment scanning
  - URL scanning & domain reputation scanning
  - Attachment sandboxing

Awareness is the key factor in defending against phishing campaigns.
There are multiple platforms that offer free phishing simulations to test staff preparedness

- KingPhisher: https://github.com/rsmusllp/king-phisher
- Gophish: https://getgophish.com/

Defence -Backups

To ensure ransomware resiliency, a backup maintenance policy plays a crucial role. Backups can be considered as the last line of defence against ransomware.

After initial access, Ransomware actors actively enumerate and infect/destroy any online backups to build pressure on the victim for negotiations on ransom payments. It is not only important to have latest offline backups but also regular testing is essential to ensure flawless quick recovery from safe backups.

The 3-2-1 backup rule may be adopted for data retention and storage:

- Keep at least three (3) copies of data.
- Store two (2) backup copies on different storage media.
- Store one (1) backup copy offsite.

As per the business case, one may opt for

1. External hard drives and disks
2. Tape Libraries
3. NAS Backup servers and solutions
4. Cloud storage

- ✓ Immutable WORM (Write Once Read Many) based backup solutions with delete protection are preferable.
- ✓ Maintenance of Snapshots with versioning can reduce recovery times (RTOs and RPOs).
- ✓ Golden image must be maintained for all critical applications
- ✓ Consider anti-malware controls in backup environment
- ✓ Consider placing backup servers in off-domain, workgroup mode, with a unique set of access credentials

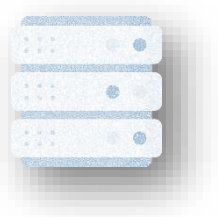
Defence -End points

In targeted attacks, once Ransomware gains initial access to the network, it attempts enumeration, privilege escalation and lateral movement. In individual attack cases, the execution of encryptor happens by targeting files with certain extensions.

End point level some baseline controls must be enforced.

- ✓ Install and maintain updated Antivirus/EDR with scheduled scan settings
- ✓ Use standard user accounts and disable administrative rights, wherever possible
- ✓ Block/restrict RDP, SMB, PowerShell and other unwanted services
- ✓ Enable & configure Ransomware protection with Controlled folder access in window-based systems
- ✓ Keep the operating system, third party applications (MS office, browsers, browser Plugins) up-to-date with the latest patches
- ✓ Consider configuring the host firewall for controlling network traffic
- ✓ Ensure web browser protection controls
- ✓ Consider whitelisting the applications using Software Restriction Policy (SRP) and AppLocker
- ✓ Implement a strict External Device (USB drive) usage policy.
- ✓ Enforce baseline security policies for Bring Your Own Device (BYOD)
- ✓ Ensure to encrypt critical data both at rest and in transit
- ✓ Consider implementing Data Leak Prevention

Defence -Hypervisors



CERT-In has observed a rise in Ransomware attacks targeting virtualised infrastructure where in a single shot several VMs hosted critical applications can be disrupted to cause a major impact. Data centres with virtualised infrastructure deployment like VMWare ESXI and Hyper-V may face severe downtime, if sufficient measures are not undertaken.

Threat actors often use vCenter/ESXi command line interface "esxcli" to enumerate and shutdown the virtual machines to start the encryption process.

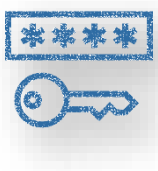
- ✓ Avoid usage of root access credentials
- ✓ Close active remote shells whenever not in use
- ✓ Restrict access to all management interfaces with proper segmentation and MFA
- ✓ Restrict/Disable SSH access to ESXi hosts and block unused ports
- ✓ Consider using ESXi Lockdown mode
- ✓ Enable "execInstalledOnly" to prohibit execution of custom code inside ESXi
- ✓ Consider disabling AD accounts for admin level access to ESXi
- ✓ Consider UEFI Secure Boot on the physical servers
- ✓ Avoid exposure of vCenter/ESXi hosts to internet

Defence -End users

Without awareness among End users /Employees & Third parties, no security control will be enough to protect the digital assets.

- ✓ Educate the end users on cyber hygiene, digital privacy, password management, safe browsing & remote work practices
- ✓ Train the end users on usage of AV/EDR tool that is installed in the systems
- ✓ Regularly conduct training and simulation sessions on topics like social engineering, phishing, Ransomware and Drive by download campaigns
- ✓ Intimate the employees about their roles and responsibilities in cyber security and process to detect and report the incidents

Defence-Access control



Credential compromise due to Info-stealer malwares is a growing concern as it is becoming a network access opportunity for RAAS affiliates. Initial access brokers (IAB) are advertising network access in dark web/underground forums, mainly sourced through stealer malware associated campaigns.

- ✓ Enforce Password change policies, Idle session timeouts, especially for accessing internet facing applications
- ✓ Enforce Multi Factor Authentication for access to critical assets
- ✓ Implement Least Privilege Access
- ✓ Avoid usage of common passwords
- ✓ Maintain strong password policy

Defence-Cloud

Threat actors are actively targeting publicly accessible cloud workloads with the objective of data exfiltration and subsequent data wiping. It is essential to understand the shared responsibility model to secure the cloud hosted resources.

- ✓ Regularly audit for misconfigurations & insecure default settings in the cloud infra
- ✓ Set strong IAM policies with principle of least privilege
- ✓ Set up the ability to recover apps and data in the cloud
- ✓ Update instances and container images regularly
- ✓ Monitor the cloud instances with appropriate security controls

Defence-Policies & Procedures

- ✓ Plan and implement policies for
  - Inventory management -Software & Hardware level
  - Patch management –
    Prioritize patching of public facing applications, specifically for
    - VPN/RDP applications
    - Firewalls
    - Email servers
    - Endpoint Management platforms
    - Web servers
  - Identity & Access management
  - Business Continuity Planning & Backup management
  - Third party risk management

Ransomware Incident Response

- Organisations should develop and test Ransomware Incident Response plan
- For necessary guidelines on Ransomware crisis response measures, the following resources may be referred.
  - *https://www.csk.gov.in/documents/RANSOMWARE_Report_Final.pdf*
  - *https://www.cert-in.org.in/s2cMainServlet?pageid=PUBVLNOTES02&VLCODE=CIAD-2022-0023*

Be prepared to face the Ransomware crisis with defence in depth approach and tested incident response plan

Report Ransomware incidents to CERT-In and other applicable regulatory / law enforcement agencies

Contact & Coordinate with CERT-In to get support in Ransomware incident response

For more information & technical assistance

Contact

Indian Computer Emergency Response Team
E-mail: incident@cert-in.org.in
Phone: 1800-11-4949
FAX: 1800-11-6969
Web: https://www.cert-in.org.in

Innovation Commitment for SAP S/4HANA until 2040

Clarity and Choice on SAP Business Suite 7

On February 4, 2020, SAP has announced an innovation commitment for SAP S/4HANA until the end of 2040. This means that until 2040, there will always be at least one release of SAP S/4HANA in maintenance.

At the same time, SAP will provide mainstream maintenance for SAP Business Suite 7 core applications until end of 2027. This offboarding phase will be followed by optional extended maintenance until end of 2030.

SAP will provide mainstream maintenance until end of 2027 for SAP Business Suite 7 core applications, which are also core applications of SAP Business All-in-One, including the latest three enhancement packages of:

- SAP ERP 6.0
- SAP Customer Relationship Management 7.0
- SAP Supply Chain Management 7.0
- SAP Supplier Relationship Management 7.0 applications
- SAP Business Suite powered by SAP HANA

Following mainstream maintenance, SAP will offer customers choice on maintenance for SAP Business Suite 7 core applications from 2028 onwards:

- Customer needing support for their Business Suite 7 core applications in longer conversion phases to SAP S/4HANA can choose the extended maintenance offering. This comes with a premium of two percent points on the maintenance basis for all support offerings for the scope of SAP Business Suite 7. It will be available for three years from beginning of 2028 until end of 2030.
- Customers who do not opt for the extended maintenance, or where extended maintenance has ended, will receive customer specific maintenance for their SAP Business Suite 7 applications.

Additional context can be found in the related press release as well as in the SAP News interview with Michael Kleinemeier, former member of the Executive Board, and Thomas Saueressig member of the Executive Board, SAP Product Engineering, about the long-term maintenance commitments for SAP S/4HANA and SAP Business Suite 7.

For more information on SAP's release and maintenance strategy, visit the dedicated pages on the SAP Support Portal:

SAP Business Suite powered by SAP HANA

SAP Note 2881788: End of SAP Business Suite 7 mainstream maintenance (log-in required)

SAP Note 1648480: Maintenance for SAP Business Suite 7 software including SAP NetWeaver (log-in required)

SAP Note 52505: Support after end of mainstream maintenance or extended maintenance (log-in required)

SAP Release Strategy (log-in required)

Product Availability Matrix (log-in required)

11 ON-PREMISES MODEL with 5 YEARS WARRANTY

ON-PREMISES								
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**	**Remarks**
1	**SUPPLY - HARDWARE**							
A	**SERVERS - DELHI**							
A.1	SAP Servers - DELHI	2x Intel 5318R 2.1GHz/165W 24C/36 MB DDR4 2933 MHz, 256 GB RAM, 2 x 1.2 TB SSD, 4 Nos. SFP+ Network Ports, 2 Nos. 1G Copper Network Ports, 32Gb Dual Port Fibre Channel HBA, Redundant Power Supply (Patch Cords, Fibre Cords etc. to connect with switches)	3	1,313,900	3,941,701	709,506	4,651,207	Current (AS-IS) Qty. = 5 Required (TO-BE) Qty. = 3 (including HA)
A.2	Backup Server - DELHI	2x Intel 4310R 2.1GHz/120W 12C/18MB DDR4 2666MHz, 64GB RAM, 2 x 480 GB SSD, 4 Nos. SFP+ Network Ports, 2x 32Gb Fibre Channel HBA, Redundant Power (Patch Cords, Fibre Cords etc. to connect with switches)	2	755,863	1,511,727	272,111	1,783,837	Current (AS-IS) Qty. = 1 Required (TO-BE) Qty. = 2 (as per industry standards)
A.3	Infrastructure Server: DELHI (AD, DNS, DHCP, AV, Win Update, NTP, EMS, Email) included storage server as VM	2x Intel 5318R 2.1GHz/165W 24C/36 MB DDR4 2933 MHz, 512 GB RAM, 2 x 1.2 TB SSD, 4 Nos. SFP+ Network Ports, 2 Nos. 1G Copper Network Ports, 32Gb Dual Port Fibre Channel HBA, Redundant Power Supply (Patch Cords, Fibre Cords etc. to connect with switches)	5	1,313,900	6,569,502	1,182,510	7,752,012	Current (AS-IS) Qty. = 7 Required (TO-BE) Qty. = 5 (including HA)
B	**SERVERS - PLANT**							

ON-PREMISES								
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**	**Remarks**
B.1	Server (Palatana, Tripura) - Domain Controller, DHCP, Windows Update, AV Server & Backup	1x Intel 5318R 2.1GHz/165W 24C/36 MB DDR4 2933 MHz, 256 GB RAM, 2 x 1.2 TB SSD, 4 Nos. SFP+ Network Ports, 2 Nos. 1G Copper Network Ports, 32Gb Dual Port Fibre Channel HBA, Redundant Power Supply (Patch Cords, Fibre Cords etc. to connect with switches)	2	1,313,900	2,627,801	473,004	3,100,805	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
B.2	Storage Server- User Backup - Palatana	2x Intel 4310R 2.1GHz/120W 12C/18MB DDR4 2666MHz, 64GB RAM, 2 x 480 GB SSD, 4 Nos. SFP+ Network Ports, 2x 32Gb Fibre Channel HBA, Redundant Power (Patch Cords, Fibre Cords etc. to connect with switches)	1	755,863	755,863	136,055	891,919	Current (AS-IS) Qty. = 1 Required (TO-BE) Qty. = 1
B.3	Backup Server - Plant	2x Intel 4310R 2.1GHz/120W 12C/18MB DDR4 2666MHz, 64GB RAM, 2 x 480 GB SSD, 4 Nos. SFP+ Network Ports, 2x 32Gb Fibre Channel HBA, Redundant Power (Patch Cords, Fibre Cords etc. to connect with switches)	1	755,863	755,863	136,055	891,919	Current (AS-IS) Qty. = 1 Required (TO-BE) Qty. = 1
C	**Storage Area Network (SAN) - DELHI**	Enterprise Storage Usable Storage Capacity on RAID6 with hotspare drive: 33TB	1	8,268,435	8,268,435	1,488,318	9,756,753	Current (AS-IS) Qty. = 1 Required (TO-BE) Qty. = 1 # Current Capacity = 23.12 TB # Used Capacity = 22 TB # Proposed Capacity = 33TB (23 TB Existing, 7 TB for VMs Boot, 3 TB for Future Provision & Migration)
D	**TAPE LIBRARY AND DATA TAPES**							

ON-PREMISES								
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**	**Remarks**
D.1	Tape Library - DELHI	LTO-8 Tape Library with 2 Drives	1	1,546,099	1,546,099	278,298	1,824,397	Current (AS-IS) Qty. = 1 Required (TO-BE) Qty. = 1
D.2	Tape Drive - PLANT	LTO-8 Tape Library with 1 Drives	1	903,822	903,822	162,688	1,066,510	Current (AS-IS) Qty. = 1 Required (TO-BE) Qty. = 1
D.3	Data Tape-DELHI	LTO-8 tape cartridges with bar codes	50	0	0	0	0	Included in D.1
D.4	Data Tape-PLANT	LTO-8 tape cartridges with bar codes	10	0	0	0	0	Included in D.2
D.5	Cleaning Tape-DELHI	LTO-8 cleaning cartridges with bar codes	5	0	0	0	0	Included in D.1
D.6	Cleaning Tape-PLANT	LTO-8 cleaning cartridges with bar codes	2	0	0	0	0	Included in D.2
D.7	Data Backup Appliance	Data Backup Appliance	1	5,130,042	5,130,042	923,408	6,053,450	Currently backup appliance is not there and to protect the primary copy of data, backup appliance is required with data encryption. This is based on current industry standards in view of ransomware threats.
E	**NETWORK - DELHI**							
E.1	SAN Switch	SAN Switch -48 Ports SAN Switch with 24 Port active ports	2	1,378,929	2,757,858	496,414	3,254,272	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
E.2	Core Switch	Core Switch - 48x 10Gig SFP+ slot having redundant power supply and L3 functionality	2	1,250,226	2,500,452	450,081	2,950,533	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
E.3	Aggregation Switch	24x 10Gig SFP+ slot having redundant power supply and L3 functionality	2	240,915	481,830	86,729	568,559	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
E.4	Management Switch	Management Switch -1G 48 Ports	1	226,940	226,940	40,849	267,789	Current (AS-IS) Qty. = 0 Required (TO-BE) Qty. = 1 (For secure connectivity to servers)

ON-PREMISES								
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**	**Remarks**
E.5	WAN Switch	L2 Switch (WAN + Internet Segment) - 24x 1Gig copper ports with 4 x 10Gig SFP+ slot	2	226,940	453,880	81,698	535,578	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
E.6	LAN Switch	48-port Local Area Network (LAN) 1G switch	4	280,606	1,122,424	202,036	1,324,460	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 4 (3 nos. to provide connectivity to all ports, 1 as hot spare in case one switch goes down)
E.7	MPLS Router	MPLS VPN Router	2	533,353	1,066,706	192,007	1,258,713	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
E.8	Internet Router	Internet Router	2	1,172,836	2,345,672	422,221	2,767,893	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
F	**NETWORK - PLANT**							
F.1	Core Switch	Core Switch - 48x 10Gig SFP+ slot having redundant power supply and L3 functionality	2	1,357,123	2,714,246	488,564	3,202,810	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
F.2	LAN Switch	48-port Local Area Network (LAN) 1G switch	7	266,631	1,866,417	335,955	2,202,372	Current (AS-IS) Qty. = 6 Required (TO-BE) Qty. = 7 (1 as hot spare in case one switch goes down)
F.3	LAN Switch	24-port Local Area Network (LAN) 1G switch	15	192,577	2,888,655	519,958	3,408,613	Current (AS-IS) Qty. = 14 Required (TO-BE) Qty. = 15 (1 as hot spare in case one switch goes down)
F.4	MPLS Router	MPLS VPN Router	2	533,353	1,066,706	192,007	1,258,713	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
F.5	Management Switch	48-port Local Area Network (LAN) 1G switch	1	226,940	226,940	40,849	267,789	Current (AS-IS) Qty. = 0 Required (TO-BE) Qty. = 1

ON-PREMISES								
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**	**Remarks**
								(For secure connectivity to servers)
G	**FIREWALLS - DELHI**							
G.1	Firewall - Internal	8 X 1 Gig ports + 4 X 10 Gig SFP+ 15 Gbps NGFW throughput NGFW + NIPS licence	2	3,362,769	6,725,538	1,210,597	7,936,135	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
G.2	Firewall - External	8 X 1 Gig ports + 4 X 10 Gig SFP+ 2 Gbps Mix throughput UTM licence	2	3,706,420	7,412,840	1,334,311	8,747,151	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
G.3	Firewall - Log Analyzer	Firewall - Log Analyzer	1	813,975	813,975	146,516	960,491	Currently Firewall Log Analyzer is not there. Required as per CERT-In guidelines.
H	**DLP**	End Point - Data Loss Prevention - 150 Users	0	35,700	0	0	0	Existing DLP shall be used. Warranty & support shall be renewed on yearly basis.
I	**Link Load Balancer**	Link Load Balancer	2	3,125,000	6,250,000	1,125,000	7,375,000	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
J	**SIEM**	Security Information and Event Management (SIEM) 2500 EPS with one year online and one year offline storage	1	9,000,000	9,000,000	1,620,000	10,620,000	Currently not implemented. Required in view of CERT-Thermal recommendations.
2	**SUPPLY - SOFTWARE**							
K	**Operating System & Database**							
K.1	Operating System - SUSE Linux	SUSE Linux Enterprise Server for SAP Applications - Unlimited Virtual Instances	3	0	0	0	0	Existing SUSE license shall be used. Warranty & support shall be renewed on yearly basis.

ON-PREMISES								
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**	**Remarks**
K.2	Operating System - Microsoft	Microsoft Windows Server Operating System Latest - Data Center Edition (48 cores - 3 x 16 core license)	4	1,517,968	6,071,872	1,092,937	7,164,809	1. Current (AS-IS) Qty. = 48 DC Edition and 96 Std Edition 2. Required (TO-BE) Qty. = 240 DC Edition and 48 Std Edition 3. Required after Utilising Existing Licenses: = 192 DC Edition and 0 Std Edition
L	**Exchange**							
L.1	Microsoft Exchange	Microsoft Exchange Server 2019 Enterprise	0	635,494	0	0	0	Existing license shall be utilised
L.2	Microsoft Exchange	Microsoft Exchange Server 2019 Standard	0	335,494	0	0	0	Existing license shall be utilised
M	**Client Access License (CAL)**							
M.1	CAL - Exchange	Microsoft Exchange Standard CAL (User) 2019	30	13,990	419,700	75,546	495,246	1. Current (AS-IS) Qty. = 100 2. Additional Required = 30
M.2	CAL - Exchange	Microsoft Exchange Enterprise CAL (User) 2019	30	13,990	419,700	75,546	495,246	1. Current (AS-IS) Qty. = 100 2. Additional Required = 30
M.3	CAL - Microsoft Server	Client Access License (CAL) for Windows Server (User CALs) 2019	30	9,639	289,170	52,051	341,221	1. Current (AS-IS) Qty. = 100 2. Additional Required = 30
N	**Backup Software & Backup Agents**							
N.1	Backup Software	Backup Software	0	8,568,919	0	0	0	Existing license shall be utlised (21TB). If additional backup capacity is required beyond 21TB, separate licenses shall be procured in future.

ON-PREMISES								
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**	**Remarks**
O	**EMS Software**	Enterprise Management System (EMS) software	1	5,650,868	5,650,868	1,017,156	6,668,024	
P	**Virtualization**	Virtualization Software with Centralized Management	20	482,480	9,649,600	1,736,928	11,386,528	
Q	**E-Mail Gateway**	E-mail Gateway Anti-spam & Anti-virus software - 130 Users	2	2,000,000	4,000,000	720,000	4,720,000	Current (AS-IS) Qty. = 2 Required (TO-BE) Qty. = 2
R	**Anti-Virus - End Point**	Anti-Virus - End Point	130	4,900	637,000	114,660	751,660	
S	**Anti-Virus - Servers**	Anti-Virus - Servers	70	15,430	1,080,100	194,418	1,274,518	
T	**HIPS**	Host Integrity Protocol (HIPS) System	90	61,607	5,544,630	998,033	6,542,663	Currently not implemented. Required in view of CERT-Thermal recommendations. # 75 OTPC Users # 10 Contractor Staff # 5 Buffer
U	**PIM**	Privileged Identity Management (PIM)	16	125,000	2,000,000	360,000	2,360,000	Currently not implemented. Required in view of CERT-Thermal recommendations. # 5 OTPC Users # 10 Contractor Staff # 1 Buffer
3	**SUPPLY - NON-IT**							
V	NON-IT - Delhi	Non-IT cabling in DC site for compatibility with new devices	1	475,000	475,000	85,500	560,500	DC already built in Delhi and can utilize same facility. However, if required, provision for additional cable is required in case of incompatibility and during migration when both old infra and new infra will be running in parallel

ON-PREMISES								
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**	**Remarks**
W	NON-IT - Plant	Data Centre Build including Civil, Electrical, Cabling, UPS supply, Racks, AC, BMS, etc.	1	4,600,000	4,600,000	828,000	5,428,000	
X	**INSTALLATION PRICE**	Installation, Testing, Migration & Commissioning	1	11,500,000	11,500,000	2,070,000	13,570,000	
4	**TOTAL COST (Z)**		-	-	-	-	**158,438,092**	

12 CLOUD BASED / HYBRID MODEL with 5 YEARS WARRANTY

CLOUD & Hybrid Model								
Sl. No	**On-premises Description**	**Cloud Description**	**Mandatory On-premises Item Qty**	**Unit Cost of On-premises Items**	**Total cost of On-premises items**	**Per Month Cost - Cloud Items**	**Total Cost for 60 Months Cloud Items**	**GST %**
1	**Compute, Storage, Backup**							
1.1	Server Type 1	1. Azure VMs, 2. Azure Storage 3. vNet 4. IP addresses 5. VPN 6. Snapshots			-	14,03,737	8,42,24,222.79	18%
1.2	Server Type 2				-		-	18%
1.3	Server Type 3				-		-	18%
1.4	SAN Switch				-		-	18%
1.5	Hybrid Enterprise Storage				-		-	18%
1.6	Backup Appliance				-		-	18%
1.7	Tape Library				-		-	18%
2	**Network & Security**							
2.1	Firewall - Internal	Azure Firewall and Manager			-	4,87,908	2,92,74,464.25	18%
2.2	Firewall - External		2	60,00,000	1,20,00,000		-	18%
2.3	SIEM		1	90,00,000	90,00,000		-	18%
2.4	Email Anti-Spam Gateway		2	20,00,000	40,00,000		-	18%
2.5	End Point - Encryption Solution		0	6,250	-		-	18%
2.6	End Point - Data Loss Prevention		0	35,700	-		-	18%
2.7	Mobile Device Management		0	7,500	-		-	18%
2.8	DDOS					-	-	18%
2.9	Core Switch	included with VMs	-		-		-	18%
2.10	DMZ Server Farm Switch	included with VMs	-		-		-	18%
2.11	Management Switch	included with VMs	-		-		-	18%

CLOUD & Hybrid Model								
Sl. No	**On-premises Description**	**Cloud Description**	**Mandatory On-premises Item Qty**	**Unit Cost of On-premises Items**	**Total cost of On-premises items**	**Per Month Cost - Cloud Items**	**Total Cost for 60 Months Cloud Items**	**GST %**
2.12	L2 Switch (WAN + Internet Segment)		4	2,44,280	9,77,120		-	18%
2.13	Aggregation Switch for Plant		2	15,71,280	31,42,560		-	18%
2.14	LAN Switches- 24 Port		6	3,07,200	18,43,200		-	18%
2.15	LAN Switches- 48 Port		14	3,85,526	53,97,360		-	18%
2.16	Link Load Balancer	Traffic Manager	-	-	-	-	-	18%
2.17	Routers - Internet		4	2,71,560	10,86,240		-	18%
2.18	Routers - MPLS		4	2,71,560	10,86,240		-	18%
3	**Software**							
3.1	SUSE Linux Enterprise Server for SAP Applications - Unlimited Virtual Instances	Included with VMs			-		-	18%
3.2	SUSE Linux Enterprise Server for X86, AMD64 & Intel64	Included with VMs			-		-	18%
3.3	Microsoft Exchange Server Enterprise Edition	Microsoft O365			-	99,000	59,40,000.00	18%
3.4	Microsoft Exchange Server Enterprise CALs	Included with O365			-		-	18%
3.5	Microsoft Windows Data Centre Edition for AD & Exchange Servers	Azure AD Service			-	1,22,113	73,26,774.31	18%
3.6	Microsoft Windows Server CALS		0	3,106	-		-	18%
3.7	Microsoft SQL Standard 2 Lic	Included with VMs						18%
3.8	Microsoft Office Professional 2021	Included with O365					-	18%
3.9	Enterprise Class Backup software	Azure Backup for Azure VM			-	2,88,806	1,73,28,380.35	18%

CLOUD & Hybrid Model								
Sl. No	**On-premises Description**	**Cloud Description**	**Mandatory On-premises Item Qty**	**Unit Cost of On-premises Items**	**Total cost of On-premises items**	**Per Month Cost - Cloud Items**	**Total Cost for 60 Months Cloud Items**	**GST %**
3.10	End Point backup Software	Azure Backup for on-premises			-	-	-	18%
3.11	Virtualization Software Latest version	Included with VMs			-		-	18%
3.12	Centralized Management for Virtualization software Latest Version	Included with VMs			-		-	18%
3.13	DR Automation Software Solution	NA			-		-	18%
3.14	Host IPS Solution (for all Physical and virtual servers Proposed)	License required separately	1	43,12,500	43,12,500		-	18%
3.15	Anti-Virus	License required separately	0	6,750	-		-	18%
3.16	Privileged Identity Management	License required separately	16	1,25,000	20,00,000		-	18%
3.17	Database Activity Monitoring	License required separately	0	-	-		-	18%
3.18	IT Service Management & Service Desk Software	Azure Monitor	0	-	-	3,99,451	2,39,67,055.16	18%
3.19	2 Factor Authentication			-	-		-	18%
4	**Non-IT**							
4.1	Data Centre Cabling supply & Installation at DC site for 4 racks	Not required						18%
4.2	Non-IT DC Build - 2 Rack DC with UPS, PAC and cabling	Not required						18%
4.3	NON- IT Infrastructure AMC for 5 years - Delhi Site	Not required						18%
5	**Services**							

CLOUD & Hybrid Model								
Sl. No	**On-premises Description**	**Cloud Description**	**Mandatory On-premises Item Qty**	**Unit Cost of On-premises Items**	**Total cost of On-premises items**	**Per Month Cost - Cloud Items**	**Total Cost for 60 Months Cloud Items**	**GST %**
5.1	One time Installation and commissioning charges & Migration to Cloud	Installation & Migration Service	1	1,10,00,000	1,10,00,000			18%
5.2	One time Installation and commissioning charges for Plant	Plant Infra Implementation	1	20,00,000	20,00,000			18%
5.3	SAP Migration Services	SAP Migration Services	1	58,71,500	58,71,500			18%
5.4	Vulnerability Assessment Service		0	14,032	-			18%
5.5	Penetration Testing Service		0	26,180	-			18%
5.6	Outbound Data Transfer Charges by Cloud Provider					-	-	
5.10	Cloud to On-premises Migration Charges					-	-	
	Total Cost (Rs.)				**6,37,16,720**		**16,80,60,897**	
							23,17,77,616.86	
						GST	4,17,19,971.03	
						Total	**27,34,97,587.89**	

13 CO-LOCATION MODEL with 5 YEARS WARRANTY

Co-Location Model							
Sl. No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**
1	**SUPPLY - HARDWARE**						
A	**SERVERS - DELHI**						
A.1	SAP Production Server - DELHI	2x Intel 5218R 2.1GHz/125W 20C/27.5MB DDR4 2667MHz, 384GB RAM, 2 x 1.2 TB 12G SAS 10K RPM , 4 Nos. SFP+ Network Ports, 2 Nos. 1G Copper Network Ports, 32Gb Dual Port Fibre Channel HBA, Redundant Power Supply (Patch Cords, Fibre Cords etc. to connect with switches)	3	11,12,689	33,38,067	6,00,852	39,38,920
A.2	Backup Server - DELHI	2x Intel 4210R 2.4GHz/100W 10C/13.75MB DDR4 2400MHz, 64GB RAM, 2 x 1.2 TB 12G SAS 10K RPM , 4 Nos. SFP+ Network Ports, 2x 32Gb Fibre Channel HBA, Redundant Power	2	7,88,477	15,76,953	2,83,852	18,60,805
A.3	Infrastructure Server: (AD, DNS, DHCP, AV, Win Update, NTP, EMS, Email) included storage server as VM	2x Intel 5218R 2.1GHz/125W 20C/27.5MB DDR4 2667MHz, 384GB RAM, 2 x 1.2 TB 12G SAS 10K RPM , 4 Nos. SFP+ Network Ports, 2 Nos. 1G Copper Network Ports, 32Gb Dual Port Fibre Channel HBA, Redundant Power Supply (Patch Cords, Fibre Cords etc. to connect with switches)	6	11,12,689	66,76,135	12,01,704	78,77,839
B	**SERVERS - PLANT**						

Co-Location Model							
Sl. No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**
B.1	Server (Palatana, Tripura) - Domain Controller, DHCP, Windows Update, AV Server & Backup	2x Intel 5218R 2.1GHz/125W 20C/27.5MB DDR4 2667MHz, 384GB RAM, 2 x 1.2 TB 12G SAS 10K RPM , 4 Nos. SFP+ Network Ports, 2 Nos. 1G Copper Network Ports, 32Gb Dual Port Fibre Channel HBA, Redundant Power Supply (Patch Cords, Fibre Cords etc. to connect with switches)	2	11,12,689	22,25,378	4,00,568	26,25,946
B.2	Storage Server- User Backup - Palatana	2x Intel 4210R 2.4GHz/100W 10C/13.75MB DDR4 2400MHz, 64GB RAM, 6 x 4 TB NL-SAS 2 Nos. SFP+ Network Ports, 2x 32Gb Fibre Channel HBA, Redundant Power	1	10,43,034	10,43,034	1,87,746	12,30,780
A.2	Backup Server - Plant	2x Intel 4210R 2.4GHz/100W 10C/13.75MB DDR4 2400MHz, 64GB RAM, 2 x 1.2 TB 12G SAS 10K RPM, 4 Nos. SFP+ Network Ports, 2x 32Gb Fibre Channel HBA, Redundant Power	1	7,88,477	7,88,477	1,41,926	9,30,402
C	**Storage Area Network (SAN) - DELHI**	Hybrid Enterprise Storage Unified Storage. Usable Storage Capacity on RAID6 with hotspare drive '- 6TB Usable on SSD/Flash Disks or higher '- 25TB usable on SAS 10K disks or higher '- 20TB Usable on NL-SAS 7.2K disks or higher	1	1,07,17,949	1,07,17,949	19,29,231	1,26,47,179
D	**TAPE LIBRARY AND DATA TAPES**						
D.1	Tape Library - DELHI	LTO-8 Tape Library with 4 Drives	1	27,25,000	27,25,000	4,90,500	32,15,500
D.2	Tape Drive - PLANT	LTO-8 Tape Library with 2 Drives	1	18,26,218	18,26,218	3,28,719	21,54,937
D.3	Data Tape-DELHI	LTO-8 tape cartridges with bar codes	50	10,013	5,00,650	90,117	5,90,767

Co-Location Model							
Sl. No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**
D.4	Data Tape-PLANT	LTO-8 tape cartridges with bar codes	10	10,013	1,00,130	18,023	1,18,153
D.5	Cleaning Tape-DELHI	LTO-8 cleaning cartridges with bar codes	5	7,048	35,240	6,343	41,583
D.6	Cleaning Tape-PLANT	LTO-8 cleaning cartridges with bar codes	2	7,048	14,096	2,537	16,633
D.7	Data Backup Appliance	100TB Usable capacity backup appliance with deduplication and compression	1	1,10,24,481	1,10,24,481	19,84,407	1,30,08,887
E	**NETWORK - DELHI**						
E.1	SAN Switch	SAN Switch -48 Ports SAN Switch with 24 Port active ports	2	22,29,363	44,58,725	8,02,571	52,61,296
E.2	Core Switch	Core Switch - 48x 10Gig SFP+ slot having redundant power supply and L3 functionality	2	30,82,640	61,65,280	11,09,750	72,75,030
E.3	Aggregation Switch	24x 10Gig SFP+ slot having redundant power supply and L3 functionality	2	28,07,320	56,14,640	10,10,635	66,25,275
	Management Switch	Management Switch -1G 48 Ports	1	3,55,526	3,55,526	63,995	4,19,520
E.5	WAN Switch	L2 Switch (WAN + Internet Segment) - 24x 1Gig copper ports with 4 x 10Gig SFP+ slot	2	2,44,280	4,88,560	87,941	5,76,501
E.6	LAN Switch	48-port Local Area Network (LAN) 1G switch	3	3,55,526	10,66,577	1,91,984	12,58,561
E.7	MPLS Router	MPLS VPN Router	2	3,71,560	7,43,120	1,33,762	8,76,882
E.8	Internet Router	Internet Router	2	3,71,560	7,43,120	1,33,762	8,76,882
	MPLS Router	MPLS VPN Router - Hosting Facility	2	3,71,560	7,43,120	1,33,762	8,76,882
F	**NETWORK - PLANT**						
F.1	Core Switch	Core Switch - 48x 10Gig SFP+ slot having redundant power supply and L3 functionality	2	30,82,640	61,65,280	11,09,750	72,75,030
F.2	LAN Switch	48-port Local Area Network (LAN) 1G switch	6	3,55,526	21,33,154	3,83,968	25,17,122
F.3	LAN Switch	24-port Local Area Network (LAN) 1G switch	14	2,97,200	41,60,800	7,48,944	49,09,744
F.4	MPLS Router	MPLS VPN Router	2	3,71,560	7,43,120	1,33,762	8,76,882

Co-Location Model							
Sl. No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**
F.5	Management Switch	48-port Local Area Network (LAN) 1G switch	1	3,55,526	3,55,526	63,995	4,19,520
F.7	L2 Switch (WAN + Internet Segment)	L2 Switch (WAN + Internet Segment) - 24x 1Gig copper ports with 4 x 10Gig SFP+ slot	2	2,97,200	5,94,400	1,06,992	7,01,392
G	**FIREWALLS - DELHI**						
G.1	Firewall - Internal	8 X 1 Gig ports + 4 X 10 Gig SFP+ 15 Gbps NGFW throghput NGFW + NIPS licence	2	35,00,000	70,00,000	12,60,000	82,60,000
G.2	Firewall - External	8 X 1 Gig ports + 4 X 10 Gig SFP+ 2 Gbps Mix throughput UTM licence	2	70,00,000	1,40,00,000	25,20,000	1,65,20,000
H	**DLP**	End Point - Data Loss Prevention - 150 Users	150	35,700	53,55,000	9,63,900	63,18,900
I	**Link Load Balancer**	Link Load Balancer	2	30,00,000	60,00,000	10,80,000	70,80,000
J	**End Point - Encryption Solution**	End Point - Encryption Solution	150	6,250	9,37,500	1,68,750	11,06,250
K	**Mobile Device Management**	Mobile Device Management	150	7,500	11,25,000	2,02,500	13,27,500
2	**SUPPLY - SOFTWARE**						
L	Operating System & Database						
L.1	Operating System - SUSE Linux	SUSE Linux Enterprise Server for SAP Applications - Unlimited Virtual Instances	3	15,75,000	47,25,000	8,50,500	55,75,500
L.2	Operating System - Microsoft	Microsoft Windows Server Operating System Latest - Data Center Edition	112	1,09,795	1,22,97,046	22,13,468	1,45,10,514
L.3	DB - Microsoft	Microsoft SQL Standard 2 Lic	0	0	0	0	0
M	Exchange						

Co-Location Model							
Sl. No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**
M.1	Microsoft Exchange	Microsoft Exchange Server 2019 Enterprise	2	6,35,494	12,70,988	2,28,778	14,99,765
M.2	Microsoft Exchange	Microsoft Exchange Server 2019 Standard	2	3,35,494	6,70,988	1,20,778	7,91,765
N	Client Access License (CAL)						
N.1	CAL - Exchange	Microsoft Exchange Standard CAL (User) 2013	150	13,990	20,98,500	3,77,730	24,76,230
N.2	CAL - Exchange	Microsoft Exchange Enterprise CAL (User) 2013	150	13,990	20,98,500	3,77,730	24,76,230
N.3	CAL - Microsoft Server	Client Access License (CAL) for Windows Server (User CALs)	150	3,106	4,65,900	83,862	5,49,762
O	Digital Certificates	SAN (Subject Alternative Name) SSL digital Certificate	4	1,22,163	4,88,652	87,957	5,76,609
P	Backup Software & Backup Agents						
P.1	Backup – Delhi	Backup software license Front end TB/Socket	20	2,85,000	57,00,000	10,26,000	67,26,000
P.2	Backup – User Backup	Backup Software and Backup Agents	100	50,000	50,00,000	9,00,000	59,00,000
Q	EMS Software	Enterprise Management System (EMS) software	1	1,10,00,000	1,10,00,000	19,80,000	1,29,80,000
R	Virtualization	Virtualization Software with Centralized Management	22	4,82,480	1,06,14,560	19,10,621	1,25,25,181
S	E-Mail Gateway	E-mail Gateway Anti-spam & Anti-virus software - 150 Users	2	20,00,000	40,00,000	7,20,000	47,20,000
T	Anti-Virus	Anti-Virus	150	6,750	10,12,500	1,82,250	11,94,750
U	MS Office	MS Office 2021	150	45,392	68,08,800	12,25,584	80,34,384
3	**Hosting Services**						
3.1	**DC Hosting - New Delhi**	Hosting Services - Per Rack 7KVA Rated Power	4	67,50,000	2,70,00,000	48,60,000	3,18,60,000

Co-Location Model							
Sl. No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**
	Cross Connects	Cross connect for Internet & MPLS	4	1,30,000	5,20,000	93,600	6,13,600
	DC Network Cabling	Copper & Fiber Cabling	4	3,00,000	12,00,000	2,16,000	14,16,000
	Seating Space	Per Seat charges	1	10,00,000	10,00,000	1,80,000	11,80,000
3.2	**NON-IT - Plant**	Data Centre Build including Civil, Electrical, Cabling, UPS supply, Racks, AC, BMS, etc.	1	65,00,000	65,00,000	11,70,000	76,70,000
4	**INSTALLATION PRICE**	Installation, Testing, Migration & Commissioning	1	1,15,00,000	1,15,00,000	20,70,000	1,35,70,000
5	**TOTAL CAPEX (W)**		-	-	-	-	**26,84,63,792**

14 In-House (OEPX) MODEL with 5 YEARS WARRANTY

In-House - OPEX Model							
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**
1	**SUPPLY - HARDWARE**						
A	**SERVERS - DELHI**						
A.1	SAP Production Server - DELHI	2x Intel 5218R 2.1GHz/125W 20C/27.5MB DDR4 2667MHz, 384GB RAM, 2 x 1.2 TB 12G SAS 10K RPM , 4 Nos. SFP+ Network Ports, 2 Nos. 1G Copper Network Ports, 32Gb Dual Port Fibre Channel HBA, Redundant Power Supply (Patch Cords, Fibre Cords etc. to connect with switches)	3	11,12,689	33,38,067	6,00,852	39,38,920
A.2	Backup Server - DELHI	2x Intel 4210R 2.4GHz/100W 10C/13.75MB DDR4 2400MHz, 64GB RAM, 2 x 1.2 TB 12G SAS 10K RPM , 4 Nos. SFP+ Network Ports, 2x 32Gb Fibre Channel HBA, Redundant Power	1	7,88,477	7,88,477	1,41,926	9,30,402
A.3	Infrastructure Server: (AD,DNS, DHCP, AV, Win Update, NTP, EMS, Email) included storage server as VM	2x Intel 5218R 2.1GHz/125W 20C/27.5MB DDR4 2667MHz, 384GB RAM, 2 x 1.2 TB 12G SAS 10K RPM , 4 Nos. SFP+ Network Ports, 2 Nos. 1G Copper Network Ports, 32Gb Dual Port Fibre Channel HBA, Redundant Power Supply (Patch Cords, Fibre Cords etc. to connect with switches)	6	11,12,689	66,76,135	12,01,704	78,77,839
B	**SERVERS - PLANT**						

In-House - OPEX Model							
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**
B.1	Server (Palatana, Tripura) - Domain Controller, DHCP, Windows Update, AV Server & Backup	2x Intel 5218R 2.1GHz/125W 20C/27.5MB DDR4 2667MHz, 384GB RAM, 2 x 1.2 TB 12G SAS 10K RPM , 4 Nos. SFP+ Network Ports, 2 Nos. 1G Copper Network Ports, 32Gb Dual Port Fibre Channel HBA, Redundant Power Supply (Patch Cords, Fibre Cords etc. to connect with switches)	2	11,12,689	22,25,378	4,00,568	26,25,946
B.2	Storage Server- User Backup - Palatana	2x Intel 4210R 2.4GHz/100W 10C/13.75MB DDR4 2400MHz, 64GB RAM, 4 x 4 TB NL-SAS 2 Nos. SFP+ Network Ports, 2x 32Gb Fibre Channel HBA, Redundant Power	1	10,43,034	10,43,034	1,87,746	12,30,780
C	**Storage Area Network (SAN) - DELHI**	Hybrid Enterprise Storage Unified Storage . Usable Storage Capacity on RAID6 with hotspare drive '- 6TB Usable on SSD/Flash Disks or higher '- 25TB usable on SAS 10K disks or higher '- 20TB Usable on NL-SAS 7.2K disks or higher	1	1,07,17,949	1,07,17,949	19,29,231	1,26,47,179
D	**TAPE LIBRARY AND DATA TAPES**						
D.1	Tape Library - DELHI	LTO-8 Tape Library with 4 Drives	1	30,77,901	30,77,901	5,54,022	36,31,923
D.2	Tape Drive - PLANT	LTO-8 Tape Library with 2 Drives	1	20,26,218	20,26,218	3,64,719	23,90,937
D.3	Data Tape-DELHI	LTO-8 tape cartridges with bar codes	75	12,013	9,00,975	1,62,176	10,63,151
D.4	Data Tape-PLANT	LTO-8 tape cartridges with bar codes	15	12,013	1,80,195	32,435	2,12,630
D.5	Cleaning Tape-DELHI	LTO-8 cleaning cartridges with bar codes	10	7,048	70,480	12,686	83,166
D.6	Cleaning Tape-PLANT	LTO-8 cleaning cartridges with bar codes	2	7,048	14,096	2,537	16,633
D.7	Data Backup Appliance	100TB Usable capacity backup appliance with deduplication and compression	1	1,10,24,481	1,10,24,481	19,84,407	1,30,08,887
E	**NETWORK - DELHI**						
E.1	SAN Switch	SAN Switch -48 Ports SAN Switch with 24 Port active ports	2	22,29,363	44,58,725	8,02,571	52,61,296

In-House - OPEX Model							
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**
E.2	Core Switch	Core Switch - 48x 10Gig SFP+ slot having redundant power supply and L3 functionality	2	39,82,640	79,65,280	14,33,750	93,99,030
E.3	DMZ Switch	24x 10Gig SFP+ slot having redundant power supply and L3 functionality	2	29,07,320	58,14,640	10,46,635	68,61,275
E.4	Aggregation Switch	Aggregation Switch -1G with 10G Uplinks	2	14,19,151	28,38,302	5,10,894	33,49,196
E.5	WAN Switch	L2 Switch (WAN + Internet Segment) - 24x 1Gig copper ports with 4 x 10Gig SFP+ slot	2	2,44,280	4,88,560	87,941	5,76,501
E.6	LAN Switch	48-port Local Area Network (LAN) 1G switch	3	4,55,526	13,66,577	2,45,984	16,12,561
E.7	MPLS Router	MPLS VPN Router	2	3,71,560	7,43,120	1,33,762	8,76,882
E.8	Internet Router	Internet Router	2	3,71,560	7,43,120	1,33,762	8,76,882
F	**NETWORK - PLANT**						
F.1	Core Switch	Core Switch - 48x 10Gig SFP+ slot having redundant power supply and L3 functionality	2	39,82,640	79,65,280	14,33,750	93,99,030
F.2	LAN Switch	48-port Local Area Network (LAN) 1G switch	6	4,55,526	27,33,154	4,91,968	32,25,122
F.3	LAN Switch	24-port Local Area Network (LAN) 1G switch	14	3,57,200	50,00,800	9,00,144	59,00,944
F.4	MPLS Router	MPLS VPN Router	2	3,71,560	7,43,120	1,33,762	8,76,882
F.5	Management Switch	48-port Local Area Network (LAN) 1G switch	2	2,44,280	4,88,560	87,941	5,76,501
F.6	Aggregation Switch	24x 10Gig SFP+ slot having redundant power supply and L3 functionality	2	29,07,320	58,14,640	10,46,635	68,61,275
F.7	L2 Switch (WAN + Internet Segment)	L2 Switch (WAN + Internet Segment) - 24x 1Gig copper ports with 4 x 10Gig SFP+ slot	2	2,44,280	4,88,560	87,941	5,76,501
G	**FIREWALLS - DELHI**						

In-House - OPEX Model							
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**
G.1	Firewall - Internal	8 X 1 Gig ports + 4 X 10 Gig SFP+ 15 Gbps NGFW throghput NGFW + NIPS licence	2	25,00,000	50,00,000	9,00,000	59,00,000
G.2	Firewall - External	8 X 1 Gig ports + 4 X 10 Gig SFP+ 2 Gbps Mix throughput UTM licence	2	70,00,000	1,40,00,000	25,20,000	1,65,20,000
H	**DLP**	End Point - Data Loss Prevention - 150 Users	150	35,700	53,55,000	9,63,900	63,18,900
I	**Link Load Balancer**	Link Load Balancer	2	30,00,000	60,00,000	10,80,000	70,80,000
J	**End Point - Encryption Solution**	End Point - Encryption Solution	150	6,250	9,37,500	1,68,750	11,06,250
K	**Mobile Device Management**	Mobile Device Management	150	7,500	11,25,000	2,02,500	13,27,500
2	**SUPPLY - SOFTWARE**						
L	Operating System & Database						
L.1	Operating System - SUSE Linux	SUSE Linux Enterprise Server for SAP Applications - Unlimited Virtual Instances	3	15,75,000	47,25,000	8,50,500	55,75,500
L.2	Operating System - Microsoft	Microsoft Windows Server Operating System Latest - Data Center Edition	112	1,09,795	1,22,97,046	22,13,468	1,45,10,514
L.3	DB - Microsoft	Microsoft SQL Standard 2 Lic	0	0	0	0	0
M	Exchange						
M.1	Microsoft Exchange	Microsoft Exchange Server 2019 Enterprise	2	6,35,494	12,70,988	2,28,778	14,99,765
M.2	Microsoft Exchange	Microsoft Exchange Server 2019 Standard	2	3,35,494	6,70,988	1,20,778	7,91,765
N	Client Access License (CAL)						

In-House - OPEX Model							
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**
N.1	CAL - Exchange	Microsoft Exchange Standard CAL (User) 2013	150	13,990	20,98,500	3,77,730	24,76,230
N.2	CAL - Exchange	Microsoft Exchange Enterprise CAL (User) 2013	150	13,990	20,98,500	3,77,730	24,76,230
N.3	CAL - Microsoft Server	Client Access License (CAL) for Windows Server (User CALs) 2012	150	3,106	4,65,900	83,862	5,49,762
O	Digital Certificates	SAN (Subject Alternative Name) SSL digital Certificate	4	1,22,163	4,88,652	87,957	5,76,609
P	Backup Software & Backup Agents						
P.1	Backup – Delhi	Backup software license Front end TB/Socket	20	2,85,000	57,00,000	10,26,000	67,26,000
P.2	Backup – User Backup	Backup Software and Backup Agents	100	50,000	50,00,000	9,00,000	59,00,000
Q	EMS Software	Enterprise Management System (EMS) software	1	1,10,00,000	1,10,00,000	19,80,000	1,29,80,000
R	Virtualization	Virtualization Software with Centralized Management	22	4,82,480	1,06,14,560	19,10,621	1,25,25,181
S	E-Mail Gateway	E-mail Gateway Anti-spam & Anti-virus software - 150 Users	2	20,00,000	40,00,000	7,20,000	47,20,000
T	Anti-Virus	Anti-Virus	150	6,750	10,12,500	1,82,250	11,94,750
U	MS Office	MS Office 2021	150	45,392	68,08,800	12,25,584	80,34,384
3	**SUPPLY - NON-IT**						
3.1	**NON-IT - Delhi**	Non-IT cabling in DC site for compatibility with new devices	1	12,00,000	12,00,000	2,16,000	14,16,000
3.2	**NON-IT - Plant**	Data Centre Build including Civil, Electrical, Cabling, UPS supply, Racks, AC, BMS, etc.	1	65,00,000	65,00,000	11,70,000	76,70,000

In-House - OPEX Model							
Sl.No.	**Item**	**System Configuration (Same or Superior to As Supplied in 2015) 5 Years Warranty & Support**	**Quantity (A)**	**Unit Price (B)**	**Total C=A*B**	**Service Tax / GST (18%) D**	**Total Price E=C+D**
4	**INSTALLATION PRICE**	Installation, Testing, Migration & Commissioning	1	1,15,00,000	1,15,00,000	20,70,000	1,35,70,000
5	**TOTAL CAPEX (W)**		-	-	-	-	**24,73,33,613**

CONSOLIDATED SITE VISIT REPORT - DATA CENTER & IT INFRASTRUCTURE

Vide note dated 27th June 2022 (**Annexure-I**), a committee comprising of Head - Corp. C & M, Head - Corp. F&A (Finance & Budgeting) and Head - Corp. IT & CISO was constituted to visit and understand IT facility of similar setup as of OTPC and to plan strategy for Data Centre & IT Infrastructure refresh of OTPC setup.

1. **Committee visited following Data Centre & IT Infrastructure (DCITI):**

1.1 Indraprastha Gas Limited, New Delhi on 10th August 2022, discussion held with CGM (ERP & IT). Report is attached as **Annexure-II.**

1.2 Pragati Power Corporation Limited, New Delhi on 25th August 2022, discussion held with AGM (IT) and other senior officers. Report is attached as **Annexure-III.**

1.3 Lanco Anpara Power Limited, Gurugram on 9th September 2022, discussion held with GM-SAP & IT. Report is attached as **Annexure-IV.**

1.4 NTPC Limited, NOIDA on 27th September 2022, discussion held with Addl. GM (IT). Report is attached as **Annexure-V.**

2. Committee visited DCITI from varied sectors, from private and as well as public sector undertakings having medium and large installations.

3. **Type of Installation**: OTPC discussed high level architecture of Data Centre & IT Infrastructure including network at Delhi Office and Palatana Plant. Above Organizations appreciated OTPC's existing IT & network setup and in their view architecture is as per industry standard. Further, OTPC informed that existing IT setup is in-house at Delhi and Palatana Plant.

4. **Proposed BoQ**: Organizations had a glance over the OTPC's BoQ proposed for refresh and generally expressed satisfaction due to its optimal design, completeness in terms of required systems, adherence to security requirements. They also appreciated 99.5% IT infrastructure availability during past seven years of its operation. Additionally, it was informed that OTPC should consider compliance to CERT-In guidelines to further strengthen cyber security posture in OTPC considering power sector is very critical in nature.

5. **Type of Installation**: Above Organizations informed that they would prefer In-House model of Data Centre due to the following points: (a) apprehensions about security aspects in Cloud Based implementations cannot be ruled out absolutely (b) unknown challenges during changing of Cloud Service Providers on completion of Contract or termination of Contract.

6. It was suggested that it would be prudent for OTPC to continue in-house IT Infrastructure setup considering that OTPC's Data Centre sizing has not grown exponentially since its 7+ years of operations on 24x7 basis. Hence, there could be hardly any cost benefit in setting-up cloud based IT setup for small/mid-size companies.

7. NTPC made one important suggestion that considering typical refresh cycle of IT setup ranges between 5 to 7 years, it shall be prudent for OTPC to consider OEM warranty and support for 7 years upfront instead of 5 years considering better pricing and OEMs long term commitment and hence ensuring stable supplies of spares and support.

8. OTPC was suggested to size the new IT setup considering future growth for next 5 to 7 years, increase in user base, business expansion, new applications, update/upgrade of SAP application including new module implementation. It was also suggested to explore Hyper Converged Infrastructure (HCI) which is unified system that combines all the elements of a traditional Data Centre (storage, compute, networking, management. Etc.) for consolidation of Data Centre space and better management.

9. **Price Estimates**: OTPC informed that estimated CAPEX cost of proposed setup is approximately Rs. 15.84 Crores (**break-up is attached as Annexure-VI**) with 5 years warranty and support including installation and migration and commissioning charges. This estimated cost is based on budgetary quotes received from respective OEMs and system integrators. Above establishments were of the view that SI's / OEMs might have submitted prices on higher side considering high inflation, USD-INR implications, chip supply constraints due to geo-political orders, and margins they might have added due to future price hike.

Head - Corp. C & M | Head - Corp. F&A (Finance & Budgeting) | Head - Corp. IT & CISO

Submitted for kind consideration records please.

CTO:

Committee Report Submitted To:

MD-OTPC:

ONGC TRIPURA POWER COMPANY LTD

AUTHORIZATION FOR EXPENSES (AFE)

AFE No : 1300000370 **Annexure - 1**

SNo.	Material Code	Short Text	Quantity	UOM	Value	Amount	Curr	Last PO No./ Line Item/ Date	Vendor	Unit Price	IInd Last PO No./ Line Item/ Date	Vendor	Unit Price
1	6900930	MAX OPERATOR WORKSTATION (max OWS)	8	NOS	2555326.88	20442615.04	INR	/000/00.00.0000		0.00			0.00
2	6900931	MAX ENGINEERING WORKSTATION (max EWS)	4	NOS	2960944.50	11843778.00	INR	/000/00.00.0000		0.00			0.00
3	6900932	MAX STORIAN WORKSTATION (max HIST)	3	NOS	2960944.50	8882833.50	INR	/000/00.00.0000		0.00			0.00
4	6900933	MAX LINK WORKSTATION (max LINK)	3	NOS	2555326.88	7665980.64	INR	/000/00.00.0000		0.00			0.00
5	6900934	MAX LARGE VIDEO SCREEN PC (max LVS)	6	NOS	2555326.88	15331961.28	INR	/000/00.00.0000		0.00			0.00
6	6900935	MAX PERFORMANCE WORKSTATION (max PERFC)	3	NOS	2555326.88	7665980.64	INR	/000/00.00.0000		0.00			0.00
7	6900936	MAX MIS WORKSTATION (max MIS)	3	NOS	2555326.88	7665980.64	INR	/000/00.00.0000		0.00			0.00
8		SUPERVISION,INSTALL & COMMISSIONING U#1	1	AU	1247971.69	1247971.69	INR			0.00			0.00

Activity	Description	Quantity	UOM	Net Value	Gross Value	Curr
8.1	SUPERVISION,INSTALL & COMMISSIONING U#1	1	AU	1,247,971.6	1,247,971.69	INR

9		SUPERVISION,INSTALL & COMMISSIONING U#2	1	AU	1247971.69	1247971.69	INR			0.00			0.00

Activity	Description	Quantity	UOM	Net Value	Gross Value	Curr
9.1	SUPERVISION,INSTALL & COMMISSIONING U#2	1	AU	1,247,971.6	1,247,971.69	INR

10	6900940	MAX 24 PORT NETWORK SWITCH, DA0659446269	20	NOS	212953.13	4259062.60	INR	/000/00.00.0000		0.00			0.00
11	6900950	MAXDNA DOMAIN CONTROLLER & BACKUP SERVER	1	NOS	5750044.13	5750044.13	INR	/000/00.00.0000		0.00			0.00

733

12/10/2020

ANNEXURE- III

SCOPE OF BHEL FOR UPGRADATION OF MAXSTATION OF UNIT 1 & 2

1. Upgradation of Operating System (OS) [Windows XP to Windows 10] in MaxStation as per following BOM.

BILL OF MATERIAL (BOM)			
STATION DESCRIPTION	**UNIT #1 (QTY)**	**UNIT #2 (QTY)**	**IN SPARE**
MAX OPERATOR WORKSTATION (max OWS)	**3**	**3**	**2**
MAX ENGINEERING WORKSTATION (max EWS)	**2**	**2**	**2**
MAX STORIAN WORKSTATION (max HIST)	**1**	**1**	**1**
MAX LINK WORKSTATION (max LINK)	**1**	**1**	**1**
MAX LARGE VIDEO SCREEN PC (max LVS)	**1**	**1**	**1**
MAX PERFORMANCE WORKSTATION (max PERFC)	**1**	**1**	**2**
MAX MIS WORKSTATION (max MIS)	**1**	**1**	**1**
NETWORK SWITCHES	**10**	**8**	**2**
DOMAIN CONTROLLLER AND BACK UP SERVER	**1**	**1**	**NA**

2. Supply and Installation of Latest System software as available.
3. Engineering Work related to converting existing MMIC, Logic, Storian Data and System loops etc. and reloading to present system.
4. Completed list of hardware, software, cablings etc. and services to be provided.
5. Historian Point Configuration, LVS alarm Data Base configuration to latest available software without any changes in functionality.
6. All existing functionality of Individual work stations like PERFC, OWS, EWS, STOR, MIS and LINK etc. shall be retained after the upgrade and same shall be demonstrated at the time of Factory Acceptance Test (FAT) and after commissioning & completion at site. After completion, punch points raised by customer to be closed as soon as possible so that availability of system shall not be hampered.
7. Following facilities/Software's (not limited) to be provided with work station.
   a) Redundancy in hard drives to be incorporated.
   b) Read/Write Drive in all Work Stations.
   c) Licensed Microsoft Office for all work Stations.
   d) Licensed PDF Viewed & Creator.
   e) Report Generation facility in all available format (like MS Excel, Word, PDF etc.)
   f) Existing Printer connection with upgraded work Stations.
   g) Licensed Antivirus (validity min 5 years) to be provided with latest availability.
8. Large Size storage space is recommended for Historian Work Station. So Higher storage capacity (more than 2 TB) should be considered for Historian PC.
9. MAX EWS work station also configured as a Stand by Historian, So Higher storage capacity (more than 2 TB) should be considered for Historian PC.
10. For LVS, 55" LED screen for 24*7 Industrial Application to be supplied in-place of Delta Make Projector Screens.

30.09.2020

11. Complete details documentation to be provided.
12. Client certificates of outsourced Hardware, Software etc. to be provided.
13. Existing network switches to be upgraded to latest as recommended by M/s BHEL.
14. All existing functionality of Network switches to be same after upgradation and same shall be demonstrated.
15. Domain Controller and Backup Server for MaxDNA (DCS) upgraded system for both the units recommended and required. Same to be provided with including necessary features and security patches.
16. Following points to in additional features in the upgraded workstations.

    I. Creating of individual user ID at system level (with logging enable) need to be provided an alternative control to track the misuse of application of specific user ID.
    II. Security Event log size was set in previous MaxStation in 512KB which is not sufficient to store logs of even one day. Logs were getting overwrite as event log settings set as Overwrite events as needed. So large log size is recommended for consideration.
    III. Enable of audit logs for the activities which could be helpful to track the unwanted events as per the organization information security policy.

17. BHEL should give the details required requirement (like backup of DPUs, existing MMIC, custom folder's backups etc.) from OTPC, to be intimated well in advanced for smooth upgradation of system.
18. Internal Connectivity, MODBUS Configuration and MAX Link PC's communication set up with other 3rd Party System (Like GT, BOP etc.).
19. Uninstallation of old system, installation & commissioning, demonstration, put in process, observation, is exclusively scope of BHEL including complete supervision.
20. Supplying of commissioning engineer, supervisors, technicians and helpers (as & when required) for all interface, cabling, power supply, system modification & integration, front-end design, additional screens etc. to be in BHEL scope.
21. Transportation of Engineers, supervisors, technicians and helpers including local transport & accommodation to be arranged by BHEL.
22. Material to be supplied in OTPC Palatana Site. Packing & Forwarding, Transit Insurance and Freight charges are in scope of M/s BHEL.

30.07.2020

Dinesh Laha

From: Operation Team OTPC
Sent: 21 December 2022 09:00
To: Narendra Kumar Gupta
Cc: Prabhat Chandra
Subject: FW: Regarding deactivation of RGMO without prior information to NERLDC

Dear sir,

FYIP

With best regards,

Sushil Kumar | Shift In-charge (Operation)| ONGC Tripura Power Company Limited
Palatana, Gomati, Tripura -799105, India | Call: +91 381 236 3803 | +91 8794716817
www.otpcindia.in

OTPC

From: NERLDC Control Room [mailto:nerldccr@grid-india.in]
Sent: 20 December 2022 19:54
To: Operation Team OTPC
Cc: N Roy (एन रॉय); S C De (एस सी डे); Biswajit Sahu (बिस्वाजित साहू)
Subject: Regarding deactivation of RGMO without prior information to NERLDC

आदरणीय महोदय/ Respected Sir,

It was observed that RGMO of Palatana Block II was deactive without taking any permission from NERLDC or any prior intimation.
As per IEGC 5.22 (f)
"*All Coal/lignite based thermal generating units of 200 MW and above, Open Cycle Gas Turbine/Combined Cycle generating stations having gas turbines of capacity more than 50 MW each and all hydro units of 25 MW and above, which are synchronized with the grid, irrespective of their ownership,* ***shall have their governors in operation at all times*** *in accordance with the following provisions:* "

Further, as per IEGC 5.2.f.ii.c: "*If any of these generating units is required to be operated without its governor in operation as specified above,* ***the RLDC shall be immediately advised***

about the reason and duration of such operation. *All governors shall have a droop setting of between 3% and 6%.*"

In view of this it is requested kindly follow the IEGC regulations as prescribed by CERC.

सादर /Regards,

पाली प्रभारी/Shift-In-Charge

उत्तर पूर्वी क्षेत्रीय भार प्रेषण केंद्र, शिलांग

North Eastern Regional Load Dispatch Centre, Shillong

दूरभाष / Contact No- 0364-2537481/2537427/8415900659/ 8415900660

यू एल डी सी फोन नम्बर/ ULDC PH NO- 23640028/23640059

शेड्यूलिंग डेस्क/ Scheduling desk: 0374-2537470/ 23640027(ULDC)

फैक्स नम्बर /Fax- 0364- 2537486/2537470

Follow Grid-India on:

Pradip Debnath

From: Aparesh Malakar [amalakar@bhel.in]
Sent: 13 June 2019 14:25
To: Pradip Debnath
Subject: FW: Re: Fwd: FW: Reg :: New Antivirus Software and Installation Guide for Maxstation (Unit#1 & Unit#2)

FYI

From: SRINIVAS ANAKAPALLI [mailto:srinivasa.a@bhel.in]
Sent: 13 June 2019 12:46
To: amalakar@bhel.in
Cc: Rajesh Kumar Singh-PSNR
Subject: Fwd: Re: Fwd: FW: Reg :: New Antivirus Software and Installation Guide for Maxstation (Unit#1 & Unit#2)

Dear Sir,

As informed by EDN engineering, new Antivirus(Symantec AV as used in maxDNA) not suitable for Windows XP based PCs.
Request customer to upgrade Windows XP based PC s to Latest version at the earliest for safe and reliable operations.

Regards,
Srinivas Anakapalli

-------- Forwarded Message --------
Subject: Re: Fwd: FW: Reg :: New Antivirus Software and Installation Guide for Maxstation (Unit#1 & Unit#2)
Date: Wed, 12 Jun 2019 11:31:02 +0530
From:KALIDAS PAL <kpal@bhel.in>
To:SRINIVAS ANAKAPALLI <srinivasa.a@bhel.in>
CC: Anil Sinha <anilsinha@bhel.in>

Dear Mr. Srinivas,

New Antivirus(Symantec AV as used in maxDNA) not suitable for Windows XP based PCs.

From:K.Pal

==========

On 6/11/2019 4:52 PM, SRINIVAS ANAKAPALLI wrote:

> Dear Sir,
>
> Please advise if New Antivirus can be offered for Windows XP based PCs at Unit#1 & Unit#2 OTPC.
>
> Regards,
> Srinivas Anakapalli
> CE-O&M Mktg

-------- Forwarded Message --------

Subject:FW: Reg :: New Antivirus Software and Installation Guide for Maxstation (Unit#1 & Unit#2)
Date: Tue, 11 Jun 2019 16:44:39 +0530
From: Aparesh Malakar <amalakar@bhel.in>
To:'SRINIVAS ANAKAPALLI-EDN' <srinivasa.a@bhel.in>
CC: Rajesh Kumar Singh-EDN <rajesh.k@bhel.in>

Dear Sir,
Please furnish Budgetary offer antivirus as per trailing mail.

--
Regards,

Aparesh Malakar
Bharat Heavy Electricals Limited
Spares & Services Business Group-Kolkata
DJ-9/1, Karunamoyee, Salt Lake City, Sector –II, Kolkata - 700091
Phone: 033-2321-6289; Fax: 033-2321-6289 / 1960
Mobile: 98833 65435, E-Mail: amalakar@bhel.in

Assuring you our best services at all times.
CIN: L74899DL1964GOI004281

From: Pradip Debnath [mailto:pradip.debnath@otpcindia.in]
Sent: 11 June 2019 16:02
To: Aparesh Malakar
Cc: Ashish Mandal AGM-SSBG Kolkata; Mohammad Musa
Subject: RE: Reg :: New Antivirus Software and Installation Guide for Maxstation (Unit#1 & Unit#2)
Importance: High

Dear Sir,

Kindly submit the offer for following workstations which antivirus already expired last year.

STATION DESCRIPTION	UNIT #1 (QTY)	UNIT #2 (QTY)
OWS	3	3
LVS	2	2
PERFC	1	1
LINK	1	1
MIS	1	1
EWS	1	1
STOR	1	1

Also find the trailing mail for your reference.

With best regards,

Pradip Debnath | Sr. Executive | C&I | ONGC Tripura Power Company Limited
Palatana, Gomati, Tripura-799105, India | Call: +91 381 236 3887 | +91 8575708964
www.otpcindia.in

Please consider the environment before printing this email.

From: Pradip Debnath
Sent: 06 June 2018 11:49
To: 'Aparesh Malakar'
Cc: Mohammad Musa; Meen Prasad Sharma; 'Ashish Mandal AGM-SSBG Kolkata'
Subject: RE: Reg :: New Antivirus Software and Installation Guide for Maxstation (Unit#1 & Unit#2)

Dear Sir,

We are waiting for you reply.

With best regards,
Pradip Debnath
Sr. Executive – C&I
ONGC Tripura Power Company Limited
(An ISO 9001, ISO 14001 and OHSAS 18001 certified Organization)
Palatana, Gomati, Tripura -799116, India
Phone: +91 381 236 3838, Mobile: +91 8575708964
Email: pradip.debnath@otpcindia.in, www.otpcindia.in

Please consider the environment before printing this email.

From: Pradip Debnath
Sent: 03 May 2018 10:49
To: Aparesh Malakar
Cc: Mohammad Musa; Meen Prasad Sharma; Ashish Mandal AGM-SSBG Kolkata
Subject: RE: Reg :: New Antivirus Software and Installation Guide for Maxstation (Unit#1 & Unit#2)
Importance: High

Dear Sir,

As discussed, please submit the separate offer for following workstations which antivirus going to be expired in next month.

STATION DESCRIPTION	UNIT #1 (QTY)	UNIT #2 (QTY)
OWS	3	3

LVS	2	2
PERFC	1	1
LINK	1	1
MIS	1	1
EWS	1	1
STOR	1	1

Implementing of up-gradation proposal from windows XP to Windows 10 will take time as budget allocation and other approval require to be taken from higher management. So for the time being we required new antivirus for securing the system.

With best regards,
Pradip Debnath
Sr. Executive – C&I
ONGC Tripura Power Company Limited
(An ISO 9001, ISO 14001 and OHSAS 18001 certified Organization)
Palatana, Gomati, Tripura -799116, India
Phone: +91 381 236 3838, Mobile: +91 8575708964
Email: pradip.debnath@otpcindia.in, www.otpcindia.in

From: Aparesh Malakar [mailto:amalakar@bhel.in]
Sent: 03 May 2018 10:31
To: Pradip Debnath
Cc: Mohammad Musa; Meen Prasad Sharma; Ashish Mandal AGM-SSBG Kolkata
Subject: FW: Reg :: New Antivirus Software and Installation Guide for Maxstation (Unit#1 & Unit#2)

Dear sir
We will submit our offer shortly for up-gradation for all MaxDNA stations as per the mail dated April 24, 2018 with inbuilt New Antivirus Software.
Hence a separate offer for New Antivirus Software is not required.

--
Regards,

Aparesh Malakar
Bharat Heavy Electricals Limited
Spares & Services Business Group-Kolkata
DJ-9/1, Karunamoyee, Salt Lake City, Sector –II, Kolkata - 700091
Phone: 033-2321-6289; Fax: 033-2321-6289 / 1960
Mobile: 98833 65435, E-Mail: amalakar@bhel.in

Assuring you our best services at all times.
CIN: L74899DL1964GOI004281

From: Pradip Debnath [mailto:pradip.debnath@otpcindia.in]
Sent: 24 April 2018 13:02
To: Aparesh Malakar

Cc: Ashish Mandal AGM-SSBG Kolkata; Mohammad Musa; Meen Prasad Sharma
Subject: Reg :: New Antivirus Software and Installation Guide for Maxstation (Unit#1 & Unit#2)
Importance: High

Dear Sir,

Kindly provide us a suitable budgetary offer of new antivirus for MaxStation both unit of OTPC , Palatana Plant.

Also requesting you to provide the installation procedure for our reference.

Please mentioned the %age of GST, HSN code etc for process further.

With best regards,
Pradip Debnath
Sr. Executive – C&I
ONGC Tripura Power Company Limited
(An ISO 9001, ISO 14001 and OHSAS 18001 certified Organization)
Palatana, Gomati, Tripura -799116, India
Phone: +91 381 236 3838, Mobile: +91 8575708964
Email: pradip.debnath@otpcindia.in, www.otpcindia.in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इलेक्ट्रॉनिक ट्रांसमिशन संदेश- ई-मेल के लिए डिस्क्लेमर

इस इलेक्ट्रॉनिक ट्रांसमिशन संदेश में दी गई जानकारी अर्थात ई-मेल और इस इलेक्ट्रॉनिक संदेश के साथ प्रेषित कोई अटैचमेंट केवल प्रेषिती (प्रेषितियों) के उपयोग के लिए है और इसमें व्यक्ति विशेष के लिए, गोपनीय या विशेष रूप से अधिकृत जानकारी हो सकती है। यदि यह जानकारी आपके लिए नहीं है तो आपको इस ई-मेल को प्रसारित, वितरित या कॉपी न करें। यदि आपको यह संदेश गलती से मिला है, तो आपको इस संदेश को नष्ट करना चाहिए और ई-मेल द्वारा प्रेषक को सूचित कर दें।
ई-मेल ट्रांसमिशन सुरक्षित या त्रुटिरहित होने की गारंटी नहीं है, क्योंकि जानकारी ट्रांसमिशन के दौरान अवरुद्ध हो सकती है, विकृत हो सकती है, खो सकती है, नष्ट हो सकती है, देर से या अपूर्ण रूप में पहुंच सकती है, या वायरस से ग्रस्त हो सकती है। इसलिए, ई-मेल और इसकी विषय-वस्तु (निर्दिष्ट त्रुटियों के साथ या उनके बगैर) की जिम्मेवारी ई-मेल तैयार करने वाले / प्रेषक या बीएचईएल या उसके सहयोगियों

की नहीं होगी। इस ई-मेल में उल्लिखित विचार या राय, यदि कोई हो, प्रेषक के ही हैं। यह आवश्यक नहीं है कि ये बीएचईएल या इसकी सहयोगी कंपनियों के विचार या राय के साथ मेल खाएं। लक्षित प्राप्तकर्ता ई-मेल या इसकी विषय-वस्तु पर कार्रवाई करने से पहले वैकल्पिक संचार तंत्र के माध्यम से जानकारी या निहितार्थ को सत्यापित करवा सकते हैं।

चेतावनी: यद्यपि कंपनी ने यह सुनिश्चित करने के लिए कि इस ई-मेल में कोई वायरस मौजूद नहीं हो, काफी सावधानी बरती है, फिर भी प्राप्तकर्ता यह जाँच कर लें कि इस ई-मेल और इसके अटैचमेंट्स में वायरस न हों। इस ई-मेल द्वारा संक्रामित किसी वायरस के कारण होने वाली किसी क्षति के लिए ई-मेल का प्रेषक या बीएचईएल जिम्मेदार नहीं हैं।

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ಭಾರತ್ ಹೆವಿ ಎಲೆಕ್ಟ್ರಿಕಲ್ಸ್ ಲಿಮಿಟೆಡ್
भारत हेवी इलेक्ट्रिकल्स लिमिटेड
Bharat Heavy Electricals Limited
(A Government of India Undertaking)
ELECTRONICS DIVISION
P.B. No. 2606, Mysore Road, Bangalore - 560 026

Gram : BHARATELEC
Telex : 0845-2436 BHCE IN
0845-8151 BHCE IN
Fax : 080-6740137
RABMN : 4041[illegible]4
PHONE : 6998
(EPABX NO)

To

Mr. Mohammed Musa
Head (C&I)
ONGC Tripura Power Company Ltd
Palatana,
Tripura
Mobile : 7085458310
E-mail : mohammad.musa@otpcindia.in

Ref: CE-MKTG/804/OTPC/OC

Dear Sir,

Sub : Upgradation of maxDNA based HMI based on Windows XP suppled by BHEL to Windows 10.
Ref : PO No. OTPC/PO/PLT/20-21/BHEL/SSBG-EDN/001 dated 23rd December, 2020.

BHEL had supplied and installed maxDNA system for STG and BOP with Windows XP Operating System at OTPC, Palatana during the year 2013-14.

M/s Microsoft has announced the end of support for Windows XP Operating system including security updates from April, 2014.

Although, BHEL continues to support Windows XP installations for maintenance until there are major issues in the hardware, all our supplies after 2014 are based on Windows10 professional OS.

In line with general industry practice, all maxDNA releases are backward compatible. Mimics that are created in maxDNA version on Windows XP will run in maxDNA version on Windows 10. Both maxDNA version on Windows XP and maxDNA version on Windows 10 can exist concurrently.

However, due to the obsolescence of Microsoft XP, the HMIs at Palatana were facing issues. Hence, BHEL advised upgradation of HMI workstations from Windows XP to Windows 10 OS for trouble free operation.

In view of the above situation, the HMI based on Windows XP were changed by BHEL under the PO referred above.

Thanking you,

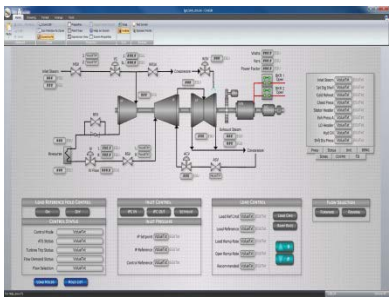
Yours faithfully

ಕೆ. ಪ್ರದೀಪ್ ಕುಮಾರ್, ಅತಿರಿಕ್ತ ಪ್ರಧಾನ ವ್ಯವಸ್ಥಾಪಕರು/ಎ.ಜಿ.ಎಂ.-ಮಾರ್ಕೆಟಿಂಗ್
के. प्रदीप कुमार, अपर महाप्रबंधक/सी.ई.-विपणन
K. PRADEEP KUMAR, ADDL. GENERAL MANAGER/CE MARKETING
BHEL-EDN, MYSURU ROAD, BENGALURU-560026

K. Pradeep Kumar
AGM (CE-Marketing)
BHEL, Electronics Division,
Bangalore

GE
Measurement &
Control

June 07, 2013



Product Life Cycle Support Notice - Update

Control Solutions

Windows XP – End of Microsoft Support Notification

The Product Life Cycle Support Policy, **(see Life Cycle Overview)** can help you plan the maintenance and ultimate evolution of your GE control system. Notices such as this one are issued at distinct life cycle milestones to inform you of pending changes and provide recommendations on how to move forward. This is the first LCN on this subject.

This notice is to inform you that Microsoft† has announced intention to end extended support of the Windows XP operating system, effective April 8, 2014. If you are still using the Windows XP operating system after that date, you may no longer receive all security updates. GE is advising users to upgrade affected systems to the Windows 7 Server 2008R2. The operator and engineering workstation used with GE's turbine, generator, and power plant control systems is based on the Windows operating system. These HMIs include Mark IV, V, Ve, VI, and VIe control systems.

Based on our commitment to provide our customers with timely updates, GE introduced an upgrade from the Windows XP operating system to the Windows 7 operating system in September 2011. The Windows 7 operating system uses 64-bit Windows 7 Ultimate (SP1) with CIMPLICITY* Advanced Viewer/Server (V08.02) and WorkstationST* applications. The first ControlST version for Windows 7 was 4.03.

Microsoft extended support for Windows 7 is currently scheduled to end in January 2020. These extended support dates are important for GE controls users who must maintain the latest applicable patches on their HMIs and software upgrades for installed HMIs.

Recommendations

The ControlST software suite is continually enhanced with new features. It is recommended that any existing systems be upgraded to the Windows 7 environment. As part of the upgrade proposal, the existing HMI system, including hardware and peripherals, should be evaluated for compatibility with the 64-bit Windows 7 operating system. Items such as printers and monitors should be evaluated to make sure drivers are available for the 64 bit environment.

For more information, please go to GE Controls Connect at www.GE-ControlsConnect.com or contact your local GE representative to obtain a proposal specific to your site requirements.

Additional Email Support - ControlsConnect@GE.com

Additional Phone Support –

North America: 1-888-943-2272 or 1-540-387-8726
Latin America (Brazil): +55-11-3958-0098
Europe (France): +33-2-72-249901
Asia/China (Singapore): +65-6622 1623
Africa/India/Middle East (U.A.E.): +971-2-699 7119

Life Cycle Overview

The life cycle of any GE control system has three main phases:

- Phase 1 – Current Production - Product has been released to market with full support including enhancements, custom modifications, new spare parts and repairs.
- Phase 2 – Post Production - Mature product that is no longer available for new installations. New spare parts are still available, and repair, exchange, and remanufacture services are available through designated Control Solutions repair centers. Standard modkits and upgrades are available. Notice of last time buy of new spare parts issued approximately one year before transitioning to Phase 3.
- Phase 3 – Legacy – The product is no longer fully supported. New spare parts are no longer manufactured. The parts & support for the product will be limited to the available resources and available components. Parts repair, exchange and remanufacturing support will be offered on a best effort basis. Customers are advised to review the potential risks of ongoing operation of the control system and consider options for supporting or upgrading to the current technology. The **GE ControlsCare** offerings are designed to provide a solution to many of these options.

Enclosure: GEZ-2019

Revision(s):

Revision #	Originator	Description	Date
-	M. Hammer	Initial Release	2013-Jun-07

The Managing Director,
ONGC Tripura Power Company Ltd
10th Floor, Core-4 and Central, Scope Minar,
Laxmi Nagar, Delhi-110092

Subject:Upgradation of Mark-VI Control System to Mark-VIe and Upgradation of HMI of Mark-VI at Palatana Plants

Dear Sir,

a. As part of the contract arrangement with BHEL under EPC Contract for Palatana Project, GE had supplied latest available version of MARK-VI control systems for gas turbines. MARK-VI control system included DCS (hardware and software), network switches, and Human Machine Interface (HMI). At the time of supply Windows-XP was the compatible software for MARK-VI and the system was delivered with the same operating system.
b. GE had issued a Product Life Cycle Support Notice to OTPC in 2014 inferring that MARK-VI had entered Post-Production phase and GE was transitioning to MARK-VIe which was in phase-1 (current production). Also, while sharing a presentation regarding MARK-VIe, it was submitted to OTPC that MARK-VI would soon enter legacy phase.
c. In legacy phase the product is no longer fully supported. New spare parts are no longer manufactured. The parts & support for the product is limited to the available resources and available components. Parts repair, exchange and remanufacturing support is offered on a best effort basis. Customers are advised to review the potential risks of ongoing operation of the control system and consider options for supporting or upgrading to the current technology.
d. Considering that Mark-VI had entered legacy phase, we had submitted to OTPC in 2018, a proposal for upgradation of Mark-VI to MARK-VIe and upgradation of HMIs. The proposal had detailed that the HMIs should be upgraded to Windows 10 platform as Microsoft had ended support for Windows XP operating system in 2014 (OS in existing HMIs).
e. OTPC had informed GE about problem being faced by them in HMI which included:
    1. HMIs hanging while in operation making operator unable to control the equipment, and
    2. No virus definition update was taking place. To protect the desktop from cyber threats, OTPC had disabled all drives (USB / CD / DVD) on the HMI.
f. After detailed review of the problem at Palatana, GE recommended upgrade of the MARK-VI control system to MARK-VIe and the HMIs due to the following reasons:
    1. MARK-VI had become obsolete and it was no longer fully supported i.e. new spare parts were not manufactured and the parts & support were limited to the available resources and available components. Without upgrading to the current technology and without successful migration to Mark Vie there were potential risks to ongoing operation of the control system which could not be predicted.
    2. The HMIs had been in use for over 10 years since synchronization of the first unit in 2012. Even after the COD of first unit in January 2014, the system had been in continual use for nearly 8 years without any upgrades and has outlived its normal life of 4-5 years.
    3. Antivirus system was outdated and unable to update due to obsolete operating system (Windows XP). Out dated anti-virus was exposing crucial plant control system to cyber threats.
    4. Windows XP operating system of HMIs had become obsolete and Microsoft had ended its support in 2014.

g. The following upgrades were hence undertaken by GE at Palatana:

1. Upgrade of hardware/software of DCS for Gas Turbines and upgrade of Network Switches
   i. In order to control user access and reduce risk, Domain control system was installed.
   ii. Normal life of network switch hardware is around 5 years. As network switches are important network components, responsible for smooth flow of data/instruction between controller and client application of the MARK-VI control system, network switches were upgraded.

2. Upgradation of MARK-VI to MARK-VIe (Phase-1) hardware and software was performed. OTPC had decided to upgrade remaining component which mainly included field instrument as part of phase-2 upgrade.

3. Upgrade of associated HMIs, which included:
   i. Upgrade of old HMIs with new HMIs (compatible with Windows 10)
   ii. Upgrade of Operating System (Windows XP to Windows 10)
   iii. Upgradation of Antivirus
   iv. Upgradation of Mark-VI to Mark-VIe HMI latest control software
4. It may also be kindly noted that many other customers in India have also opted for such upgrades and have been successfully implemented.

As already evidenced above, the complete upgrade of the DCS, HMIs and Network switches was required at Palatana. In the event of any failure of any component of MARK-VI system, the plant could have been exposed to huge generation losses.

Thanking you.

Yours faithfully

For GE

Jagdish Rao
Senior Service Director - IN/SL/MAU
GE Gas Power South Asia

Recommendation Report

Further to visit to your Plant and as per your request, please find herwith our recommendations for both CW and RW Chlorination Plants for upgradation, ease in operation and maintenance and for further safety of CW and RW chlorination Plants,

1. For ASV Operation in Auto Mode during Fail Safe Condition, M/s PCS recommends to install a new common Auto shut off valve interlocked with new Vacuum switch with isolation valve in Stream 1 and Stream 2 of CW Chlorination plant. We shall provide a small dedicated control panel which shall also be energized by a UPS to cover when main power supply trips. This is only for new shutoff valve and new vacuum switches. It may be noted that the present evaporators are bypassed, as the system is running directly with gas instead of liquid chlorine to gas conversion. The reason being the current capacity is adequate for the needs of cooling water chlorination and working well. Hence this kind of shutoff in Gas Line is feasible. UPS, if available shall be provided by m/s OTPC for this dedicated control Panel. The Load requirement for the same shall be provided by M/s PCS.

2. Similarly for ASV Operation in Auto Mode during Fail Safe Condition, M/s PCS recommends to install a new common Auto shut off valve interlocked with new Vacuum switch with isolation valve in Stream 1 and Stream 2 of RW chlorination plant. We shall provide a dedicated small control panel which shall also be energized by a UPS to cover when main power supply trips, only for new shutoff valve and new vacuum switches. UPS, if available shall be provided by m/s OTPC for this dedicated control Panel. The Load requirement for the same shall be provided by M/s PCS.

3. M/s PCS recommends OTPC to check the healthiness of the present installed Vacuum switches in gas vacuum line[set point trigger contacts to work at low vacuum] and Pressure Switch in motive water line. [set point trigger contacts to work at low water pressure]. Also, checking the present electrically operated motorized shut off valve functioning. Once this healthiness of switches and Valves is done, PCS can send its Personnel to check looping of the interlock in the control panel to make it work automatically. If unavailable, provision of same to be done. Offer for same shall be provided by m/s PCS.

4. For better safety and operation effectiveness M/s PCS recommends M/s OTPC to go for additional Tonner valve *[Reference picture attached] for chlorine cylinder valve to be connected in series to cover any emergencies of main cylinder valve choking or passing or unable to close due to blunting of valve stem over long period of use. At present one SCABA is available at CW Chlorination System and one at RW Chlorination System. PCS suggests to procure one more set for each location to cover any emergencies. It takes only few minutes to close Chlorine Cylinder Valves in case of any emergency by the trained operator using SCBA and source of leak can be cut immediately. Also Handling of emergency kit and emergency situation in Chlorine Gas Leak Area should be done by trained Personnel using SCBA only.

5. M/s PCS recommends M/s OTPC to maintain adequate Preventive and Operational Critical spares like Automatic Vacuum regulator, Pressure Reducing Valve, Safety Valves(Check Valve, Drain Valve, Vacuum Relief Valve and Pressure Relief Valve) , Rotameter, Flow control Valve, Injector etc.. [many of them has already been ordered). PCS recommends M/s OTPC to go for Spares of M/s PCS for their genuine spares and service for safety, performance and longevity of the equipment.

6. M/s PCS recommends M/s OTPC to go for periodic maintenance contract either half yearly or yearly once. This shall cover parts from Chlorine Copper tube to Injector [gas line line, vacuum line]. Our PCS Expert shall be present for two or three mandays to check-up, overhaul the system with manpower tools and spares provided by M/s OPTC to keep the plant in tip-top condition. Consumable spares and minor spares like O rings, Lead washers and lead gaskets, Copper Tube, Glass Tube of Rotametereetc to be changed periodically and stocked adequately.

Additional Toner Picture

Thanks and best Regards
For PERFECT CHLORO SYSTEM

Jagan Narayanan. V.G
980029244
ceo@perfectchloro.com

Dinesh Laha

From: Alokesh Hazarika
Sent: 24 August 2020 12:00
To: Avishek Chatterjee
Cc: 'Rahul.Purkayastha@lntebg.com'; Babiranjan Tripathy; Tapankumar Dey; Smruti Ranjan Das
Subject: Convertion of 45 KW module to 60 KW module (L&T make)
Attachments: 45 KW scheme.pdf; 60 KW scheme.pdf; As built drawings 415V GT PMCC-PART-1.pdf

Dear Sir,

As discussed, we would like to convert the existing 45 KW module to 60 KW module.

Existing 45 KW module is used for exhaust motor of 55 KW rating.

The scheme drawing of existing 45 KW motor, 22F-B is SWH6436. Scheme attached.

The scheme drawing of 60 KW motor, 1F-A is SWH6442. Scheme attached. This scheme is only for reference of contactor, cable sizing etc.

While upgradation to 60 KW, SWH6436 scheme needs to be followed.

A total of 4 units needs to be modified / supply and servicing of 4 sets of main BUS droppers needs to be done . Kindly go through the scheme

We know it's a challenging task however we are looking forward for the best solution to this.

With best regards,

Alokesh Hazarika | Asst. Manager | EMD | ONGC Tripura Power Company Limited
Palatana, Gomati, Tripura-799105, India | Call: +91 381 236 3885 | +918787606131
www.otpcindia.in

OTPC

Dinesh Laha

From: David CD <dcd@eeltdh2.com>
Sent: 20 November 2024 17:06
To: Mitangshu Saha
Cc: Narendra Kumar Gupta; 'Sachin Kr. Chauhan'
Subject: RE: Budgetary Proposal from M/S Eastern Electrilyser

Dear Sir,

This is with reference to your trailing e-Mail dated 08/11/2024 and your telephonic discussions with our Mr. Sachin Kr. Chauhan, Chief of Operations (COO) regarding Obsolesce certificate.

Please note that H2 plant rectifier Model - TCR(CC/CP) 14V/2025A is upgraded with a new design of an IGBT based rectifier of Model - KXGF2000A/15V.

As per the design provided by the OEM, critical cards and spare support of Model TCR(CC/CP) 14V/2025A are not available.

This is for your information and record.

Thanks & Regards,
David. C.D
Executive Assistant
Mobile: +91-7291099347

From: Mitangshu Saha [mailto:mitangshu.saha@otpcindia.in]
Sent: 08 November 2024 12:37
To: 'David CD' (dcd@eeltdh2.com) <dcd@eeltdh2.com>
Cc: Narendra Kumar Gupta <nk.gupta@otpcindia.in>
Subject: RE: Budgetary Proposal from M/S Eastern Electrilyser

Dear Sir,

Obsolesce certificate/communication for analogue rectifier can also be provided in place of OEM recommendations.

With best regards,
Mitangshu Saha
Assistant Manager (Electrical Maintenan
ONGC Tripura Power Company Lim
(An ISO 9001, ISO 14001 and OHSAS 18001 certified Orga
Palatana, Gomati, Tripura -799105, India
Phone: +91 381 236 3888 Mobile: + 91 7

From: Mitangshu Saha
Sent: 08 November 2024 12:29
To: 'David CD' (dcd@eeltdh2.com)
Cc: Narendra Kumar Gupta
Subject: Budgetary Proposal from M/S Eastern Electrilyser

Dear Sir,

Refer attached proposal dated 02.05.22.
Please share the OEM recommendation that was provided to OTPC at that time for upgrading our H2 plant rectifier from Analogue to IGBT.

With best regards,
Mitangshu Saha
Assistant Manager (Electrical Maintenan
ONGC Tripura Power Company Lim
(An ISO 9001, ISO 14001 and OHSAS 18001 certified Orga
Palatana, Gomati, Tripura -799105, India
Phone: +91 381 236 3888 Mobile: + 91 7

From: David CD [mailto:david@easternelectrolyser.com]
Sent: 02 May 2022 12:58
To: Alokesh Hazarika; Smruti Ranjan Das
Cc: chintantewari@hotmail.com
Subject: Budgetary Proposal.

Subject :- Budgetary Proposal.

Dear Sir,

Please find the Budgetary Proposal as attached.

You are requested to go through the same and in case of any further clarifications, please feel free to contact the undersigned.

Assuring you of our best services always.

Thanks & Regards,

David. C.D
M/s EASTERN ELECTROLYSER LIMITED
B-14, Sector-57, Noida
Uttar Pradesh (U.P) – 201301 (INDIA)
Phone : +91-120-4912750
E-Mail : david@easternelectrolyser.com
info@easternelectrolyser.com
Website: https://ddei5-0-ctp.trendmicro.com:443/wis/clicktime/v1/query?url=www.eeltdh2.com&umid=50B064A1-2661-9D06-B8F7-BF138246D01E&auth=48681783a7797a2304ab0ed10d70dc7975e0eb69-db8cd2abd95aba77dcf64f3d100b0cf813a8fb34
CIN No:- U32109UP1987PLC113324
PAN No: AAACE1390E, TAN No: MRTE02067C, IEC NO: 0594002630

|Hydrogen/Oxygen Gas Plants |Electrolytic Cells |Gas Purification & Compression System |

MARSH

OPERATIONAL RISK SURVEY REPORT

ONGC TRIPURA POWER COMPANY, UDAIPUR, TRIPURA, INDIA

APRIL 2019

Prepared by: Sundeep Pugliya BE(Mechanical), CPM
Sundeep.pugliya@marsh.com
Global Energy Risk Engineering - India

Following: A survey visit to the OTPC, Udaipur, Tripura, India Power Plant on 5th and 6th April 2019 and discussions with the site personnel

REV. OTPC.U.UW.1.0

SOLUTIONS...DEFINED, DESIGNED, AND DELIVERED.

MARSH & McLENNAN COMPANIES

Revision History

Revision	Date	Comments
OTPC.U.UW.1.0	30 April 2019	Draft issue following April 2019 survey

OTPC, Udaipur, Tripura, India

It is acknowledged that this report is based upon analysis of information that has been provided by persons other than Marsh, and Marsh makes no representation or warranty in relation to the accuracy, currency or completeness of factual information contained in it. This report is not intended to identify all hazards that may exist, nor is it intended to be an exhaustive view of all possibilities or eventualities.

Any recommendations for risk improvement contained herein are purely advisory, and the decision and responsibility for implementation rests with the recipient's management. This report does not guarantee, assure or warrant that compliance with any recommendations will eliminate all hazards or accidents, or that the recipient is in compliance with any laws, statutes, regulations or directives.

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Abbreviations

AC	Alternating Current
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
AP	Authorised Person
APH	Air Preheater
ASCE	American Society Of Civil Engineers
APS	Automatic Plant start-up (Shutdown)
CEMS	Continuous Emissions Monitoring System
CO_2	Carbon Dioxide
COD	Commercial Operation Date
CW	Cooling Water
DC	Direct Current
DIN	Deutsches Institut für Normung.
DGA	Dissolved Gas Analysis
DLN	Dry Low NOx
EDG	Emergency Diesel Generator
EPC	Engineering Procurement & Construction
ERP	Emergency Response Plan
ESD	Emergency Shutdown Device
ESP	Electrostatic Precipitator
FD	Forced Draught
FGD	Flue Gas Desulphurisation
FOF	Forced Outage Factor
GCF	Gross Capacity Factor
GSU	Generator Step Up (transformer)
ha	Hectares
HFO	Heavy Fuel Oil
HP	High Pressure
HSE	Health, Safety & Environment
HWP	Hot Work Permit
HV	High Voltage (>1000V)
Hz	Hertz (cycles)
I&C	Instrument & Control
I/O	Input-Output
ID	Induced Draught
IOSH	Institution of Occupational Safety and Health

IPP	Independent Power Producer
IPD	Iso-Phase Bus Duct
ISO	International Standards Organisation
kV	One thousand volts
LDO	Light Diesel Oil
LP	Low Pressure
LV	Low Voltage
Maj	Major
MCR	Maximum Continuous Rating
MFL	Maximum Foreseeable Loss
Min	Minor
MMD	Mechanical Maintenance Department
MPa	Mega (Million) Pascal (pressure)
MV	Medium Voltage
MW	Mega (Million) Watt electrical
NCF	Net Capacity Factor
NFPA	National Fire Protection Association
NOx	Nitrous Oxides
NRV	Non Return Valve
OE	Owners Engineer
OEM	Original Equipment Manufacturer
O&M	Operations & Maintenance
OMA	Operation & Maintenance Agreement
OHSAS	Occupational Health & Safety Assessment System
PCOD	Project Commercial Operation Date
PML	Probable Maximum Loss
PPA	Power Purchase Agreement
ppb	Parts per billion
PPE	Personal Protective Equipment
RC	Reinforced Concrete
SAP	Senior Authorized Person
SWFGD	Sea Water Flue Gas Desulphurisation
tph	tonnes per hour
UBS	Uniform Building Standard
UPS	Uninterruptible Power Supply
VDU	Visual Display Unit
WMS	Work Management System

Company Specific Abbreviations

BHEL	Bharat Heavy Electrical Limited
BIS	Bureau Of Indian Standards
DGM	Deputy General Manager
EHS	Environment Health and Safety
EMD	Electrical Maintenance Department
EOP	Emergency Operating Procedure
FLOP	Fire Loss of Profit
FOLHS	Fibre Optic Linear Heat Sensing Cables
GM	General Manager
IBT	Inter connecting Bus Transformer
IIF- II	India Infrastructure Fund – II
IL&FS	Infrastructure Leasing and Financial Services Limited
INR	Indian National Rupees
IR	Infra-Red
LOTO	Lock Out Tag Out
MLOP	Machinery Breakdown Loss of Profit
OFS	Off site Services
ONGC	Oïl and Natural Gas Company
OTPC	ONGC Tripura Power Company
PTW	Permit To Work
RLA	Residual Life Assessment
SOP	Standard Operating Procedures
TAC	Tariff Advisory Committee
TC	Technical Cell
TMD	Turbine Maintenance Department

CONTENTS

SECTION ONE

INTRODUCTION

This Risk Survey report has been prepared at the request of insurers and reinsurers on behalf of OTPC following a two day survey of OTPC, Udaipur, Tripura Plant on 5th and 6th April, 2019.

Marsh visited OTPC, Udaipur, Tripura previously in November 2015 for the risk engineering survey of the plant.

Objectives and Acknowledgements

The principal objectives of this report are to provide an exposure information update for the projects incumbent operational insurance partners market, and to provide OTPC with the benefit of independent loss control opinion with experience in the specific technology adopted.

Information contained in this report was to an agenda sent to the plant prior to the visit. Discussions with site personnel at the time and following the visit, and observations made during a tour of the plant provided more information of site operations.

There was no physical testing of systems carried out at the time of this visit.

The survey was carried out by Sundeep Pugliya of Global Energy Risk Engineering, Marsh India. The visit was arranged by OTPC in Udaipur Plant and was coordinated by Mr. Sajjan Kumar Sharma (Sr. Manager, Finance and Accounts) and Mr Sital Ray (Manager (EHS).

We gratefully acknowledge the contribution of everyone involved in the survey and in particular the following personnel.

Mr. Bibek Roy	-	DGM (O&M) and Plant In charge
Mr. Sajjan Kumar Sharma	-	Sr. Manager (F&A)
Mr. Narendra Kumar Gupta	-	Sr. Manager (Operation)
Mr. Sital Ray	-	Manager (EHS)
Mr. Premananda Nath Sharma	-	Manager (F&A)
Mr. Souvik Chowdhury	-	Manager (Technical Cell)
Mr. Md. Musa	-	Head C&I Maintenance
Mr. Bhaskar Sen Chowdhury	-	Head Mechanical Maintenance
Mr. S R Das	-	Head Electrical Maintenance
Mr. Raju Singh Parihar	-	Assistant Manager (Fire)

SECTION TWO

EXECUTIVE SUMMARY

Background

Oil & Natural Gas Corporation Ltd. (“ONGC”), a company of the Government of India, owns significant natural gas reserves in the North Eastern state of Tripura. However, these natural gas reserves were not developed commercially due to low industrial demand in the North-Eastern region.

The complexities of logistics and attendant costs limited the economic viability of transportation of gas to other parts of the country where gas is in deficit. In order to optimally utilize the gas available in Tripura and to supply power to the deficit areas of North Eastern States of India, ONGC along with Infrastructure Leasing and Financial Services Limited (IL&FS) and Government of Tripura formed a Special Purpose Vehicle ONGC Tripura Power Company (OTPC) by entering into a Shareholders’ Agreement (SHA) on September 18, 2008 to implement a 726.6 MW Combined Cycle Gas Turbine (CCGT) thermal power plant at Palatana, Tripura.

The first block (363.3 MW) of the power plant was declared under Commercial Operation from 4th January, 2014 and the second block (363.3 MW) of the two blocks was declared under Commercial Operation from 24th March 2015. BHEL was the EPC contractor for setting up of the power plant.

Description Summary

Location

The site co-ordinates are: Longitude 91.4396 (E) and Latitude 23.4992 (N).

The plant is located at Palatana, Udaipur Village at Gomoti District in the Indian state of Tripura.

As per Munich RE Nathan charts, the plant site is located in Zone 2 for earthquakes, Zone 5 for lightning, Zone 2 for tornados and in Zone 3 for flash floods. For the other natural perils including storms, cyclones, tsunami and volcanoes, the site is in “no hazard” or low hazard zones. All the critical structures like chimney, HRSGs, TG buildings, Tall Transfer towers etc. are provided with the lightning protection covering the respective areas.

The area of the plant is approximately 80 ha and the layout of the site provides good spatial separation.

The nearest commercial airport is at Agartala, which is the main airport for the region and is situated around 73 km to the North West of the plant. There was no indication of flight paths over the site during the survey.

The road access to the plant is through State Highway.

Plant

The first block (363.3 MW) of the power plant was declared under Commercial Operation from 4th January, 2014 and the second block (363.3 MW) of the two blocks was declared under Commercial Operation from 24th March 2015. BHEL was the EPC contractor for setting up of the power plant.

The plant comprises two blocks of Combined Cycle Gas Turbine power stations having capacity of 363.3 MW each. Apart from the main plants (Gas Turbines Generators, Steam Turbine Generators and HRSG Units), the plant is equipped with all the balance of plant facilities such as switchyards, Plant Water Treatment facilities, water intake and storage facilities, cooling water systems, hydrogen generation plant and gas receiving, pressure boosting and processing units.

Project zero date or notice to proceed date was 11th August 2008.

EPC contract was awarded to Bharat Heavy Electrical Limited. Make of the major equipment is as mentioned in the below table:

Package Description	Supplier
Gas Turbine Generator	General Electric, India
Steam Turbine Generator	Bharat Heavy Electrical Limited, India
HRSG	Bharat Heavy Electrical Limited, India
Switchyard	Bharat Heavy Electrical Limited, India
HV Transformers	Bharat Heavy Electrical Limited, India
Fire water Pumps	Flow more, India
DM Plant	Ion Exchange, India

Fire Protection

Plant is equipped with fire detection and protection systems. All the detection systems (installed in the different hazardous areas) are connected to the central fire alarm panels and fire stations for better monitoring and control.

Fire alarm and detection system has been supplied by Detectomat, Germany (https://www.detectomat.com).

A basic level of fire detection and protection system was observed in the plant during the survey.

Fire protection and detection system has been supplied by UTC Fire and Security India Limited.

Fire detection systems are installed at Gas Turbine enclosures, Steam Turbine Generator enclosure, main plant control room, DCS panel rooms, station switchgear rooms, Lube oil skids, Generator Step up Transformers, Station Transformers, Auxiliary Transformers and main plant cable cellar rooms.

Fire and gas detection systems at gas receiving and processing stations and gas booster compressor complex are not installed (Recommendation 2019/04/14).

Automatic fixed fire protection systems are installed at Gas Turbine enclosures, Steam Turbine Generator enclosures, Main control and DCS rooms, Lube oil skids, Generator Step up Transformers, Station Transformers, Auxiliary Transformers and main plant cable cellar rooms.

Fixed fire protection and detection systems at Steam Turbine Generator bearings and Gas Turbine Generator Seal oil tank skids are not installed (Recommendation 2019/04/10 and 2019/04/11).

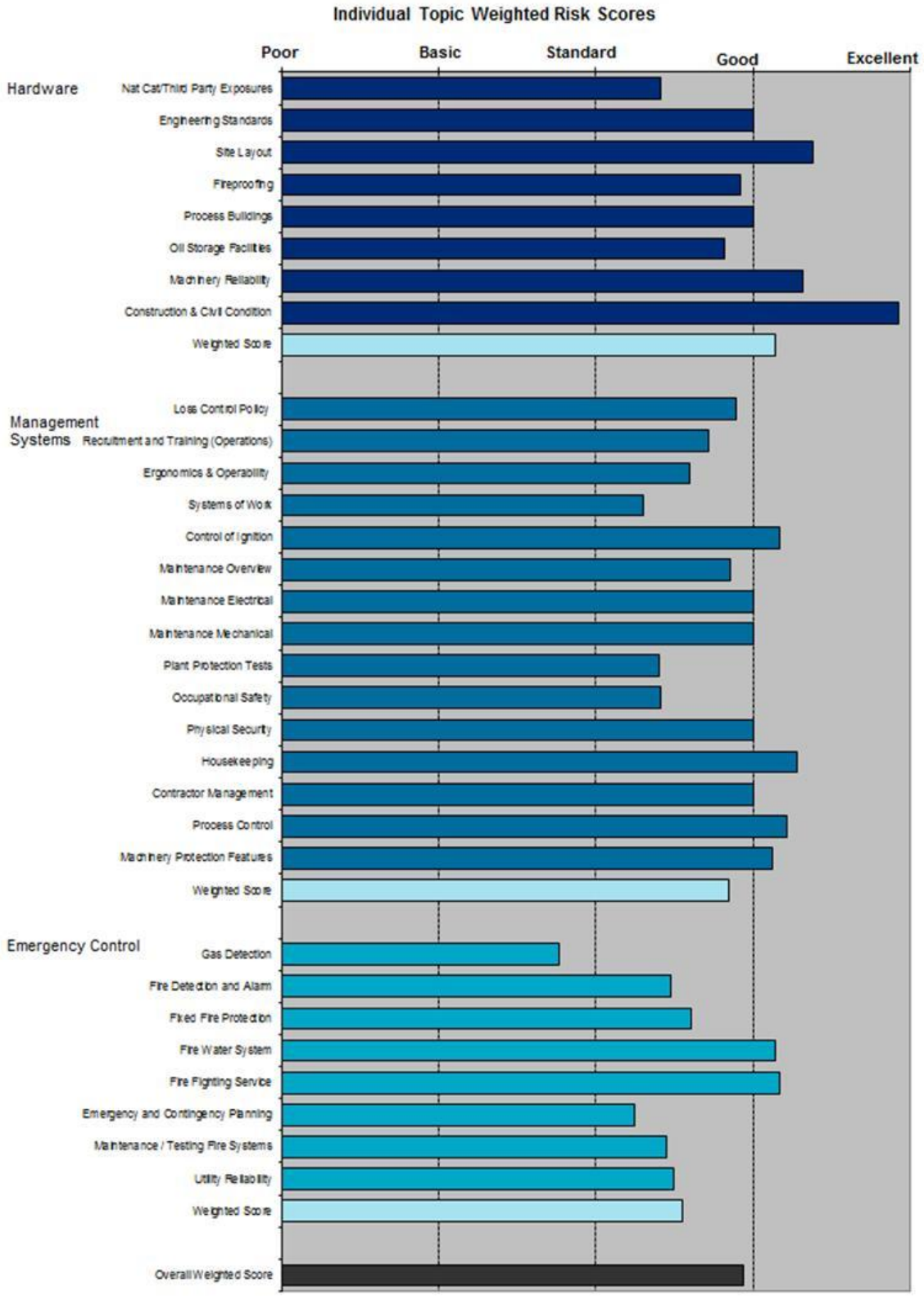
Plant comprises of spray (for fixed fire protection system) and hydrant water reticulation system. These reticulation systems are mostly above ground. Fire water pumps are separate for spray and hydrant fire water system.

Plant is equipped with two numbers of motor driven pumps, one numbers of diesel engine driven pump, two numbers of jockey pumps, two set of compressors and one hydro pneumatic tank for hydrant system and one motor driven pump, one diesel engine driven pump for spray system.

Fire water tank is a concrete tank with a capacity of 3000 cubic meters capacity and is equipped with automatic level control mechanism. The intake to the fire water tank is directly from the clarifiers through gravity with a motorized isolation valve.

Site consists of a raw water reservoir of 1,78,000 cubic meters capacity.

Risk Quality



Recommendations Overview

15 new Risk Improvement Recommendations and eight observations were raised following the survey, which were well received by the site management and are as mentioned below:

2019.04.01	Annual Steam Turbine and Gas Turbine functional overspeed test
2019.04.02	Monthly DC lube oil pump run test on cut in pressure set point
2019.04.03	Monthly Steam Turbine Stop and control Valve exercising
2019.04.04	Annual Emergency shut off valve exercising test
2019.04.05	Implementation of GE upgrade Packages for Gas Turbines
2019.04.06	Gas Turbine door fan test
2019.04.07	Emergency Diesel Generator annual load test
2019.04.08	Fire water testing as per NFPA 25
2019.04.09	Fire detection identification below false flooring in control room
2019.04.10	Fixed fire protection system for Steam Turbine Generator bearings as per NFPA 850
2019.04.11	Gas Turbine seal oil system fixed fire protection system
2019.04.12	Annual foam solution test
2019.04.13	Critical Piping inspection
2019.04.14	Gas detection and interlocking of the gas leak signal with the emergency shut of valve
2019.04.15	STG AC and DC Lube Oil Pump Power Cables

Following Observations also made during the survey

- During the discussions with the site team, it could not be established that the positive fire zoning/isolation in the control and DCS rooms above false sealing has been envisaged effectively.
- Fire signal to respective area equipment trip interlocking is not envisaged.
- Unit 1 steam turbine got jammed during the Turbine costing down after the trip because of station black out scenario.
- Presently, Ware house fire detection system is limited to some of the air conditioned areas only whereas, it needs to be extended to cover the whole covered area as a lot of expensive spare parts are stored.
- Uncontrolled growth of vegetation near critical area like transformer and switchyard area need to be controlled.
- Fault signals were persisting on main and repeater fire alarm panels since last three months, which need to be attended on priority.
- An audit to verify Plant illumination level is required as in some critical area like fire water pump house the illumination level was observed low.
- Standard and Emergency Operating Procedures were last updated in 2015. These should be updated at least once in two years.

Insured Values and Estimates

Following values are considered based on John Foord Paper.

Main Equipment Value	Million US $
Gas Turbine + Generator	81
Transformers	27
Steam Turbine + Generator	40
HRSGs	40
Balance of Plant	80

The loss scenarios have included additional clean-up costs and work on the assumption that equipment will be replaced at the same contract value.

The loss scenarios do not include the potential of third party damage and claims.

Lead Times

Lead times for the critical equipment have been considered as mentioned below (for the loss calculation):

Equipment	Months
Gas Turbine	16
Generators	16
HRSG	13.5
Steam Turbine	13
Transformers	10

In practice OEM's look to improve on standard lead times and will deal with the supply on a case to case basis.

Insured Values

Following are the sum insured values based on the latest policy in place:

- Property Damage Sum Insured: INR 3,822 Cr
- Business Interruption Sum Insured: INR 653 Cr (Annual)
- Business Interruption Indemnity Period: 18 months
- Deductibles:
  - Property Damage: 5% of claim amount subject to minimum of 5,000,000.
  - Deductibles for Mobile / office equipment's – 5% of the claim amount subject to minimum of INR 1,000,000 for each and every loss.
  - Fire Loss Of Profit: 14 days of Gross Profit.
  - Machinery Breakdown Loss Of Profit: 21 days OF Gross Profit.

History

Losses

No losses reported till date.

Upgrades

No upgrades reported.

Technical Issues

Jamming of Unit 1 steam turbine rotor, during the Steam Turbine costing down after the trip due to station black out.

Conclusion

Strengths

- Critical equipment has proven technology.
- Good site layout.
- Good civil construction of various plant and non-plant buildings and structures like chimney.
- Good housekeeping.
- Fire proofing levels are good.
- Good plant firefighting services and good mutual support from the fire stations in the plant vicinity.
- Good record of previous recommendation implementation.

Weaknesses

- Plant safety systems need improvement.
- Testing and inspection of fire water equipment needs improvement.
- Fixed fire protection system for Steam Turbine Generators bearings and seal oil skid (for Gas Turbine Generators).
- Gas detection is not available at gas receiving station and gas booster compressor building.

Opinion

In our opinion, the plant can be considered to be:

- **Better than standard risk** with respect to emergency control, including fire protection.
- **Better than standard risk** with respect to management systems.
- **Good risk** with respect to hardware systems.

Overall, in our opinion, the plant can be considered to be a **Better than standard risk** based on our method of combining the individual risk ranking scores.

SECTION THREE

RISK IMPROVEMENT RECOMMENDATIONS

Prioritisation

The criteria used to prioritise the recommendations are summarised in the following Table.

Code	Description
Critical	Extreme Risk; should be brought to the attention of plant management and immediately progressed.
A	High Priority; requires attention of senior management and an action plan developed as a priority.
B	Moderate Risk; requires action at the earliest opportunity.
C	Low Risk; Opportunity for industry best practice initiatives providing long term benefits.

As a result of this survey 15 new recommendations and eight observations have been made which were well received by the management team.

12 out of 28 previous recommendations were closed and one is superseded, which demonstrates good response.

New Recommendations Summary

Description	Category	Reference
Annual Steam Turbine and Gas Turbine functional overspeed test	Critical	2019.04.01
Monthly DC lube oil and seal oil pump run test on cut in pressure set point	Critical	2019.04.02
Monthly Steam Turbine Stop and control Valve exercising	Critical	2019.04.03
Annual Emergency shut off valve exercising test	Critical	2019.04.04
Implementation of GE upgrade Packages for Gas Turbines	A	2019.04.05
Gas Turbine door fan test	B	2019.04.06
Emergency Diesel Generator annual load test	B	2019.04.07
Fire water testing as per NFPA 25	B	2019.04.08
Fire detection identification below false flooring in control room	C	2019.04.09
Fixed fire protection system for Steam Turbine Generator bearings as per NFPA 850	A	2019.04.10
Gas Turbine seal oil system fixed fire protection system	A	2019.04.11
Annual foam solution test	B	2019.04.12
Critical Piping inspection	B	2019.04.13
Gas detection and interlocking of the gas leak signal with the emergency shut of valve	A	2019.04.14
STG AC and DC Lube Oil Pump Power Cables	B	2019.04.15

Following Observations also made during the survey

- During the discussions with the site team, it could not be established that the positive fire zoning/isolation in the control and DCS rooms above false sealing has been envisaged effectively.
- Fire signal to respective area equipment trip interlocking is not envisaged.
- Unit 1 steam turbine got jammed during the Turbine costing down after the trip because of station black out scenario.

- Presently, Ware house fire detection system is limited to some of the air conditioned areas only whereas, it needs to be extended to cover the whole covered area as a lot of expensive spare parts are stored.
- Uncontrolled growth of vegetation near critical area like transformer and switchyard area need to be controlled.
- Fault signals were persisting on main and repeater fire alarm panels since last three months, which need to be attended on priority.
- An audit to verify Plant illumination level is required as in some critical area like fire water pump house the illumination level was observed low.
- Standard and Emergency Operating Procedures were last updated in 2015. These should be updated at least once in two years.

Previous Outstanding Recommendations Summary

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/1	1. Establish a fire protection impairment system to supervise all fire protection and detection system impairment regardless of the reason or duration of the impairment. The program should also include the reminders to be sent to the respective department that valve(s) are/is closed, the pump is not in “Auto” mode, isolation valves are closed/ partially shut and immediate attention is required to restore the protection. 2. Provide additional protection measures till the impairment is fixed and record the same in the impairment form (e.g. informing the local fire brigade to be on standby in the event of breakdown of fire pumps).	Complete Within 3 months	Impairment procedures need to be prepared	Sample Impairment Procedure copy shared with OTPC.	Under Progress
2015/2	All the isolation valves in the fire protection system i.e. from the fire water tank to the remotest hydrant point, including valves in the sprinkler system and deluge system should be chained and locked in fully open position to prevent malicious or accidental closure of the isolation valve leading to impairment of the fire protection system. Valves in the supply line of the diesel to the fire engine should also be chained in normal operating position.	Complete Within 3 months	All isolation valves of the deluge system kept chain locked. It has been found that 30% of the isolation valves of hydrant line are installed at underground level and there are chances of water accumulation and sometime during heavy rain it got submerged. So, in those cases the locks get rusted/damaged in locking condition and unable to be opened which can lead to major abnormalities.	A Bund of about 200 mm can be constructed around the pit and plastic Ties can be used for the locking of isolation valves.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/4	Carry out weekly property loss prevention rounds to cover the entire power station. The visits should be conducted using check sheet which should typically list down but not limited to the following: 1. Storage of ordinary combustibles below the cable trays in cable gallery, hydrogen manifold room, Diesel generator room etc. 2. Storage of the oil drums in proper containment so that they may not be affected by the knock on damage. 3. The electrical cables are properly laid and terminated. 4. Hot work permit system is being followed in totality as per the hot work policy. 5. “No Smoking” procedure is being followed. 6. Impairment management system is followed. 7. Leakage of oil from level gauges other connections in diesel day tanks to be avoided.	Complete Within 3 months	All completed except Point number 6.	Sample Impairment Procedure copy shared with OTPC.	Under Progress
2015/5	Improve the existing hot work permit by including the following in the precaution list: 1. To check whether the fire protection and detection system in the area is operational. 2. The combustibles within 11 m of the work should be relocated or covered with fire retardant blankets when hot work is carried out at ground level. 3. For elevated hot work, combustible materials should be either relocated a minimum of 50 ft. (15.2 m) from the hot work area or properly protected with fire retardant welding blankets or the hot work operation isolated with welding screens. Suspend fire-resistive welding blankets under hot work conducted near the ceiling. Place noncombustible screens around hot work at the floor to trap sparks. Every elevated hot work operation needs to be evaluated on a case-by-case basis to determine a reasonable safe distance from hot work to combustible occupancies or construction. 4. Seal all floor penetrations and opening on walls in the above mentioned distance using noncombustible materials. 5. Fire watch should be continuously provided during hot work and one hour after the hot work is complete. Furthermore, the watch period should be extended three hours after the continuous watch period. This could be intermittent watch and the fire alarm system can be used in this period for monitoring. Finally, the permit should be closed by the fire watch. 6. Ensure all personals involved in hot works are using all personal protective equipment.	Complete Within 3 months	All completed except Point 4.	Sealing of cable openings below false floor at Battery charger room is balance. Moreover, intumescent paint should be applied to the cables near to the sealing area.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/7	Inspection and Testing: 1. Conduct weekly system inspections to see that nozzles are clear and in proper position, that all operating controls are properly set, and that system components have not been damaged 2. Check the agent quantity and pressure of clean agent containers semi-annually. Refill or replace halocarbon clean agent containers if they show a loss in agent quantity of more than 5% or loss in pressure (adjusted for temperature) of more than 10%. Refill or replace inert gas clean agent containers if they show a loss in pressure (adjusted for temperature) of more than 5% 3. Inspect thoroughly inspect clean agent systems for proper operation exclusive of a discharge test every year. Inspect and test all actuating and operating devices in accordance with the system manufacturer's recommendations as outlined in the appropriate system design, installation, operation and maintenance manual. Regular service contracts with the system manufacturer's authorized representative are advised. 4. Inspect thoroughly the clean agent system protected enclosure every year. Determine if penetrations or other changes have occurred that could adversely affect agent leakage or change the volume of the hazard or both. Correct any conditions discovered during the inspection that could result in inability to maintain the clean agent concentration. If uncertainty still exists with regard to the enclosure integrity, conduct an enclosure integrity test of the enclosure. Maintenance: 5. Maintain clean agent systems in operating condition at all times and restore to service promptly after any impairment or operation. 6. Seal any penetrations made through the clean agent system protected enclosure immediately.	Complete Within 3 months	Completed	Checklist for the inspection and test of Argonite system to be prepared and preserved as records for verification.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/12	1. Pre-plan with the local fire brigade by inviting them for the annual mock fire drills. During their visit, they should be appraised on the various hazards prevailing at the location and providing them with the details of the firefighting capabilities of the plant. 2. Alternatively, the plot plan of the plant displayed at the entrance gate should be revised to indicate the number and the capacity of the fire pumps, fire water storage and the locations of the electrical panel rooms.	Complete Within 3 months	Under Progress		Under Progress
2015/13	1. Provide a copy of business continuity plan to Marsh Risk Consultancy for review. 2. Meanwhile, verify whether the existing Business Continuity plan includes a scenario where-in the main transformers, steam generators and the cooling towers are damaged due to fire. If these scenarios are not included then the plan should be revised to include the time required to procure, install and commission the equipment and the back up plans to ensure continuous production. 3. It is also recommended to keep a copy of business continuity plan at site along with corporate office.	Complete Within 3 months	Business Continuity Plan is to be obtained from Delhi Office.	Please provide the Business Continuity Plan.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/15	1. Verify if the containment provided for the main lube oil tank and emergency/drain lube oil tank is designed to contain the largest expected lube oil spill and water spray system discharge and is designed and installed as per NFPA/FM Global standards. 2. Close all the openings in the existing containment made for the lube oil system area of steam turbine. 3. Provide approved flange guards over the flanges of the lube oil pipeline available at the level of the solid turbo-generator operating floor, flanges on the cooling canister and the flanges at the level of the main lube oil tank that fall outside the secondary containment along with adequate drainage leading to outside the building. 4. Extend spray system on flanges, lube oil coolers, lube oil filters and also above and below main oil tank. 5. Provide Sprinkler system for turbine operating floor, under the turbine floor, on mezzanine floors as per the guidance in FMDS 7-101. 6. Provide the layout drawings and hydraulic calculation for the water spray system being installed for the main lube oil tank and emergency/drain lube oil tank to verify whether the discharge density of the system is 12 mm/min over the exposed area of the main lube oil tank. The verification will be based on the guidance provided in FM Global Property Loss Prevention Data Sheet, 7-101. 7. Test the Lube oil pumps every month as per FMDS 13-3 to ensure the reliability of the lube oil system.	Complete Within 6 months	Completed	Flange guards on oil piping flanges near Steam Turbine to be provided and extension of fixed fire spray system till lube oil coolers and filters to be provided.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/18	1. Maintain the Argonite flooding system in auto mode. Automatic detection system should be integrated with the Argonite flooding system to activate in case of fire. It should always be ensure that Argonite flooding system is always maintained in the auto mode. 2. Install Argonite nozzles below raised floorings as required in FMDS 5-32 for combustible false floorings. 3. Conduct an enclosure integrity test for the control room in guidance provided in NFPA 2001. 4. Acknowledge the alarms/troubles in the fire alarm panel. Maintain a log book of all the alarms and trouble. 5. Wire the fire detection system to the air conditioning units/air handling units and cut-off the air supply when the fire detection system is activated. 6. Provide self-closing mechanism for doors of the control room to avoid open doors at the time of release of extinguishing agent. 7. Provide design calculation of Argonite flooding system to Marsh Risk consulting for review to ensure the adequacy of the system.	Complete Within 3 months	Under Progress	Interfacing of fire signals with the HVAC equipment for tripping and enclose integrity test is to be carried out.	Under Progress
2015/20	1. Ensure all the filled and empty cylinders are chained properly. 2. Provide automatic fire detection and protection systems in hydrogen generation plant as per FMDS 7-91 section 2.4.3. 3. Route the signal from hydrogen analyser installed in the hydrogen generation plant to the unit control room.	Immediate Action	Under Progress	Automatic fire detection and protection system in hydrogen generation plant to be provided.	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/21	1. Seal the opening between the hydrogen manifold room and the gas turbine hall on the ground floor. 2. Provide ventilation in the room at ceiling level at a minimum of ten air changes per hour. The ventilation rate should increase to 25 air changes per hour upon operation of the hydrogen gas analyser at not more than a 2% level (50% of LEL). 3. Provide approved hydrogen gas analysers to sound an alarm and increase ventilation at a 2% hydrogen concentration in room. At present hand held hydrogen detector is used to monitor the hydrogen concentration. 4. Chain all the filled and empty hydrogen cylinders. 5. Avoid any loose connections/tapings on the electrical wires	Immediate Action	Under Progress	Under Progress	Under Progress
2015/22	1. Provide adequate containment and drainage for the maintenance oil tank located in BFP (Boiler Feed Pump) room. Containment was provided for maintenance oil tank in the BFP room but it was open from one end. 2. Provide adequate containment for the lube oil tank of Gas booster compressors. 3. Install Automatic fire detection and protection system on the lube oil tank area of the Gas booster compressor area at ground floor. 4. Provide automatic shutdown of oil pumps of Lube oil tanks of GBC (Gas Booster Compressor) actuated by heat detectors located at ceiling level or by activation of sprinklers.	Complete within 3 months	Under Progress	Point number 3 and 4 are superseded by new recommendation 2019/04/14	Under Progress
2015/23	1. Provide Continuous ventilation that is provided at a rate of not less than 1 ft3/min/ft2 (5.1 L/sec/m2) of floor area of the room or cabinet as per NFPA 70E. 2. Provide Hydrogen detector in the battery bank room with alarm in control room. 3. Smoke detector in battery charging room was observed to be capped. 4. Install Argonite system considering the openings in the false ceiling, main access door etc. 5. Provide design calculation of Argonite flooding system. 6. Conduct enclosure integrity test for battery rooms and battery charging area after installing Argonite system.	Complete within 3 months	Under Progress	Under Progress	Under Progress

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/24	Provide sprinkler protection for the inside of the cooling towers as per the guidelines available in FM Global datasheet 1-6.	Complete within 3 months	Under Progress	Under Progress	Under Progress
2015/25	1. Provide proper bolting/grouting of the control panels in the CER room to prevent shake damage due to shaking of ground during earthquake. 2. Install Argonite nozzles below raised floorings as required in FMDS 5-32 for combustible false floorings.	Complete within 3 months	Completed	Argonite nozzles have been provided but the Sealing of cable openings below false floor at Battery charger room is balance.	Under Progress

Previous Completed Recommendations Summary

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/3	Create a valve supervision program for all the valves in the fire protection network. Following should be include in the program: 1. Create a valve list which lists down all the valves with each having a unique number. 2. Carry out weekly visual valve inspection to inspect whether the chain and the locks are in place. 3. Once every month, carry out physical inspection of the non-indicating gate valves which means opening the valve in fully open position, then closing the valve three turns and then re-opening the valve in fully open position and finally chain and lock the valve. 4. Once every month fully operate the butter fly valves by closing and then re-opening them. Chain and lock the valve in close position after testing. 5. Operate each valve fully once every year to ensure reliable operation of the control valves. 6. Document the status of each valve.	Complete Within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/6	1. Maintain all electrical driven firefighting pumps in auto mode to operate as per the signal given by installed pressure switches for initiation. 2. Plan and do an annual pump test according to NFPA 25 to compare the achieved flow and pressure against the design pump curve. 3. Maintain fire pumps at regular intervals (daily, weekly, annually) to deliver rated pressure at rated flow. Note all the pump parameters i.e. pressure, flow rate (if possible), water level etc. during every test. (Checklist for the fire pump system maintenance is included in the Appendix) 4. Train pump room operators to put all systems in Auto/ safe mode post testing/ at all times. 5. Verify the level of the fire water in fire water tanks and diesel level in diesel day tanks respectively. The water level should be at least 90% of that of the normal water level and the diesel should be at least 75% full. 6. Verify the manual operation of the fire pumps in the weekly tests	Complete Within 3 months	Completed	Completed	Completed - Closed
2015/8	Develop a preventive maintenance program for testing of the safety interlocks, automatic starting of the emergency lube oil pumps and over speed trip tests for gas turbines and steam turbine as per the guidance provided in FMDS 13-17 and FMDS 13-3 respectively for gas turbine and steam turbine.	Complete Within 3 months	This recommendation is superseded by Recommendation 2019/04/01, 2019/04/02, 2019/04/03 and 2019/04/04		Superseded
2015/9	Augment existing electrical inspection program to include regular inspection of all the electrical fittings such as junction boxes, electrical cables and other electrical and illumination fittings at high hazard areas and other sections throughout the site. Following points can be incorporated in the inspection schedule: 1. Eliminate usage of temporary wiring (such as extension cords) within the facilities. Temporary or loose wiring and connections in electrical cables should be avoided at the site. 2. All electrical bulbs should be provided with enclosures and mechanical guards to prevent hot filament from falling and acting as potential ignition source. 3. All electrical fittings should be properly clamped and protected from any knock on damage.	Complete Within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/10	Following recommendation are made to improve the existing emergency response plan (ERP): 1. Include following in the ERP: - Sprinkler control valve operator: A person who knows where all valves are located and is responsible for operating them in the event of a fire. - Fire pump operator: A person who checks the automatic starting pump when the fire alarm sounds - Salvage team: Team that gets the facility back in operation as soon as possible after an emergency. 2. Since site is exposed to 50 years EQ zone , 60 m/s wind zone and close to 500 year flood zone. It is recommended to include natural hazard such as Earthquake, Flood, and Wind in the ERP as per the recommendation made below. 3. Each type of emergency event has specific characteristics that must be anticipated and prepared for. Hence it is recommended to include specific control measures as per each event considered in ERP. 4. Frequently, back-shifts will have a reduced staff. This may require that personnel be assigned to perform multiple functions. Hence it is required to conduct mock drill at night time also. 5. Provide alternate for each key position. Ensure that people from emergency response team is available in all shift and during holidays also.	Complete Within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/11	Formalize an earthquake emergency plan and include the following in the earthquake emergency response plan: 1. Examine all fuel-fired equipment for leaks. 2. Consider shutdown of gas supplies as appropriate. 3. Examine fire protection water supplies to determine if they are impaired. 4. Examine all fire protection systems to determine if they are damaged. 5. Initiate repairs to all fire protection equipment as needed to have them restored to service. 6. Examine production equipment for damage and make necessary repairs before starting up. 7. Control ignition sources including hot work, smoking, etc., particularly if fire protection systems are impaired. 8. Use the FM Global Hot Work Permit System for any hot work to be performed in and around the facility. 9. Examine all electrical equipment and conduct necessary repairs. 10. Examine building structures and facades for damage and take necessary steps to repair and/or stabilize. 11. Examine exterior structures, equipment, and storage and take appropriate action. 12. Other site-specific activities as outlined in the Emergency response Plan.	Complete Within 3 months	Completed	Completed	Completed - Closed
2015/14	1. Avoid storage of combustible materials in the hydrogen manifold room. 2. Prevent storage of unused cables in the fire pump room. 3. Arrest oil leakage in the lube oil system area of the steam turbine. Source of leakage should be identified and proper measures should be taken to prevent such occurrence.	Immediate Action	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/16	1. Provide secondary containment to hold the entire contents of the Lube oil tank of gas turbine plus 50 mm of freeboard. 2. Make the CO2 flooding system operational for lube oil system enclosure of gas turbine. 3. Close all the doors of the lube oil enclosure to ensure proper operation of CO2 flooding system. Supervisory alarm should be triggered in control room if the gate is opened. 4. Conduct enclosure integrity test (i.e. door fan test) of Lub oil enclosure in guidance with NFPA 2001. 5. Provide a metal hood of at least 0.5 mm thickness over the seal oil tank and provide sprinkler or deluge system along with adequate drainage & containment designed and installed as per NFPA/FM global standards with a discharge rate of 12 mm/min over the exposed area of the seal oil tank. Wire the sprinkler/deluge system to cut-off the seal oil pumping action in the event of a spray fire. 6. Test the Lube oil pumps every month as per FMDS 13-17 to ensure the reliability of the lube oil system of gas turbines.	Complete within 6 months	Completed	Completed	Completed - Closed
2015/17	Following recommendations are made to improve the reliability of the fire pumps: 1. Detect leakages in the fire protection line and normalise the jockey pump operation. 2. Maintain all the fire pumps in auto mode. 3. Arrest the leakages from the discharge side control valve of diesel engine driven fire pump. 4. Provide individual pressure sensing to test each fire pump and test them as per the recommendation made earlier. 5. Provide containment for diesel day tank to prevent the spillage of oil from diesel day tank. 6. Seal all the cable penetrations in the fire pump rooms. Remove unused electrical cables from the fire pump room. 7. Provide easy identification of all the fire control panels by painting them red and providing identification tag. 8. Install the fire pump control panel for electrical panel near the pumps. As informed, at present the control panel for electrical fire pump is located away from the fire pump house in the cooling water pump house electrical room.	Complete within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/19	1. Provide emergency oil spillage containment below the diesel day tanks of emergency diesel generator installed in fire Pump room and DG room respectively, to contain emergency oil spillage from the day tanks. The minimum height of the curb should be 100 mm. As per NFPA 20, standard for the Installation of Stationary Pumps for Fire Protection, 2013 Edition, 11.4.1.2.4 Single wall fuel tanks shall be enclosed with a wall, curb, or dike sufficient to hold the entire capacity of the tank plus 50mm free board or 110% of the tank capacity. 2. Provide level transmitter or magnetic type level indicator or protected glass type level indicator instead of plastic sight tube for diesel day tank measurement. 3. Provide regular checks for possible diesel leakage from flange joints, level gauges etc. 4. Provide spray nozzles on the HVWS (High Velocity Water Spray System) pipeline installed on the diesel day tank of the emergency diesel generator. 5. Remove the covers provided on the Quartzite bulb type heat detector line installed on diesel day tank. 6. Provide hood on the vent of the diesel day tank. Check for the provision of providing the vent outside the diesel generator room.	Immediate Action	Completed	Completed	Completed - Closed
2015/26	1. Repair the existing fire detection system installed in the electrical panel room. Caps on the smoke detectors should be removed to make it operational. 2. Arrest the leakages observed on the MVWS (Medium velocity spray system) line installed on the cable galleries in cable vault located at 0m elevation. 3. Seal all the cable openings present in the cable vault. Some openings were due to the drain pipes installed in the cable vault room. Same should also be sealed properly. 4. Provide adequate fire extinguishers in the cable vault room. Carry a weekly loss prevention round to ensure that all the fire extinguishers are properly placed and easily accessible. 5. Provide design calculation for the spray system provided in the cable vault room to Marsh risk consultancy for review and verify adequacy of the system.	Complete within 3 months	Completed	Completed	Completed - Closed

Reference	Description	Priority	Recommendation Update by Client	Marsh Comments	Status
2015/27	Provide the following engineering information in order to verify the adequacy of the metal roof sheet of main power block and metal wall cladding attachments of the GBC (Gas booster compressor area): - Linear dimensions of the building. - Peak and eaves height of the building. - Thickness of roof sheet. - Distance between the purlins. - Linear distance of the fasteners on the purlins. - Diameter of the metal fasteners head.	Complete within 3 months	Completed	Completed	Completed - Closed
2015/28	1. Provide earthquake protection for fixed fire protection system as per FMDS 2-8. Following recommendation should be followed in this regards: - Brace fire protection piping to minimize uncontrolled differential movement between the equipment and the structure(s) to which they are attached. - Provide flexibility on piping systems and on other equipment where differential movement between portions of those piping systems or equipment is expected. Except where large differential movement occurs over a short distance, flexible couplings provide sufficient flexibility between portions of sprinkler piping systems where needed. - Provide clearance between piping or equipment and structural members, walls, floors, or other objects so that potential damage from impact is minimized. - Provide anchorage to minimize potential sliding and/or overturning. - Use appropriate types of pipe hangers and sway bracing, properly located and attached to the structure to minimize the potential for pullout. - Use appropriate types of piping and pipe-joining methods to minimize potential pipe breaks 2. Provide seismic safety shut off valves on the natural gas pipelines as per guidance in FMDS 1-11. 3. Properly bolt/grout all the electrical panels, control panels, racks in maintenance store room to prevent over toppling of equipment during earthquake.	Complete within 6 months	Completed	Completed	Completed - Closed

New Recommendations Details

Annual Steam Turbine and Gas Turbine functional overspeed test	Critical	2019/04/01
Date Raised / Revised	April 2019	
Risk Exposure	Machinery Breakdown	
Description	Steam Turbines and Gas Turbines are equipped with electronic over speed protection devices. Physical overspeed test was carried out during the commissioning stage and there after overspeed protection tests were not conducted. It is imperative to conduct the steam turbine and Gas Turbine overspeed tests on regular basis to ensure the integrity of the protection devices. Huge losses have occurred around the world because of the steam turbine/Gas Turbine overspeeding as the protection devices didn't work.	
Recommendation	It is recommended to carry out the functional steam turbine and Gas Turbine overspeed test on annual basis. This functional test can be carried out at reduced speed set point.	
Client Response	Client agreed to carry out the test as recommended.	
Status	***April 2019: New***	

Monthly DC lube oil and seal oil pump run test on cut in pressure set point	Critical	2019/04/02
Date Raised / Revised	April 2019	
Risk Exposure	Machinery Breakdown	
Description	During the discussions with operation department, it was informed that DC emergency lube oil and generator seal oil pump auto start at lube oil header pressure low set point is not being tested though the weekly push button start test is carried out. Testing of DC emergency lube oil and eal il Pumps should include activation of the pressure switch to verify functionality of the system. In the event that main and standby lube oil pumps were to fail, the DC Emergency Lube Oil Pump is required to ensure that the bearings are supplied with oil whilst the turbine generator runs down. Failure of DC lube oil pump systems has resulted in insurance losses due to journal damage.	
Recommendation	It is recommended to test the auto operation of DC lube oil and seal oil pumps at least on monthly basis to ensure the availability of these pumps in need.	
Client Response	Client agreed to carry out the test as recommended.	
Status	***April 2019: New***	

Monthly Steam Turbine Stop and Control Valve exercising	Critical	2019/04/03
Date Raised / Revised	April 2019	
Risk Exposure	Machinery Breakdown	
Description	Load demand from the grid is varying on continuous basis and so is the control valves' position. In view of the above, control valves are exercised on daily basis. Moreover, it was noted during the discussion with site team that there is no routine to check the freeness/smooth movement of Steam Turbine stop valves. Free movement of stop and control valves is a must in order to ensure the full closure of the valves (without any sticking of valve stems inside gland) when the steam turbine trip command initiates. Closure of the valves reduces risk of Steam Turbine overspeed to a great extent.	
Recommendation	It is recommended to test the free movement/floating of steam Turbine stop valve on monthly basis.	
Client Response	Client agreed to carry out the test as recommended.	

Monthly Steam Turbine Stop and Control Valve exercising		Critical	2019/04/03
Status	***April 2019: New***		

Annual Emergency shut off Valve test		Critical	2019/04/04
Date Raised / Revised	April 2019		
Risk Exposure	Fire		
Description	Site is equipped with the Emergency Shut off valve at the plant gas receiving station. Upstream of the plant gas receiving station, ONGC (the gas supplier) has its gas receiving and processing station, which is just besides the OTPC gas receiving station. Client informed that currently there is no routine of Emergency Shut off valve testing however, the shut off valve installed at ONGC side is tested annually. Each GT has a double block and bleed valve arrangement on its gas supply line. It was further noted during the discussion that currently the plant gas leak detection is not wired for the closure of Emergency Shutoff device.		
Recommendation	It is recommended to wire the plant gas leak detection signals for the Emergency Shut off valve closure and that the Emergency Shut off valve should be tested on annual basis.		
Client Response	May trip the unit in the event of false/spurious signal. May require further discussion before implementation.		
Status	***April 2019: New***		

Implementation of GE upgrade Packages for Gas Turbines		A	2019/04/05
Date Raised / Revised	April 2019		
Risk Exposure	Machinery Breakdown		
Description	Site is equipped with GE's 9FA machines. GE has issued upgrade packages one to five for the Gas Turbines. Site has implemented package one and two only till date.		
Recommendation	It is recommended to implement the upgrade packages suitably.		
Client Response	It requires significant investment which may not get approved by CERC outside O&M expense. Hence this point needs further discussion before implementation.		
Status	***April 2019: New***		

Gas Turbine door fan test		B	2019/04/06
Date Raised / Revised	April 2019		
Risk Exposure	Fire		
Description	The top sections of the gas turbine enclosures are generally dismantled during a major overhaul. Following reassembly after overhaul, the enclosures are not tested to verify the integrity of its seals. It is important to ensure that in the event of a fire, the discharged CO2 would be able to maintain the required concentration for the required amount of time, generally accepted as 30 minutes, to extinguish the fire. If the fire is not extinguished due to leaks in the enclosure, thereby compromising the CO2 concentration, the fire may reignite, causing significant property damage and generation downtime.		
Recommendation	It is recommended that enclosure air tightness tests are performed either through Door Fan Testing – this test involves the use of a fan to pressurise the enclosure and measuring the air leakage rate from the enclosure over a period of time. (or) CO2 Discharge Testing – this test involves an actual CO2 discharge in the enclosure and measuring the resulting CO2 concentration over a period of time.		
Client Response	Client agreed to carry out the recommendation.		
Status	***April 2019: New***		

Emergency Diesel Generator annual load test	B	2019/04/07
Date Raised / Revised	April 2019	
Risk Exposure	Fire	
Description	Emergency Diesel Generators are push button started on weekly basis. Currently auto synchronization and load test is not being carried out. When a diesel generator is run unloaded very little fuel is injected into the cylinders. As a result, the combustion is not robust and incomplete combustion products can collect behind the compression rings of the piston and prevent them from sealing properly. Over time this will cause the engine to run poorly and lose power.	
Recommendation	It is recommended to carry out the load test on Emergency Diesel Generator as per NFPA 110.	
Client Response	Client agreed to carry out the recommendation.	
Status	***April 2019: New***	

Fire water testing as per NFPA 25	B	2019/04/08
Date Raised / Revised	April 2019	
Risk Exposure	Fire	
Description	The site has electric and diesel firewater pumps. These are understood to be run weekly however these are not performance tested in accordance with NFPA 25 standard. Monthly and Annual testing of fire pumps comes under NFPA 25, '*Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, and 2008 Edition*'. Note: There is an updated version 2014 Edition The standard annual flow test requires testing the pump at minimum, rated and peak flows by controlling the quantity of water discharged through an approved test device. A full set of performance readings should be taken at each flow condition including; electrical motor current and voltage, pump speed in rpm, pump suction and discharge pressure, and discharge flow. Pump performance should be compared with the pump design curve and with previous annual flow test reports. Degradation in excess of 5% of the pressure of the initial unadjusted acceptance test curve or nameplate shall require an investigation to reveal the cause of degraded performance and restorative maintenance. The standard monthly no flow test requires testing of motor driven pumps for 10 minutes and testing of diesel engine driven pumps for 30 minutes as per NFPA 25. Reference should be made to NFPA 25, which also makes other recommendations and precautions to be taken, and gives full details of the test requirements.	
Recommendation	It is recommended that monthly no flow and annual flow tests of fire pumps should be carried out in accordance with NFPA 25 standard. The results should be plotted and compared to the pump design curves to check for degradation.	
Client Response	Client agreed to carry out the same.	
Status	***April 2019: New***	

Fire detector identification below control room false flooring	C	2019/04/09
Date Raised / Revised	April 2019	
Risk Exposure	Fire	
Description	During the control room visit, it was observed that below the false flooring, smoke detectors were installed for the fire detection. On the false floor tiles, however, there were no identification marks to locate the smoke detectors, which are installed below.	
Recommendation	It is recommended to put the identification marks at the respective false floor tile for the ease of identification of smoke detectors.	
Client Response	Client agreed to carry out the recommendation.	
Status	***April 2019: New***	

Fixed fire protection system for Steam Turbine Generator bearings and diesel engine for fire water pump as per NFPA 850	A	2019/04/10
Date Raised / Revised	April 2019	
Risk Exposure	Fire.	
Description	The main steam turbine generator bearings have no fixed fire protection as per NFPA 850. If a major failure occurs followed by fire the entire plant will be shut down for an extended period of time. Steam turbine generator lubricating oil fires do occur and these events are among the most severe of loss incidents resulting in extensive damage and long durations to repair. Within the insurance industry a steam turbine generator lubricating oil fire is considered as an MFL (Maximum Foreseeable Loss) event.	
Recommendation	It is recommended that fixed fire protection system should be provided for the main steam turbine generator bearings in accordance with NFPA 850 'Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations', 2015 Edition.	
Client Response	Client shall discuss internally and revert.	
Status	***April 2019: New***	

Gas Turbine seal oil system fixed fire protection system as per NFPA 850	A	2019/04/11
Date Raised / Revised	April 2019	
Risk Exposure	Fire.	
Description	The Gas Turbine Generator seal oil system has no fixed fire protection. Gas Turbine seal oil system is a mineral oil and very critical as it seals generator hydrogen. In the event of fire, the seal oil system may be out of operation and this may cause hydrogen leak from the generator.	
Recommendation	It is recommended to provide fixed fire protection system on the Gas Turbine generator seal oil system in line with NFPA 850.	
Client Response	Client shall discuss internally and revert.	
Status	***April 2019: New***	

Annual foam solution test	B	2019/04/12
Date Raised / Revised	April 2019	
Risk Exposure	Fire	
Description	It was observed and discussed during the site visit that the fire-fighting foam solution (Aqueous Film Forming Foam for fuel oil tanks) is not tested on regular basis. Foam concentrate can deteriorate and is affected by high ambient temperature conditions	
Recommendation	As per NFPA 25, fire-fighting foam solution should be tested annually.	
Client Response	Client agreed to comply with this recommendation.	
Status	***April 2019: New***	

Critical Piping Inspection	B	2019/04/13
Date Raised / Revised	April 2019	
Risk Exposure	Machinery Breakdown	

Critical Piping Inspection		B	2019/04/13
Description	During the discussion with Mechanical maintenance team it was noted that critical piping like Main steam, Hot Reheat, Cold Reheat, Feed water piping etc. are not inspected periodically. Critical piping have many critical welds, bends and pipe support system (including variable and constant spring hanger supports), which need periodic inspection and maintenance. Critical Pipe supports need to be inspected in both hot and cold condition and should be subject to adjustments or replacements based on the inspection outcome.		
Recommendation	It is recommended to inspect critical piping and inspection should cover critical bends, welds and piping supporting system.		
Client Response	Client informed that the critical weld inspection will be difficult to perform as the arrangement of resources and spares will be difficult because of the remoteness of site but client agreed to perform the support inspections as recommended.		
Status	***April 2019: New***		

Gas detection and interlocking of the gas leak signal with the emergency shut of valve.		A	2019/04/14
Date Raised / Revised	April 2019		
Risk Exposure	Fire		
Description	It was observed during the site tour and discussions with the site team that currently, gas detection system is not installed at gas booster compressors. Gas leakage is an extreme fire and explosion hazard and needs to be monitored on continuous basis. Moreover, the gas leak detectors should be interlocked with the closure of emergency shutdown valve, installed at gas receiving station.		
Recommendation	It is recommended to install the gas detection system at gas booster compressors and to interlock/wire the gas leak signal with the Emergency shut off valves.		
Client Response	Client agreed to comply with the recommendation.		
Status	***April 2019: New***		

STG AC and DC Lube Oil Pump Power Cables		B	2019/04/15
Date Raised / Revised	April 2019		
Risk Exposure	Fire		
Description	Steam Turbine Lube oil tank is cited at “0” meter TG building. The power cables to the STG AC and DC oil pump motors are running together in the proximity of the main lube oil tank. A fire in this area could quickly burn out both cables and starve the bearings of oil before the STG has been brought to rest. The following extract is taken from the 2010 edition of NFPA 850: 7.7.3.8 “cable for operation of lube oil pumps should be protected from the fire exposure. Protection can consist of separation of cable AC and DC oil pump or 1- Hr fire resistive coating (derating of cable should be considered)”.		
Recommendation	It is recommended that fire proof paint (intumescent paint) to be applied to the power cables from the STG AC and DC lube oil pump motors terminals up to the conduit portion.		
Client Response	Client agreed to comply with the recommendation.		
Status	***April 2019: New***		

SECTION FOUR

SITE DESCRIPTION

Power Plant is located at Village Palatana, Udaipur in Gomoti district in the Indian state of Tripura. The plant comprises two blocks of Combined Cycle Power plants i.e. power block 1 and block 2.

The first block (363.3 MW) of the power plant was declared under Commercial Operation from 4th January, 2014 and the second block (363.3 MW) of the two blocks was declared under Commercial Operation from 24th March 2015.

Owners

Shareholding pattern of the company is as mentioned below:

Company Name	Percentage Shareholding
Oil and Natural Gas Company Limited (ONGC)	50
Infrastructure Leasing and Financial Services Limited (IL&FS)	26
India Infrastructure Fund – II (IIF- II)	23.5
Government of Tripura	0.5

Operator

Plant Operation and Maintenance contract has been awarded to STEAG Energy Services since 3rd January 2017 for three years.

STEAG GmbH operates power plants using fossil fuels and renewable energy sources.It produces and supplies electricity and thermal energy worldwide. It also provides district heating for households, utilizing residues from coal fired power plants in concrete industry, and large scale battery systems to secure electricity supply.

It serves to energy utilities, municipal enterprises, and industrial and commercial businesses; and customers ranging from private individuals to large consumers and property companies.

STEAG GmbH was formerly known as Evonik STEAG GmbH and changed its name to STEAG GmbH in June 2011.

The company was founded in 1937 and is based in Essen, Germany.

Business Model

Currently OTPC have long term power purchase agreement for 726 MW with the following state electricity boards:

State	Capacity (MW)
Assam	240
Meghalaya	79
Manipur	42
Nagaland	27
Arunachal Pradesh	22
Mizoram	22
Tripura	196
Balance on Merchant Sales	98

State	Capacity (MW)
Total	**726**

Site Description

Location

The grid coordinates for the sites are:

Co-ordinates:	Longitude	Latitude
OTPC, Udaipur, Tripura	91.4396° (E)	23.4992° (N)

The plant is located at Palatana, Udaipur Village at Gomoti District in the Indian state of Tripura.

As per Munich RE Nathan charts, the plant site is located in Zone 2 for earthquakes, Zone 5 for lightning, Zone 2 for tornados and in Zone 3 for flash floods. For the other natural perils including storms, cyclones, tsunami and volcanoes, the site is in “no hazard” or low hazard zones. All the critical structures like chimney, HRSGs, GTT buildings, etc. are provided with the lightning protection covering the respective areas.

The area of the plant is approximately 80 ha and the layout of the site provides good spatial separation.

The nearest commercial airport is at Agartala, which is the main airport for the region and is situated around 73 km to the North West of the plant. There was no indication of flight paths over the site during the survey.

The road access to the plant is through State highway.

Natural Perils

The most recent Nathan Single Risk Assessment Report is shown in the following chart.

Hazard Score Rating

Hazard zoning values for significant natural hazards

	low	high	hazard rating
Earthquake			Zone 2
Volcanoes			No hazard
Tsunami			No hazard
Tropical cyclone			Zone 1
Extratropical storm			No hazard
Hail			Zone 2
Tornado			Zone 2
Lightning			Zone 5
Wildfire			Zone 2
River flood			Zone 0
Flash flood			Zone 3
Storm surge			No hazard

Overall the risk is considered as high due to higher storm/cyclone and lightening exposure.

Third Party Risks

Plant is surrounded by agricultural land from three sides and Udaipur town from the forth side. There are no third party hazards in the locality.

Layout

The plant occupies a large area and is well laid out.

Both the Gas Turbines are housed at “0” meter TG building with a separation of around 70 meters in parallel configuration.

Both the Steam turbines are housed in the turbine building at TG floor with an axial configuration having separation of around 75 meters.

HRSGs are outdoor installations located within their own steel frame support structures to the West of the Turbine Hall with approximately 70 m separation. The flue gas from each HRSG is released via steel stake located to the West of the HRSGs. The Plant Gas receiving and conditioning facilities are located to the North East of the main plant with about 350 meters of separation and can be considered as separate risk.

Hydrogen Generation Plant is located in the South East of Turbine hall with a separation of around 550 meters and can be considered as a separate risk as well.

Steam Turbine Generator lubricating oil tanks and pumps are located at Turbine hall “0” meter floor and the tanks are bunded with oil drainage facility in place. Lubricating oil tanks are equipped with fixed fire protection system. Fixed fire protection system is not extended up to the lube oil filters and coolers. Fixed fire protection system for steam turbine generator bearings and lube oil piping is not installed (Recommendation 2019/04/10).

Gas Turbine lube oil system is located just besides respective Gas Turbine enclosure at “0” meter floor and in a separate enclosure. The enclosure is equipped with CO_2 based compressed gas fire protection system.

The seal oil skids/tanks for Gas Turbine are located in a pit at the ground floor of the Turbine Hall (besides Gas Turbine Enclosures). These tanks are not equipped with fixed fire protection system (Recommendation 2019/04/11).

The Station transformers, Generator Step up (GSU) Transformers (for Gas Turbine Generators and Steam Turbine Generators) and Unit Auxiliary transformers are located to the East of the turbine hall.

A blast/ fire wall and containment (filled with stone chips) has been provided between each GSU transformer, Unit Auxiliary transformer and station transformer suitably as per NFPA 850.

GSUs, Station transformers and Unit Auxiliary Transformers are equipped with fixed fire protection systems.

Chemical house is located around 170 meters south east of TG building.

Cooling towers are located around 250 meters south west of TG building.

Construction

All the major buildings like turbine hall, ware house building, admin building, Fire water pump house, switchyard control building, DM Plant and other water treatment buildings are constructed of non-combustible material.

Details of various plant and non-plant buildings are as mentioned below:

Description	Roof material	Walls material	Remarks
Turbine Generator hall	Non-combustible Unprotected	RCC walls	
Unit Control Room	Combustible	RCC walls with wooden interior decoration on partition walls	False floorings tiles are also combustible in nature (made up of wooden dust)
Fire Pump Room	Non-combustible Unprotected	RCC walls	
Fire Station	Non-combustible Unprotected	RCC Walls	
Gas receiving station and GBC (Gas Booster Compressor) area	Non-combustible Unprotected	Steel structure	

SECTION FIVE

PROCESS DESCRIPTION

Gas Turbines

Gas turbines (model MS 9001FA+e) is supplied by General electric.

This is single fuel fired machine which can only run on natural gas. This machine has 18 stages compressor with 1:16.5 compression ratio. Gas Turbines are equipped with Dry Low Nox type (DLN 2.0) combustors.

Gas turbine is a three stage impulse type turbine with shaft rated speed at 3000 rpm. The various interlocks on the gas turbine includes but not limited to low lube oil pressure (alarm and trip), generator trip lockout, exhaust pressure high (trip), excessive vibrations (alarm and trip), control system fault (trip) etc.

Pre-ignition trips includes DC lube oil DC pump under voltage (trip), failure to ignite on gas (trip), shutdown gas leak test failed (trip), start-up gas leak test failed (trip), gas purge fault (trip), natural gas level Hi Hi level (trip), seal oil DC motor under voltage (trip) etc.

Post ignition trip on gas turbines includes loss of flame, high exhaust temperature, load tunnel temperature high, exhaust over temperature, exhaust thermocouple open, compressor bleed valve position trouble etc.

Master protective trip on gas turbine includes protective status trip, pre-ignition trip, post-ignition trip, starting device trip, inlet guide vane control trouble, gas purge fault trip etc. Compressor degradation program is in place which includes online and offline water washing of the compressors.

Online water washing is done for 15 min. every 48 hours. Offline water washing is done during shutdown of the unit or every six months whichever is earlier.

Cross section view of the 9FA machine is as shown below:

Cross sectional view of DLN 2.0 combustor is as shown below:

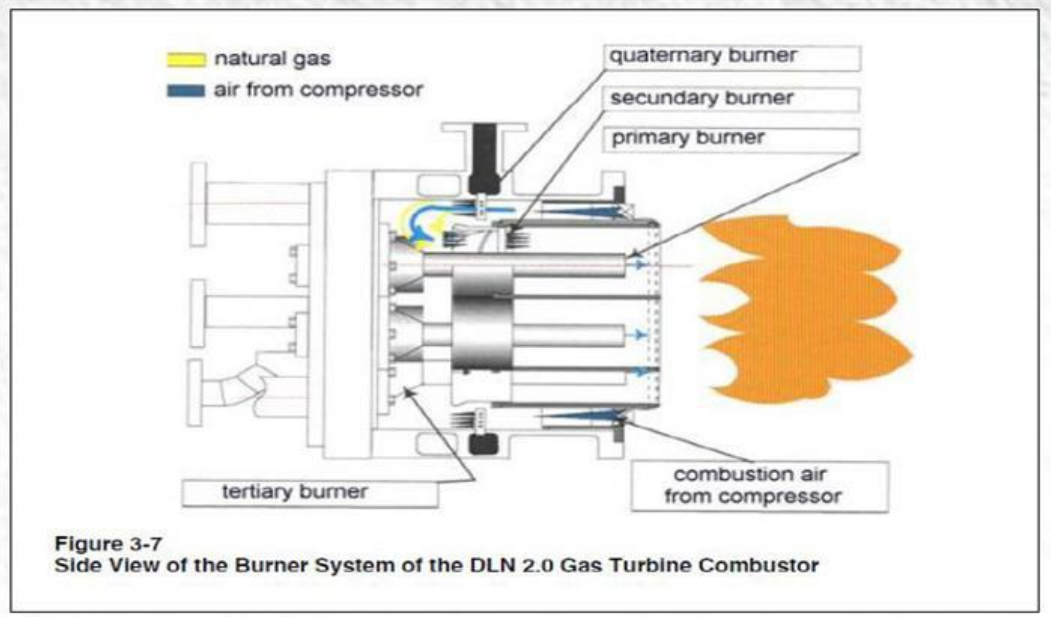


Figure 3-7
Side View of the Burner System of the DLN 2.0 Gas Turbine Combustor

Gas Turbine Specifications are as mentioned in the below table:

Designation	GT1 and GT2
General	
Service Status	Base Load
Spacing	50 meters
Turbine	
Designer	GE
Commissioning Year	For Block 1 it is 2014 and for Block 2 it is 2015
Model Number	9FA
Compressor stages	18
Compression Ratio	16.5:1
Compressor extraction stages	9th and 13th stages
Turbine stages	03
Type of Gas Turbine	Impulse Type
Combustor Chamber	Annular arrangement
No. of Combustors	18
Type of Combustors	Reverse Flow, Can annular
Type of burners	DLN 2+
Rating (MW)	232 (at site condition)
Fuels	Natural Gas
Liquid fuel NOx control type	No provision for liquid fuel injection. No use of water for Nox control.
Exhaust Temp (°C)	700
Speed RPM	3000
On line vibration analysers	Seismic velocity type (12 mm/sec alarm and 25 mm/sec Trip)

Lubricating Oil/Seal Oil	
System/Type	Mineral Oil ISO VG32
Piping	Welded
Containment	Yes

Steam Turbines

Details of the Steam Turbines are outlined in the following Table.

STEAM TURBINE - General Specifications	
Designation	**ST 1 and 2**
Spacing	50 meters
GENERAL	
Service Status	Continuous
Number of units	2
TURBINE	
Designer	Bharat Heavy Electrical Limited, India
Type & N° of cylinders & reheat	Two cylinder reheat condensing turbine
PCOD / Year	Unit 1 in 2014 and Unit 2 in 2015
Rating (MW)	131
Speed (RPM)	3,000
Online vibration monitoring system	Available (Alarm: 7 mm/sec, Trip: 11 mm/sec)
Online relative shaft vibrations	Alarm value 22 µm
LUBRICATING OIL/SEAL OIL	
Type	Mineral Oil
Piping	Stainless steel, Welded
Containment	Provided
Reservoir location	Lube Oil Tank at “0” meter TG Building
VIBRATION MONITORING	
HP/ IP/LP Steam Temperature and Pressure	
Pressure (MPa)	13.4/3.46/.44
Temperature (°C)	540/330/230

HRSG

The Heat Recovery Steam Generator (HRSG) is of horizontal, natural circulation, unfired, triple pressure reheat type.

The HRSG is designed to generate steam at 134 Kg/cm^2 & 540ºC (+/- 5ºC) at Main Steam Stop valve outlet at GT (gas turbine) base load in designed ambient temperature of 27ºC with natural gas firing in GT.

The HP steam is generated from HRSG at a pressure of 134 Kg/cm^2 and temperature of 540ºC with a flow rate of 289.6TPH (Tonnes per hour).

The IP steam is generated from HRSG at a pressure of 34.6 Kg/cm^2 and temperature of 330ºC with a flow rate of 35.6 TPH.

The LP (Low Pressure) steam is generated from HRSG at a pressure of 4.4 Kg/cm^2 and temperature of 230ºC with a flow rate of 36.7 TPH.
Safety relief valves are installed on IP economizer and water pre heater. As informed they are tested every year as per statuary law.

All the parameters of HRSG are continuously monitored using BHEL make MAXDNA DCS controllers in the unit control room.

Details of the HRSGs are outlined in the following table.

Designation	HRSG 1 and 2
Service Status	Continuous
Spacing	50 meters
GENERAL	
Number of units	2
Designer	BHEL (Bharat Heavy Electrical Limited), India
PCOD / Year	Block 1 in 2014 and Block 2 in 2015
Type	Horizontal, Natural Circulation, Water tube, top supported, fully drainable, modular design, Triple Pressure with Reheat type waste heat boiler.
Steam flow (t/h) HP / IP/LP	289.6/35.6/36.7
Steam pressure (MPa) HP/IP/LP	13.4/3.46/.44
Steam temperature (°C) HP /IP/LP	540/330/230
Boiler Fuels	NA
MISCELLANEOUS	
Water Chemistry Testing/Controls	Ammonia and Hydrazine as low pressure and Tri Sodium Phosphate as high pressure Dosing.
Boiler Feed water Pumps	2X100% HP BFP and 2x100 LP BFP (motor driven)

Gas Turbine Generators

Details of Generators are outlined in the following table.

Generator	
Designation	**Generator Unit 1 and 2**
Make	Bharat Heavy Electrical Limited
PCOD / Year	Unit 1 in 2014 and Unit 2 in 2015
Rated voltage (kV)	15.75
Rated output	232.39 MW (at site conditions)
Phase	3 Phase
Frequency (Hz)	50
Power Factor lagging / leading	0.85 Lagging
Rotor cooling	Hydrogen
Stator cooling	Hydrogen
Insulation Class	F

Plant comprises two Emergency Diesel Generator sets of 750 kVA each and has been supplied by Jackson, India.

Steam Turbine Generators

Generator	
Designation	**Generator Unit 1 and 2**
Make	Bharat Heavy Electrical Limited
PCOD / Year	Unit 1 in 2014 and Unit 2 in 2015
Rated voltage (kV)	15.75
Rated output	131 MW
Phase	3 Phase
Frequency (Hz)	50
Power Factor lagging / leading	0.85 Lagging
Rotor cooling	Air
Stator cooling	Air
Insulation Class	F

Transformers

Details for Transformers are as mentioned in below table.

Transformers	Gas Turbine Generator Transformer	Steam Turbine Generator Transformer	Station Transformer	Unit Auxiliary Transformer
Number	02	02	02	02
PCOD Year	Unit 1 in 2014 and Unit 2 in 2015	Unit 1 in 2014 and Unit 2 in 2015	Unit 1 in 2014 and Unit 2 in 2015	Unit 1 in 2014 and Unit 2 in 2015
Rating (MVA)	287 (@27ºC)	150	20/25	16
Serial Voltage (kV)	15.75 – 420	15.75 - 420	132 – 6.9	15.75 – 6.9
# Phases	3	3	3	3
Frequency (Hz)	50	50	50	50
Cooling	OFAF	ONAF	ONAN/ONAF	ONAF
Oil type	Mineral	Mineral	Mineral	Mineral
Drainage/Containment	Available	Available	Available	Available
Blast wall to NFPA 850	Available	Available	Available	Available
Protection Relays	Available	Available	Available	Available
Vector Group	YNd1	YNd1	YNyn0	Dyn11
Tap Changing equipment type	OLTC +/- 10% IN 1.25% Steps in HV side	OLTC +/- 10% IN 1.25% Steps in HV side	OLTC – 12.5% to +7.5% IN 1.25% Steps in HV side	OLTC +/- 05% IN 2.5% Steps in HV side

Switchyard

Plant comprises of air insulated switchyard of 400 kV and 132 kV.

All the generators are connected to 400 kV switchyard through generator transformers and 132 KV switchyard through Inter connecting transformers. Two overhead 400 kV outgoing overhead transmission lines supply the power grid sub stations and two overhead 132 KV lines are connected to state sub stations.

Generator circuit breakers are installed in the 400 kV switchyard side. They are supplied by ABB.

Station transformers are connected to the 132 kV switchyard.

Fuel Supply Systems

Natural Gas receiving station

ONGC supplies natural gas to the plant from the wells, which are located around 10 km to 57 km from plant.

Gas from ONGC side is supplied at a pressure of 14-15 Kg/cm^2 at a temperature of 27-28ºC. Upstream of the OTPC gas conditioning skid, ONGC also has gas conditioning skid, which is just besides the OTPC skid and is being operated by ONGC personnel.

There are two streams, one running and one standby present in Initial Gas Conditioning Skid (IGCS), each having scrubber and Filter-Separator.

There are 3 Gas Booster Compressors (GBCs) in the Gas Boosting Compressor Station (2 running, 1 standby for 2 Units).

From the IGCS, the gas flows to GBCs where the pressure of the gas increases to 32-34 Kg/cm^2 and temperature increases to 130ºC.

From IGCS the gas flows to Final Gas Conditioning Skid (FGCS), separate for both Units, where the temperature of gas is increased to 185ºC.

There is a gas flow Measure Control Room in the IGCS.

There was no gas detection and alarm system provided in the said Control Room in the event of any leakage of natural gas (Recommendation 2019/04/14).

Online Chromatography is done at the site near the gas metering station.

There are two redundant lines for chromatography. Helium is used as the carrier gas for gas chromatography.

Site is located in 50 years earthquake zone (as per FMDS 1-2), seismic shutoff valves were not installed on the natural gas pipelines to shut off the gas supply automatically in case of earthquake.

River Water Supplies

The source of plant raw water is river Gomati and the water intake point is only 2 km away from the project site.

There are four numbers of vertical pumps of capacity 1100 m^3/h installed to supply water to the project through a GRP pipeline of 900 mm diameter, which is stored in a reservoir of capacity 1, 78,000 cubic meters.

Raw water is clarified in the pre water treatment plant and then stored in the clarified water tank and fire water tank.

Water from clarifiers is directly routed to clarified water tank and fire water storage tanks through gravity with a motorized isolation valve.

From clarified water tanks, water is either used as service water, make up water for condenser cooling water system, or at Demineralised plant.

Plant comprises two raw water clarifiers.

There is a chemical house for chemical treatment of raw water. Alum, biodispersent and Flocculent are added in the raw water before it is clarified in clarifiers.

Compressed Air

Plant comprises of two screw air compressors (of 100% capacity each), supplied by Atlas Copco

Out of the two compressors, one is in service for service and instrumentation air requirements and the other one is in standby.

Cooling Towers

The cooling towers employed at site are counter flow induced draft parabolic masonry cooling towers with plastic fills (Each unit have one cooling tower with 8 cells out of which 7 are in running mode while one is redundant).

The condenser cooling system is water cooled with vacuum extraction pumps.

Cooling water cycle can only run in closed cycle mode. It is not designed to be operated in once through cycle.

Plant Protection Systems

Gas Turbine Protection systems

Gas Turbine Protection and control Systems are implemented through the Distributed Control System (DCS).

DCS for Gas turbine protection and control systems has been supplied by GE (MARK VI).

Gas Turbine major protections include (but not limited to):

- Over speed protection (electronic protection systems are in place).
- Lube/control oil pressure low.
- Vibration high (12 mm/sec alarm and 25 mm/sec Trip).
- Loss of flame.
- Over Temperature.
- Combustion monitoring.

HRSG Protection Systems

Plant HRSG Protection System is implemented through the Distributed Control System (DCS).

HRSG is equipped with BHEL make (MAXDNA 4.2.2 – SP4) DCS systems. This is (Safety Instrumented Level) SIL 2 rated system.

HRSGs are not equipped with duct burners and have three pressure drums i.e. High pressure, Intermediate pressure and Low pressure drums.

Each drum is equipped with three level transmitters and one hydrastep. These level transmitters are used for HRSG protection and control based on 2oo3 voting. These level transmitters are calibrated on annual basis by C&I maintenance during annual shutdown.

There are 2X100% High pressure Boiler Feedwater pumps and 2X100% Low Pressure Boiler feed water pumps, which feed HRSG.

Steam Turbine Protection System

Plant Steam Turbine Protection System (TPS) and Steam Turbine Control system (TCS) are implemented through the Distributed Control System (DCS).

DCS for Steam turbine protection and control systems has been supplied by BHEL (MAXDNA 4.2.2 SP4) only.

Steam Turbine protections include (but not limited to):

- Turbine over speed protection (both mechanical and electronic protection systems are in place).
- Turbine lube/control oil pressure low.
- Turbine vibration high (200µm is Alarm and 320 µm is Trip).
- Turbine shaft and Casing differential expansion.
- Turbine eccentricity high.
- Turbines exhaust pressure high.
- Lube oil level low in Main Lube oil Tank.

Generator and Transformer Protection System

Generators have following (but not limited to) digital protections installed:

- Generator protection trip, where in the electrical tripping is getting initiated by the various differential protection relays installed.
- Generator vibration high.
- Generators lube oil pressure low.
- Generator seal oil pressure low.

Transformers (for both the blocks) have different type of differential protection relays, and Buchholz relays, installed for all the electrical protections.

Control Systems

There is a control room for the plant. Control room is located on the steam turbine floor, overlooking the Steam Turbine floor.

Plant comprises of following DCS/control system:

- BHEL's MAXDNA 4.2.2 SP4 for HRSG and Steam Turbine control systems.
- GE's MARK VI for Gas Turbine control and protection.
- Other Balance of plant systems like DM Plant, Hydrogen generation plant, cooling water systems are equipped with GE make PLC systems.
- Fire water system is equipped with Rockwell Make PLC.

UPS / DC Power Supplies

Plant is equipped with 220V DC system comprises of Ni-Cd battery banks and battery chargers (one working and one stand by) for critical drives operation, switchgear control supply and emergency lighting.

For gas turbine control systems (GE make MARK VI), 125 V DC systems have been installed (1 Working and 1 standby per Block)

For HRSG and Steam Turbine control systems following UPSs are installed.

- 230V (50Hz) AC UPS (one working and one standby) have been installed in each unit.
- 230V AC supply is directly fed to DCS as a power supply.

The 230V UPS is installed to cater the power requirements of HMIs (Human Machine Interfaces), SCADA and power supply for some critical valves and actuators like actuator for boiler feed water pump scoop coupling actuator.

Projects

No new projects reported.

Insurance Loss History

No Losses reported till date.

SECTION SIX

PLANT STATUS

Operational Performance

System Control and Dispatch

Plant receives load demand from a Load dispatch centre located in Shillong, Meghalaya.

On the day of the survey, only Block 2 was operational with the gross output as 328 MW.

Block 1 was out of operation due to the jamming of the steam turbine post a steam turbine trip initiated due to plant black out.

Performance Data

Station Performance

Year	Availability Factor	Plant Heat Rate (Kcal/KWh)
2016 - 2017	67%	1805
2017 - 2018	64%	1834
2018-2019	85.15	1790

Fired and Outage Hours

Year	Unit 1fired Hours	Unit 2 Fired Hours	Plant Planned outage Hours	Plant Forced outage hours
2016 - 2017	7591	7726	1428	797
2017 - 2018	8026	8083	944	485
2018-2019	8223	8401	384	479

Warranties

All the warranties are expired.

Technical Issues

Steam Turbine

During the survey, Block 1 steam turbine was out of operation due to jamming, post a trip on account of station black out.

After the Steam Turbine trip, while coasting down, both the AC and DC jacking oil pumps didn't come into operation in auto at the RPM set point and finally AC jacking oil pump was started in manual mode locally.

By the time AC Jacking oil pump started in manual mode, steam turbine got jammed.

As informed by the site team, this issue has occurred many times earlier as well. Historically, after cooling down (to around 170ºC), the steam turbine gets free and then rolled again.

It was understood that OTPC has discussed the issue with OEM (Bharat Heavy Electrical Limited) and carried out steam turbine inspections (Based on the OEM's recommendations) like checking internal clearances, bearings etc. and found the same in order.

Further, site informed that same issue is there in the similar steam turbines installed for the other clients as well.

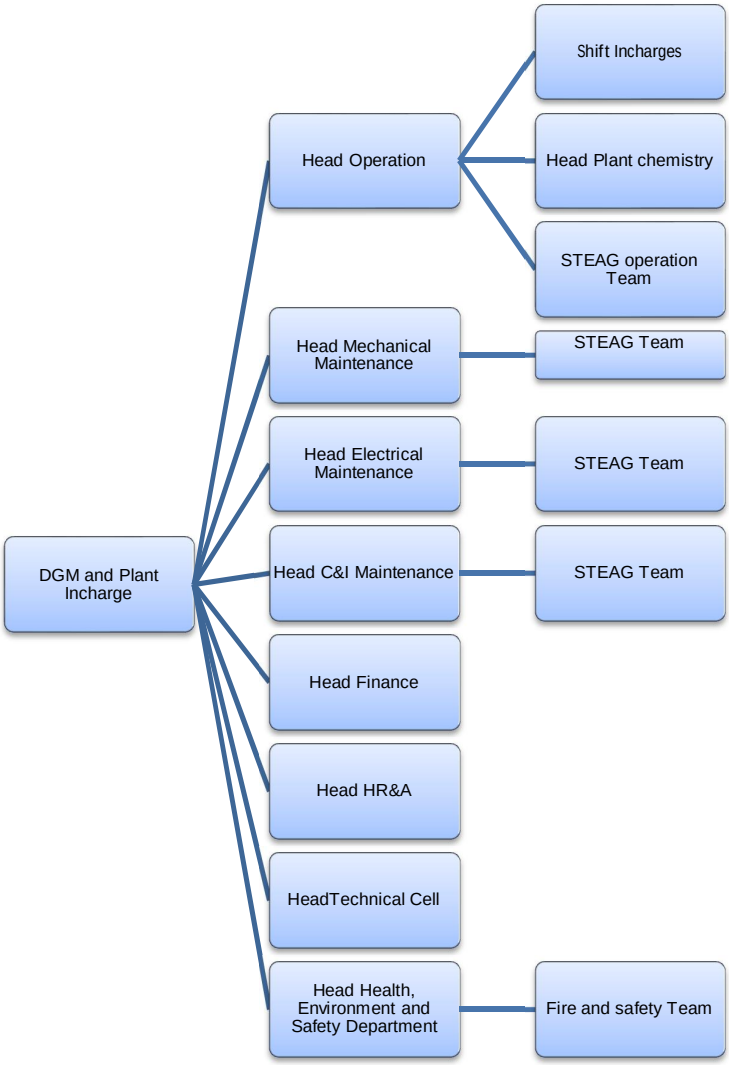
Site is in discussion with BHEL on this issue and awaiting the response.

SECTION SEVEN

MANAGEMENT SYSTEMS

Site Organisation

The Owner's management team at site includes:



Accreditations

OTPC has acquired following accreditations:

- ISO 9001:2015.
- ISO 14001:2015.
- BS OHSAS 18001:2007.

Management of Change (MOC)

During the control room visit it was observed that OTPC has a good system of trip bypass control.

OTPC has divided the protection / permissive bypass control into two groups for better monitoring. First group is for equipment protection bypass control. This bypass request is initiated by unit control room operators. This request is then approved by shift charge engineers.

Second group pertains to the unit protection / trip bypass control. In this, further approval of Plant In charge is also sought.

In Plant daily O&M meetings, each bypass is discussed in detail. Any trip/protection bypass getting extended beyond the approved time period is brought to the higher management's notice and plan to expedite the normalization is also prepared and followed up.

Document Management

Standard and Emergency Operating Procedures are being managed in electronic as well as physical form.

Physical copies of the procedures are kept at control room but these are not updated on regular basis. These procedures were last updated in 2015.

Individual maintenance departments hold records of their respective maintenance reports.

During the control room visit, various documents like start-up procedures, permissive and protection documents, pre start check list and pre start check list for electrical operations observed in paper form and operators informed that the above mentioned procedures were used extensively.

Operations

Organisation

Plant Operation and Maintenance contract has been awarded to STEAG Energy Services since 3rd January 2017 for three years.

There are four shift groups, which rotates in three shifts. Morning shift runs from 7AM to 2PM, evening shift from 2 PM to 10PM and night shift from 10PM to 7AM.

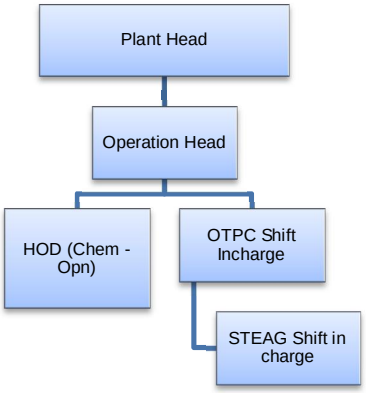
STEAG is currently deploying three desk engineers and one shift in charge engineer at control room and four operators and two helpers at site, per shift.

OTPC deploys one control room shift in charge in each shift. STEAG team reports into OTPC shift in charge and OTPC shift in charge further reports into plant operation head.

In view of the above, STEAG deploys 35 persons in plant operation.

Desk operators report into shift in charge and shift in charge reports into Operation head.

Organogram of the operation team is as mentioned below:



Operations Staffing

The operation staff level currently seems to be sufficient.

Shift Handover Procedure

Three levels of shift handover are there as mentioned below:

- Shift handover at desk operator (STEAG) level: This happens face to face with an overlap of 30 Minutes. Desk operators maintain manual logbooks.
- Shift handover at shift charge (STEAG) Level: This also happens face to face with an overlap of 40 -50 Minutes. Shift Charge Engineers maintain manual log books.
- Shift handover at shift charge (OTPC) level: This also happens face to face with an overlap of 40 -50 Minutes. Shift Charge Engineers maintain manual log books

Operating Procedures

Standard Operating Procedure documents are being managed in physical as well as electronic form and are not updated on regular basis (captured in observations).

During the control room visit, various documents like start-up procedures, permissive and protection documents, pre start check list and pre start check list for electrical operations observed in paper form and operators informed that the above mentioned procedures were used extensively.

Training and Competence Assurance

Selection procedure for trainee engineers at OTPC includes rounds of technical and personal interviews.

After the selections candidates are designated as Trainees and are going through one year rigorous training programme. This training programme comprises of class room sessions and site visits.

After completion of the training, candidates are absorbed into various OTPC departments for different roles.

Regular refresher trainings are also conducted for operation and maintenance staff.

Simulator trainings have not been planned till now.

Safe System of Work

Equipment isolation

This subject has been covered in standard operating procedures described above. This system involves all the departments, sections, individuals and contractor working at the plants and pipelines.

Prior to issuance of any permit to work, requisitioner needs to submit the duly approved job safety analysis form (JSA) by safety department. JSA form enlists the type of work, requirement of PPEs, lifting tackles to be deployed and health of this equipment, requirement of scaffolding and health of this etc.

There is a lock out tag out (LOTO) system in place for equipment isolation and support the production of Isolation Certificates by the Authorised Persons. Authorised person is a competent person adequately trained and appointed in writing by OTPC, after testing, to carry out specific work on any system, apparatus or plant. The certificate of appointment shall state the type of work the person is authorised to carry out, and the apparatus, plant or section to which it applies. The authorised person can receive, clear and suspend his Permit to Work (PTW).

Hot Permits are issued for a day only. It was observed that this is followed rigorously and the hot PTWs are cancelled on the same day and if required these are issued the next day.

Types of permits based on work are as mentioned below:

1. PTW: Permit to work where electrical isolations are required.
2. LWC: Permits where no electrical isolations are required but the area of work is limited.
3. SFF: Sanction for test permit.
4. Auxiliary PTW: For any hot work.

Control of Work

Permission for the execution of work is controlled through Permits issued by the Authorised Person and based on Isolation Certificates. There are a range of different permits in use depending on the result of the risk assessment carried out by the AP, permits used includes:

- Permit to Work.
- Hot Work Permit.
- Confined Space Permit.
- Working at Height Permit.
- Permit for Excavations.

Operational Testing Routines

Steam Turbines and gas turbines are equipped with electronic overspeed protection devices. Functional overspeed test at reduced RPM is not conducted annually (Recommendation 2019.04.01). Presently actual overspeed test are planned during major shutdowns.

Control Valves of the Steam Turbines are subjected to continuous exercising as the load set point is changed based on the demand however; stop valves are not subject to exercising (Recommendation 2019.04.03). Quick closing NRVs' are checked for freedom of movement on monthly basis.

Stop and control valve tightness test is conducted on opportunity or at least on annual basis, which is good practice.

DC Oil Pumps for lube and seal oil are operated on daily basis by push button start but the starting of the pumps on low oil pressure is not simulated on regular basis (Recommendation 2019/04/02).

Annual emergency shut off valve (installed at gas receiving station) testing is not carried out (Recommendation 2019/04/04).

The Emergency Diesel Generator (EDG) is push button started on weekly basis but synchronization and full load test is not conducted during annually (2019/04/07).

Capacity test for DC batteries (full discharge) is carried out on annual basis.

In HRSG annual Trevi test (online) is being carried out on annual basis by third party.

HRSG drum level transmitters are tested and calibrated on annual basis.

Changeover of UPS is carried out on regular basis.

Water / Steam Chemistry Controls

All volatile treatment (Reducing) is being carried out presently where in both ammonia and hydrazine is dosed after the condensate polishing units.

Tri sodium Phosphate (TSP) is dosed directly into the HRSG drums.

Cation Conductivity meters is installed at all the strategic location to detect any tube leakages in condenser.

Grab samples are collected per shift to cross check the correctness of online analysers.

Off Load Preservation

Following off load preservation practices are being followed for different equipment:

- HRSGs are preserved by wet preservation and regular monitoring and correction of water quality.
- Steam Turbines are preserved by hot air circulation and periodic barring.
- For generators, hydrogen is charged all the time.

Ergonomics & Operability

Control Rooms were observed to provide good spatial separation between unitized control desks and well laid out. The majority of the critical equipment was observed with labels and good access all around.

Lighting levels in the plant need an audit (captured in observations) and access to all the critical equipment and valves is provided.

Standard and emergency Operating Procedures are maintained both in electronic and physical form in control room but the same are not updated on regular basis. It was last updated in 2015 (captured in observations).

During the control room visit, various documents like start-up procedures, permissive and protection documents, pre start check list and pre start check list for electrical operations observed in paper form and operators informed that the above mentioned procedures were used extensively.

Alarm Management

During the discussions with the site team, it was observed that currently alarms are managed based on the priority with colour coding however, number of alarms per operator per shift is currently not monitored.

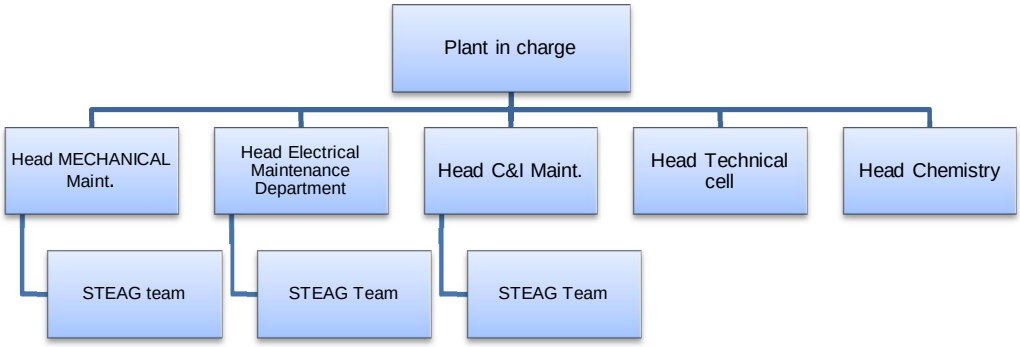
For Fire detection system, Fire alarm reporting system has been installed in the control room. The repeater Fire alarm reporting system has been installed in the fire control building as well. All the fire alarms are displayed both at control room and fire control building simultaneously.

Maintenance

Organisation

Plant Operation and Maintenance contract has been awarded to STEAG Energy Services since 3rd January 2017 for three years.

The maintenance organisation (OTPC) is shown in the following chart.



OTPC persons are deployed only at the key positions to supervise the O&M contractor and for spare part management.

In all there are around 65 persons in maintenance department (including STEAG).

Work Identification, Planning and Control

The Maintenance Philosophy is based on a blend of Preventive, Predictive, Pro-active and Corrective Maintenance activities.

Maintenance management module of SAP is currently in place for planning all types of routine maintenance activities, spare part management, capturing and monitoring regular defects and managing store activities like material issue, stock maintenance, material receipt etc.

Any abnormality, defects etc. are also captured in the SAP. While capturing the defects, concerned departments are assigned and notified with the maintenance jobs.

Regular follow up on the pending defects is being carried out during daily O&M Meetings.

Currently, for Gas Turbines Hot Gas Path Inspection (HGPI) is carried out every 32000 factored fired hours and Major Inspection (MI) is planned every 64000 effective burning hours (i.e. 32000 hrs, after the HGPI).

Block 1 GT HGPI was carried out in Aug 2017 and Major Inspection is planned in Aug 2021. Block 2 GT HGPI is planned in Aug 2019 and Major Inspection is planned in March 2023.

Steam Turbine Minor Shutdown is planned every 25000 Hrs and major shutdown is planned in every 1,00000 hrs.

Condition Monitoring Tools used for Predictive Maintenance include:

- Online Vibration Monitoring.
- Portable Vibration Monitoring by portable instrument.
- Temperature Monitoring.
- Thermography.
- Ultrasonic thickness gauging (UT).

- Material Identification.
- Dye penetrant test (DPT).

Gas Turbines

OTPC has entered a long term service agreement with GE.

This LTSA is in force till 2026 and covers HGPI and Major inspection and supply of all the required spares, which need replacement. Moreover, two GE persons are deputed at site for coordination.

During HGPI Following activities are carried out:

- Boroscope inspection of compressor.
- IGV calibration.
- Bell mouth cleaning.
- Replacement of all (three stages) gas turbine buckets, shrouds and nozzles.
- Replacement of combustor fuel nozzles, transition piece, liners and end cap.

During Major inspection other than the above activities, compressor is thoroughly inspected after opening the compressor casing.

Steam Turbines

Minor Steam Turbine overhauls are scheduled to be carried out every 25,000 effective running hours and the scope of the work includes:

- Bearing inspection.
- Alignment checks.
- Stop valves and governor valves are inspected and overhauled.
- Inspections of last stage blades.

In Major Steam Turbine overhauls (scheduled every 1,00000 effective running hours), in addition to the work carried out during minor overhauls, the scope of work for the major overhauls includes:

- Casing removal and full strip down of the Turbine.
- Rotor removal, cleaning and inspection.
- Magnetic particle inspection and ultrasonic inspection on Turbine rotor, blades, piping and flanges.
- Metallurgical replication on welded joints.

Steam Turbine Lube oil analysis is carried out on monthly basis where in Lube oil viscosity, colour, moisture and acidity is analysed and trended.

OEM is contracted for the Steam Turbine overhauling. This subcontract is both for spares and service.

Generators

Minor overhaul are scheduled to be carried out on the Generators every 25,000 effective running hours.

The scope of work for a minor overhaul includes:

- Visual inspections and cleaning.
- Excitation system overhaul.
- Bearing inspections.
- Cleaning and inspection of coolers.
- Replacement of all consumables and gaskets.

- Inspection of all connections.
- Hydrogen seal clearance inspection.

Testing during minor overhauls includes Insulation Resistance (IR), Polarisation Index (PI) and testing of current transformers and voltage transformers. Generators protection testing is performed and includes both secondary and primary injection.

The scope of work for a major overhaul (scheduled every 100,000 effective running hours) also includes:

- Generator rotor removal.
- Full inspection of all Generators.
- Wedge tightness checks- the wedged are of the spring type.
- Tan Delta testing of the windings.
- Dye Penetrant.
- Ultrasonic testing for flaws / cracks.

Testing during major overhauls includes IR, PI, testing of current Transformers and voltage transformers, off line partial discharge monitoring and a high voltage tests.

OEM team members are contracted for supervision of Generator overhauling.

HRSGs

The scope of overhauls includes:

- Full visual inspection of all tube banks, headers, steam drum and deaerator.
- Ultrasonic thickness checks in critical areas on tubes, headers and piping.
- Hydro tests are performed after repairs have been carried out. Final hydro tests (at 1.25 times the design pressure) are witnesses by a boiler inspector (Represents Statutory Body under the constitution of India; Boiler Regulation Act 1950).
- Dismantle pressure safety relief valves; inspect components including the use of dye penetrant inspection and recalibrate.
- Flanged pressure safety relief valves are removed, overhauled by a specialist company and bench tested in the presence of an OTPC representative.
- All rotating equipment is internally inspected, bearings are inspected and alignment is checked.
- All the headers are subjected to Ultrasonic tests and die penetrant tests to check any defects.

HRSG safety valves are Trevi tested on Annual basis.

High Energy Pipework

High energy piping inspection is not being carried out currently (Recommendation 2019/04/13).

Transformers

Transformer insulation oil is sampled from all the transformers biannually and sent to CPRI, Guwahati labs or STEAG Labs, Noida for DGA. The STEAG lab for DGA oil analysis is NABL accredited.

Tests for Furans and corrosive sulphur are also performed on transformer oil.
Results for last DGA analysis were observed and TDGC levels were observed satisfactory with respect to the levels as per IEEE C57.104 -2008.

Major Transformer maintenance is scheduled to be carried out every 2 to 3 years. The scope of work includes:

- Visual inspection including High Voltage and Low Voltage bushings.

- Cleaning.
- Cooling system maintenance.
- Protection testing.
- The tap changer is cycled through its full range.
- Tan Delta test on Bushing and winding.
- Turn ratio test.
- Magnetic balance test.
- Magnetising current test.
- Trips interlock tests.

Balance of Plant

Motors

Large High Voltage motors are scheduled every six months for maintenance. During this maintenance, vibration analysis, current and temperature trend monitoring is done during running.

The overhaul of large motors is carried out on annual basis where in rotors are threaded out for full electrical test.

Generator Circuit Breaker

During the annual overhauls following activities are carried out on Generator circuit breakers:

- Contact Resistance test.
- Time elapse in make or break of the contact.
- Open-close- open test.
- Dynamic Contact resistance

DC Power System

Routines have been established for maintenance of batteries and inverters. Batteries are of Nickle cadmium type.

Following activities are done on DC system as a preventive maintenance:

- Voltage Monitoring.
- Terminal tightness.
- Insulation resistance test for chargers.
- Earth Fault monitoring.

Battery full discharge / capacity tests are carried out on annual basis.

I&C Systems

Maintenance routines have been established for instrumentation and control equipment on a weekly, monthly, annual, minor overhaul and major overhaul basis.

Critical transmitters are inspected, calibrated and certified every year. Non critical transmitters are tested once in every 2 years.

DCS loop testing is carried out in every minor overhaul. One static IP (with firewalls) has been assigned to the DCS OEM for online fault diagnosis.

Predictive Maintenance

Vibration Monitoring

Gas Turbine Generators, Steam Turbine Generators and large motors (High Voltage Motors like Condensate extraction pumps, boiler feed water pumps and CW pumps) are equipped with fixed vibration monitoring system.

Vibration readings are displayed in the control rooms and are being monitored.

Vibration checks on the other rotating equipment are carried out, using a portable device on quarterly basis.

Vibration data is downloaded analysed and equipment vibration levels are trended.

Thermographic Surveys

Thermographic surveys on electrical equipment such as transformers, large motors, Switch gear etc. are carried out on regular basis.

Site is equipped with Thermographic cameras.

Lube Oil Analysis

Quarterly Steam Turbine Lube oil analysis is carried out where in colour, viscosity, acidity and moisture is analysed and trended.

Metal particles analysis is carried out on request or after equipment overhaul.

Spares

SAP is deployed for spare part management.

Optimum spare part inventory levels are defined in the SAP system for all the equipment. Material issue, new arrival is also captured into the SAP system. Notifications are generated and sent to the concerned maintenance team member if inventory falls below a certain levels.

Moreover, existing spare parts are categorized as per criticality and Usage.

Different type of storage facilities like Open yards, closed and semi closed, air-conditioned etc. are there for different materials.

Currently gas turbine spares, which are envisaged to be replaced during HGPI and MI, are available but the compressor spares are not available. This was discussed with the site team and it is understood that OTPC has connections with GE and other clients having similar GT sets for the arrangement of compressor spares if required.

Safety

Tripura State Rifles, a security force of government of Tripura is deployed in the plant for security of the plant whereas fire and safety is being taken care by STEAG and OTPC staff.

All contractors' staff and new staff have initial safety induction (orientation) training. Safety procedures follow Occupational Safety and Health Administration System (OSHAS) guidelines. New recruits initially work under a foreman and an individual work specific training plan includes safety training.

Near Miss, first aid, reportable and fatal incidents are monitored.

Smoking is not allowed in the plant.

There is a procedure for investigating accidents including determining root cause. The investigation team members are dependent on the severity. Action from the investigation is reviewed quarterly for progress. Near misses are reported.

For contract labours, prior to issuance of gate passes safety training and medical examination is a must.

A full-fledged executive training program on fire and safety is mandatory along with the annual refresher training.

Plant safety parameters are as mentioned in the below table:

Parameter	Units	2015	2016	2017	2018
Loss Time Injury	Nos.	0	0	0	1
First- aid cases	Nos.	26	97	34	12
Occupational Diseases	Nos	0	0	0	0
Safety Training Hours	Man-hours	283	657	2460	2596

Environment

The plant emission limits are outlined in the following Table (measured in March 2019):

Parameter	Unit of Measurement	Limit	Typical
Particulates(PM10)	PPM	50	44
SOx	PPM	200	0.94
NOx	PPM	50	19 - 20
Effluent PH	PH	6.5 – 8.5	6.92 – 7.79
ETP Effluent - TSS	Mg/l	NA	16.19

Physical Security

Tripura State Rifles, a security force of government of Tripura is deployed for the Plant security.

Access to the site is through a gatehouse that is continuously manned by armed guards.

Visitors require prior approval for issue of a Gate Pass and are accompanied from the gatehouse by a member of the plant staff.

The site is surrounded by approximately 2 m high brick and RCC Wall (topped with strands of barbed wire).

Cyber Security

Good cyber security measures observed at site.

Site intranet is completely isolated from the internet through firewalls.

All Units have independent LAN systems.

External memory device ports have been disabled in all the laptops and PCs.

SECTION EIGHT

EMERGENCY CONTROL

Fire Protection Features

Plant is equipped with fire detection and protection systems. All the detection systems (installed in the different hazardous areas) are connected to the central fire alarm panels and fire stations for better monitoring and control.

Fire alarm and detection system has been supplied by Detectomat, Germany (https://www.detectomat.com).

A basic level of fire detection and protection system was observed in the plant during the survey.

Fire protection and detection system has been supplied by UTC Fire and Security India Limited.

Fire detection systems are installed at Gas Turbine Enclosures, Steam Turbine Generator enclosure, main plant control room, DCS panel rooms, station switchgear rooms, Lube oil skids, Generator Step up Transformers, Station Transformers, Auxiliary Transformers and main plant cable cellar rooms.

Fire and gas detection systems at gas receiving and processing stations and gas booster compressor complex are not installed (Recommendation 2019/04/14).

Automatic fixed fire protection systems are installed at Gas Turbine enclosures, Steam Turbine Generator enclosures, Main control and DCS rooms, Lube oil skids, Generator Step up Transformers, Station Transformers, Auxiliary Transformers and main plant cable cellar rooms.

Fixed fire protection and detection systems at Steam Turbine Generator bearings and Gas Turbine Generator Seal oil tank skids are not installed (Recommendation 2019/04/10 and 2019/04/11).

Plant comprises of spray (for fixed fire protection system) and hydrant water reticulation system. These reticulation systems are mostly above ground. Fire water pumps are separate for spray and hydrant fire water system.

Plant is equipped with two numbers of motor driven pumps, one numbers of diesel engine driven pump, two numbers of jockey pumps, two set of compressors and one hydro pneumatic tank for hydrant system and one motor driven pump, one diesel engine driven pump for spray system.

Fire water tank is a concrete tank with a capacity of 3000 cubic meters capacity and is equipped with automatic level control mechanism. The intake to the fire water tank is directly from the clarifiers through gravity with a motorized isolation valve.

Site consists of a raw water reservoir of 178,000 cubic meters capacity.

Plant fire water system comprises of following pumps:

Pumps	Quantity	Flow (m^3/hr)	Head (m)	Supplier	Type
Main Hydrant Pumps (Electrical)	02	273	88	Flow more, India	Vertical Centrifugal
Stand by hydrant Pump (Diesel Engine driven)	01	273	88	Flow more, India	Vertical Centrifugal
Main Spray Pumps (Motor driven)	01	273	88	Flow more, India	Vertical Centrifugal

Pumps	Quantity	Flow (m^3/hr)	Head (m)	Supplier	Type
Stand by Spray pump (Diesel Engine driven)	01	273	88	Flow more, India	Vertical Centrifugal
Jockey Pump	02	20	95	Flow more, India	Vertical Centrifugal
Air Compressors	2	30	NA		
Hydro pneumatic tanks	1	80 M^3	NA		

Standards

As informed by the site team fire protection and detection systems have been designed based on respective NFPA standards.

Critical areas like Steam Turbine Generator bearings lube oil piping and GT Generator seal oil system as per NFPA 850 (Recommendation 2019.04.10 and 2019.04.11).

Passive Fire Protection

Separate Fire Compartments and Other Aspects

The plant occupies a large area and is well laid out.

Both the Gas Turbines are housed at “0” meter TG building with a separation of around 70 meters in parallel configuration.

Both the Steam turbines are housed in the turbine building at TG floor with an axial configuration having separation of around 75 meters.

HRSGs are outdoor installations located within their own steel frame support structures to the West of the Turbine Hall with approximately 70 m separation. The flue gas from each HRSG is released via steel stake located to the West of the HRSGs. The Plant Gas receiving and conditioning facilities are located to the North East of the main plant with about 350 meters of separation and can be considered as separate risk.

Hydrogen Generation Plant is located in the South East of Turbine hall with a separation of around 550 meters and can be considered as a separate risk as well.

Steam Turbine Generator lubricating oil tanks and pumps are located at Turbine hall “0” meter floor and the tanks are bunded with oil drainage facility in place. Lubricating oil tanks are equipped with fixed fire protection system. Fixed fire protection system is not extended up to the lube oil filters and coolers. Fixed fire protection system for steam turbine generator bearings and lube oil piping is not installed (Recommendation 2019/04/10).

Gas Turbine lube oil system is located just besides respective Gas Turbine enclosure at “0” meter floor and in a separate enclosure. The enclosure is equipped with CO_2 based compressed gas fire protection system.

The seal oil skids/tanks for Gas Turbine are located in a pit at the ground floor of the Turbine Hall (besides Gas Turbine Enclosures). These tanks are not equipped with fixed fire protection system (Recommendation 2019/04/11).

The Station transformers, Generator Step up (GSU) Transformers (for Gas Turbine Generators and Steam Turbine Generators) and Unit Auxiliary transformers are located to the East of the turbine hall.

A blast/ fire wall and containment (filled with stone chips) has been provided between each GSU transformer, Unit Auxiliary transformer and station transformer suitably as per NFPA 850.

GSUs, Station transformers and Unit Auxiliary Transformers are equipped with fixed fire protection systems.

Good cable sealing arrangements were observed in cable rooms and switchgear rooms.

AC and DC lube oil pump, power and control cables are running through the same route but are not painted with intumescent paint (Recommendation 2019/04/15).

Fire and Gas Detection

Detection Systems

Fire detectors installed include:

- Photoelectric smoke detectors.
- Probe type conventional heat detectors.
- Multi sensor.
- Linear Heat Sensing (LHS) cables.

Detection is installed in the following areas:

- Gas Turbines enclosure.
- Control Room (including floor voids).
- All switch rooms and cable rooms.
- DCS room.
- Transformers.
- Cable raceways.
- Lube oil tanks for Gas and Steam Turbines.
- Stores (Air conditioned area only).

Fire and Gas Alarm Systems

Plant is divided into different fire zones as per design. Each zone is equipped with the various types of fire detectors.

These fire detectors are connected to the fire alarm panels located in control rooms and fire station building.

Fire alarm and detection system has been supplied by Detectomat, Germany (https://www.detectomat.com).

Hydrogen Gas detection system is installed in hydrogen generation plant and wired to the local PLC system.

Natural Gas detection system is installed in Gas Turbine enclosures. The signals are wired to DCS for alarm and tripping as mentioned below:

- 5% LEL for high alarm.
- 12% LEL for High- High Alarm.
- 25% LEL for tripping.

Fire Water Systems

Design

Fire water systems are designed based on TAC (Tariff Advisor Committee) guidelines.

Fire water system is equipped with one fire water tank (of 3000 m^3). This is an RCC tank and receives water directly from clarifiers through gravity.

Fire water tank is equipped with level transmitters, which controls the water level in the tank automatically.

Pumps for hydrant and spray fire water systems are separate and has been sized sufficiently as informed by site team.

Fire Main

All the critical areas in the plant such as mentioned below are equipped with dedicated hydrant and spray ring mains:

- TG Building & HRSGs.
- ESP/ESP Control Room.
- Transformer yard & 400 kV/132 kV switch yard/control room.
- DM Plant.
- Fire Station.
- Hydrogen Plant.
- CT MCC Room.
- Plant Air Compressor Building.
- Air washer room.
- Stores.
- Chemical Storage.

Fire water spray and hydrant pipes are mostly laid over ground except some areas like switchyard, which is currently being changed to over ground.

Fire hydrants are installed as per TAC (Tariff Advisory Committee) guidelines and the details are as mentioned below:

- Outdoor hydrants.
- Internal hydrants.
- Double headed hydrants.
- Water monitors.
- Total number of equivalent hydrants.

Fixed Protection

Fixed Fire Protection Summary

A summary of the fixed fire protection systems installed are shown the following Table.

Zone	Activation	Fire Protection
Gas Turbine enclosure	2 Number Gas detectors and 6 Numbers of heat detectors	CO_2 gas system
GTG Lube oil tanks	Heat	Automatic Deluge
STG Lube Oil Tanks	Heat	Automatic Deluge
Gas Turbine Generator step up Transformers	Q B detectors	Automatic Deluge
Steam Turbine Generator step up Transformers	Q B detectors	Automatic Deluge
Station and Unit aux. Transformer	Q B detectors	Automatic Deluge
Control rooms	smoke	Argonite system
DCS and computer rooms	Smoke	Argonite system
Cable cellar rooms	LHS and smoke detectors	Automatic Deluge
Switchgear Rooms	Smoke detectors	None
Gas booster compressor building	None	None
Hydrogen Generation Plant	Hydrogen gas leak detection	None

Mobile Equipment

Fire Appliances

Following fire extinguishers are installed in the plant at different locations:

Type of Fire Extinguisher	Quantity
Water (9 Litre)	40
Mech Foam(9 Litre)	5
ABC 2kg	2
ABC 5 kg	6
ABC 6kg	20
CO_2 4.5 kg	37
CO_2 6.5 kg	3
CO_2 9 kg	10
CO_2 22.5 kg	8
DCP 5 kg	163
DCP 25 kg	7
DCP 50 kg	2
Total	303

Plant is equipped with two numbers of fire tenders of 3000 Litres water capacity each and two numbers of 200 Litre foam trolleys.

Plant consists of following firefighting installations:

Description	Quantity
Fire Hydrant	102
Fire escape hydrant	40
Water monitor	3
Deluge valves (MVWS:12 and HVWS:22)	34
Hose boxes	142
Area isolation gate valves	31

Emergency Plans

There is a disaster management Plan in place which takes care of the various emergency scenarios. As discussed with the site safety team, regular emergency drills are also carried out for the intended spontaneous action from all the employees in case of any emergency.

Based on the various emergency scenarios / situations mentioned in the disaster management plans, following emergency drills are performed at site:

- Annually once involving external agency.
- Mock drill fortnightly internally.

Disaster management plans are updated every two years/ (or) whenever the change is there and these plans are also approved by factory inspectorate office.

Fire Response

Site Fire Response

Deployment of firefighting team is in STEAG's scope as a part of O&M contract.

Firefighting cover is provided on a 24 hour basis on a three 8 hour shift pattern using four shift teams with each team lead by a shift supervisor.

Following persons are deployed per shift:

- Two Fire tender drivers.
- Two Firemen.
- One supervisor.

Around 05 persons are deployed in each shift, as mentioned above. In view of the same the total manpower of the fire team is around 21 persons.

Moreover, fire team has around 14 dedicated persons for the maintenance purpose which is a good practice.

Mutual aid

OTPC has the mutual aid arrangement with the following:

- Udaipur fire service department, Udaipur which is around 10 km from site.
- Kakraban Fire service, which is around 06 kmfrom site.

Mock drills were conducted recently to see the response time for the arrival of fire tender and team from Udaipur and Kakraban fire service department. Both the teams arrived within 10 to 15 minutes at site.

The mutual aid arrangement is for sharing ambulance facilities also.

Site is equipped with one of ambulances also.

Fire Systems Inspection, Maintenance & Testing

Inspection testing and maintenance of the fire water pumps and fire detection and protection system is carried out by fire and safety department.

All the fire extinguishers are inspected on monthly basis and refilled if found empty or with less weight. Fire extinguishers observed with the tags, which show that monthly inspections are carried out.

All the fire hydrants are also monthly inspected. During inspection, correctness of local pressure gauges with respect to actual water pressure, freeness of hydrant valves, availability of water etc. are checked and corrected if found with the problem.

Testing of Fixed fire protection system of transformers, Main Lube oil tanks and cable cellar rooms is carried out on annual basis.

Fire water pumps are tested but as informed by site, these are not tested as per NFPA 25 guidelines (Recommendation 2019/04/08).

Housekeeping

Housekeeping in the plant was generally in order.

Cleaning of dry vegetation in the areas like switchyard and transformer yard is required on immediate basis.

Fire System Impairment Procedure

Formal fire impairment procedure is not available (Recommendation 2015/01).

Ignition Source Control

Hot work is controlled through the Permit to Work system. A fire watch post hot work completion is provided by the fire department.

Vehicle access to the site is strictly controlled by site Security and only essential vehicles are allowed onto the Power Plant area.

Smoking is not allowed in the plant.

SECTION NINE

LOSS SCENARIOS

Loss Definition

In this section of the report, a review is presented of the probable principal Material Damage loss exposures relating to the plant, indicating a Probable Maximum Loss (PML) and Maximum Foreseeable Loss (MFL) for each scenario.

The scenarios considered are those related from physical damage perils conventionally insured and from machinery breakdown.

The definition of PML is as follows:

"The Probable Maximum Loss in respect of Property Damage and Business Interruption from an insured event that is considered to be limited to the initiating object or area and occurs at a time when normal protection is in service and functions correctly."

The definition of the MFL is:

"The Maximum Foreseeable Loss where severely adverse conditions are present. A loss resulting from an event that is considered to be of a major magnitude that causes damage not only to the initiating equipment or area but also to surrounding equipment, buildings and infrastructure and occurs when normal protection is out of service. This includes the consequences of a fire or explosion in the most critical area of the property assuming the loss or failure of all existing fixed fire protection systems but assumes passive fire protection works and emergency response works. It also includes the highly unlikely catastrophic incidents such as earthquake, hurricane etc."

Plant and equipment for the OTPC, Udaipur Plant is those typically associated with the production of electrical energy from Gas fired Turbine Generators, HRSGs and steam turbine generators. Consequently, the losses are those expected from the operation of heavy industrial equipment, large rotating plant, steam pressure vessels, piping, lubricating oil systems, together with transformers, power and control cabling necessary for the operation of the plant.

Property Values

Following values are considered based on John Foord Paper.

Main Equipment Value	Million US $
Gas Turbine + Generator	81
Transformers	27
Steam Turbine + Generator	40
HRSG	40
Balance of Plant	80

The loss scenarios have included additional clean-up costs and work on the assumption that equipment will be replaced at the same contract value.

The loss scenarios do not include the potential of third party damage and claims.

Lead Times

Lead times for the critical equipment have been considered as mentioned below (for the loss calculation):

Equipment	Months
Gas Turbine	16
Generators	16
HRSG	13.5
Steam Turbine	13
Transformers	10

In practice OEMs look to improve on standard lead times and will deal with the supply on a case to case basis.

Insured Values

Following are the sum insured values based on the latest policy in place:

- Property Damage Sum Insured: INR 3,822 Cr.
- Business Interruption Sum Insured: INR 653 Cr (Annual).
- Business Interruption Indemnity Period: 18 months.
- Deductibles:
  - Property Damage: 5% of claim amount subject to minimum of 5,000,000.
  - Deductibles for Mobile / office equipment's – 5% of the claim amount subject to minimum of INR 1,000,000 for each and every loss.
  - Fire Loss Of Profit: 14 days of Gross Profit.
  - Machinery Breakdown Loss Of Profit: 21 days OF Gross Profit.

Probable Maximum Loss

Loss Event	Property Damage Mn US$	BI Estimate MW x Months	Description of Loss
Severe DOD due to combustor failure or compressor blade failure resulting in loss of turbine section	32	363 MW for 12 Months	Assumes loss because of the DOD in either combustor or compressor and damages the hot gas path. Considering 60% damage.
Generator Transformer explosion	3	363 MW for 10 Months	Assumes explosion in Gas Turbine Generator transformer by some electrical fault. Assumes complete replacement of the transformer.
Steam Turbine Generator Fire	8	131 MW for 7 Months	An oil leak in the generator side causes a fire. The fire team responds and damage is minimized. Specialists are required to repair the damage to the Generator. Estimate 20% of STG value.
Loss of HRSG pressure parts requiring replacement during over-pressurization	16	363 MW for 8 Months	Pressure part losses resulting from over pressurization in case safety valves fail to open. Estimate 40% of HRSG value

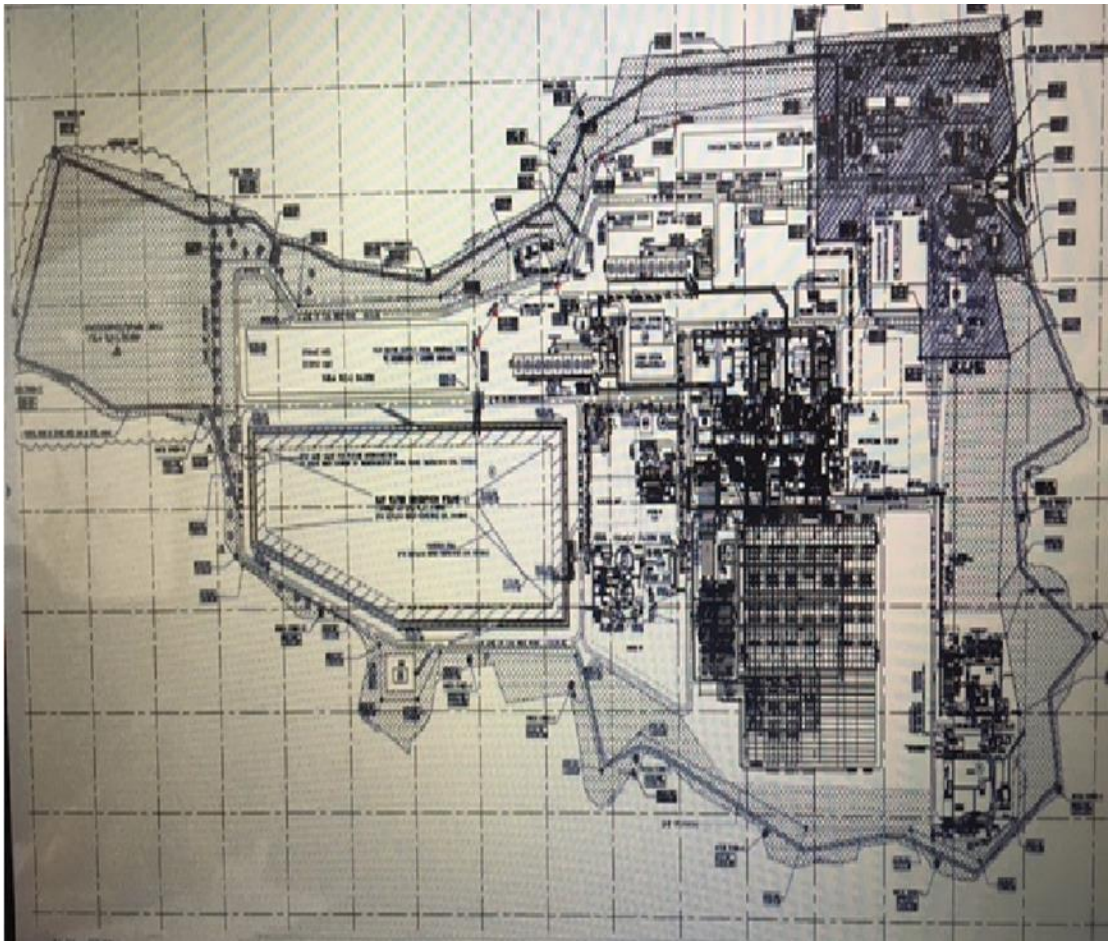
Loss Event	Property Damage Mn US$	BI Estimate MW x Months	Description of Loss
Inundation of ground floor TG Building and GT enclosure where in all the ground floor TG equipment got damaged and need replacement.	10	363 MW for 8 Months	Assuming all the" 0 "meter TG and GT auxiliary equipment got damaged and need replacement. Considered this loss as the area is in high river flood zone (Zone 500) as per Munich re.

Maximum Foreseeable Loss

Loss Event	Property Damage Mn US$	BI Estimate MW x Months	Description of Loss
Earthquake	14	363 MW for 16 Months	An overall damage level equivalent to 5% of the total plant value is suggested for the loss resulting from earthquake event. This represents direct earthquake damage and the following fire damage. Estimate to be 5% of Plant value.
Major GT loss	105	363 MW for 24 Months	Explosion in GT and severe damage to GT and Generator followed by Hydrogen explosion in generator. Assumes total loss of Gas turbine and generator requiring complete replacement + 12% Debris removal+20% damage to the adjacent unit.
Major ST uncontrolled Lube oil fire	53	363 MW for 20 Months	Assumes catastrophic loss of ST, with significant building damage and partial collapse. Assumes most of the major equipment suffers external damage only and can be salvaged. Estimate full replacement cost of 1 STG + debris removal, clean up and minor damage to adjacent STGs.
ST over speed without following fire	53	363 MW for 20 Months	Assumes total loss of turbine and generator requiring complete replacement + 12% Debris removal+20% damage to the adjacent unit.
Major HRSG pressure part loss	15	363 MW for 10 Months	Assumed considerable loss of pressure parts including drum .

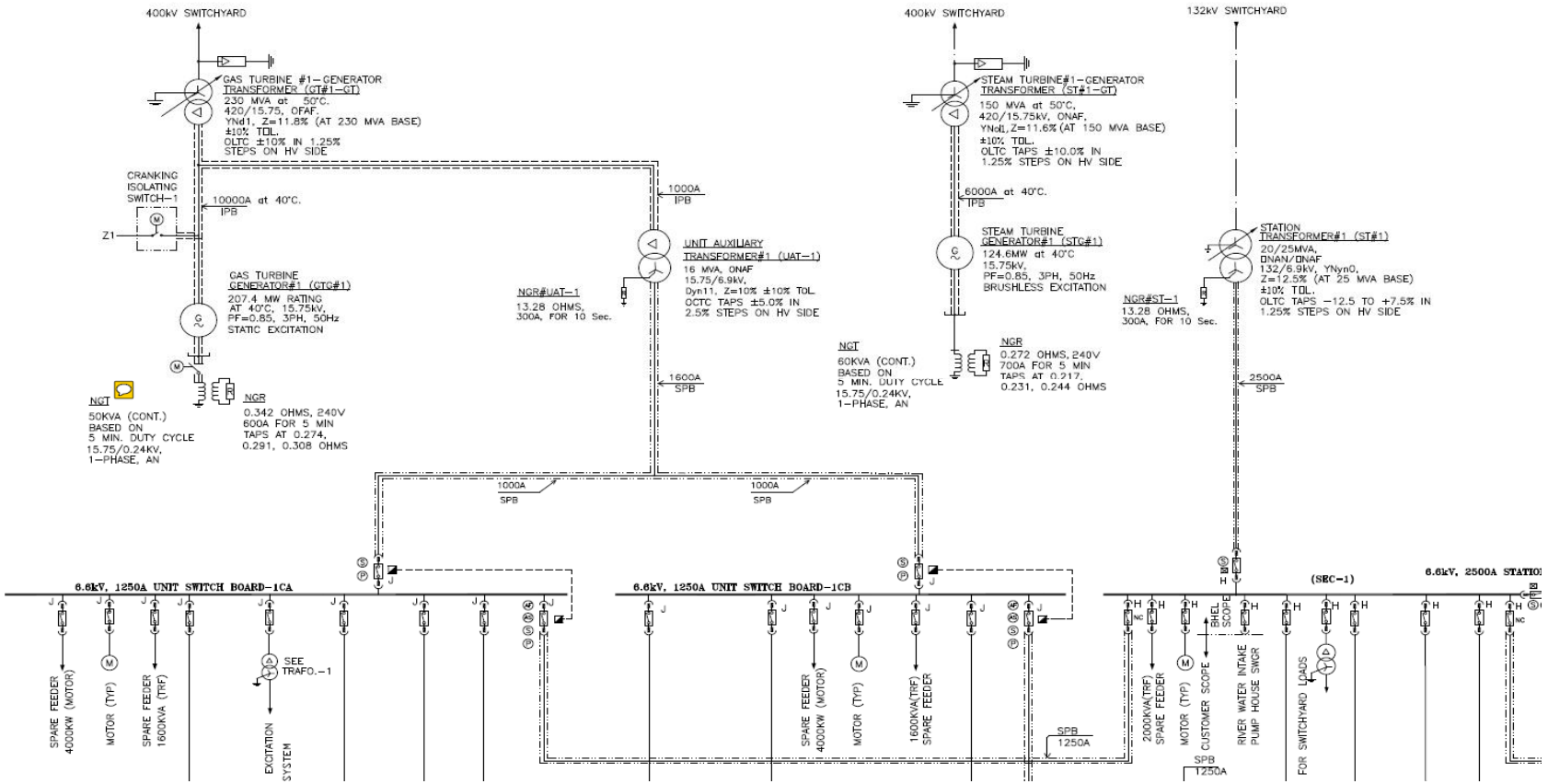
APPENDIX A

PLOT PLAN



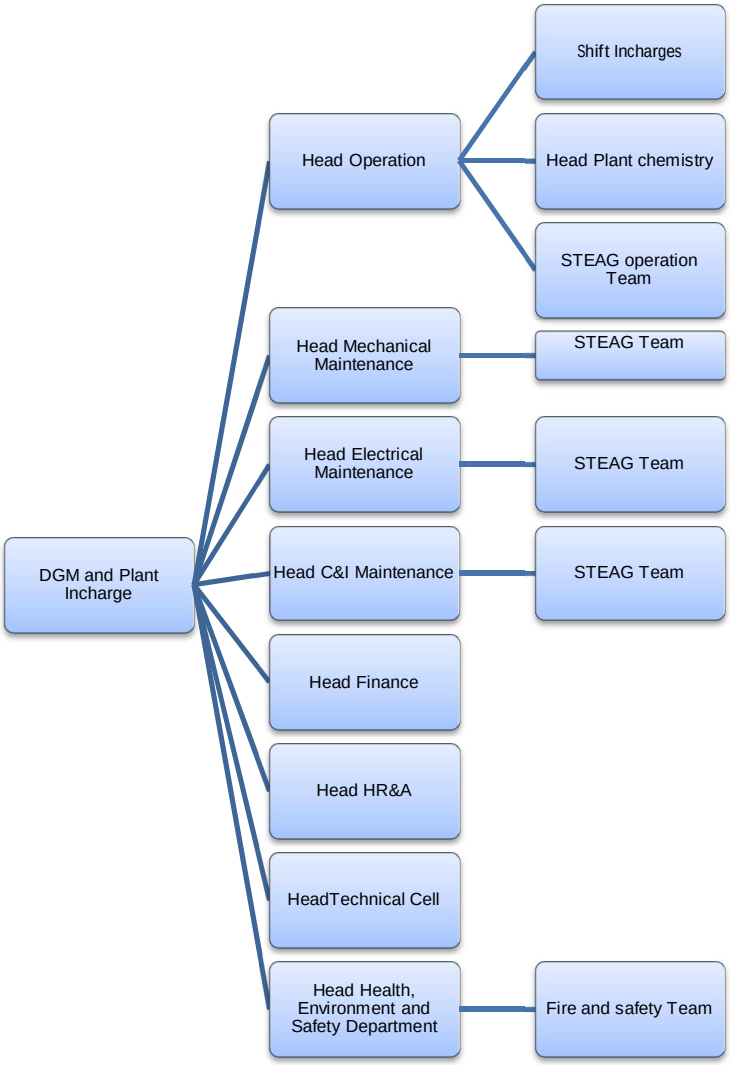
APPENDIX B

SINGLE LINE ELECTRICAL DIAGRAM (FOR ONE BLOCK)



APPENDIX C

ORGANISATION STRUCTURE



Click here to enter text.

Marsh Ltd.
1 Tower Place West, Tower Place
London EC3R 5BU

ENERGY AUDIT REPORT

2 X 363.3 MW (CCPP)

ONGC Tripura Power Company Limited

Palatana, Udaipur, Tripura

(An ISO 9001:2008 certified Company)
STEAG Energy Services India Pvt. Ltd.
(Formerly Evonik Energy Services (India) Pvt. Ltd.)
(A wholly owned subsidiary of STEAG Energy Services GmbH, Germany)
A-29, Sector-16, NOIDA-201301, India

September - 2017

ACKNOWLEDGMENT

Steag Energy Services India Private Limited, SESI expresses their sincere gratitude to the management of ONGC Tripura Power Company , Palatana, Udaipur, Tripura for their cooperation in carrying out the energy audit of Combined Cycle Power Plant at Palatana, Udaipur, Tripura.

We would like to express our deep sense of gratitude to the all departments who helped us with infrastructure / arrangements and encouragement in our endeavor. The valuable information / input furnished by the Plant Manager & Technical Cell personnel of the plant during site activity are also highly appreciable.

We do hope you will find our recommendations useful in saving energy and recover your investment in the periods estimated. While we have made every attempt to adhere to high quality standards in both data collection and analysis as well as in presentation through the report; we welcome your suggestions towards improvement of the report.

Finally, we thank all those who helped us directly or indirectly to execute this Energy Audit project.

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LIST OF FIGURES

LIST OF TABLES

The working details of Energy Audit Project are as follows:

Project	Energy Audit
Client	ONGC Tripura Power Company Limited
Site	ONGC Tripura Power Company Limited, Palatana, Udaipur, Gomati district, Tripura.
Consultant	Steag Energy Services India Pvt Ltd., Noida, UP, India -201301
Project Scope	Energy audit of the 2X363.3 MW Combined Cycle Gas Turbine (CCGT) power plant and process to assess the loss in the system/subsystems and identify energy efficiency measures to be taken.
Note	*The recommendations in this report are based on the present operating conditions of equipments/systems.*

Index (Revision)	Date	Description	Prepared By	Reviewed By	Approved By
R0	21/07/2017	Energy Audit Report	Mr. K G Sudhan Ramkumar, Mr. Mayakant Shukla, Mr. Vineet Ku Jha Mr. Manish Sharma	Mr. Lalatendu Pattanayak	Mr. Rakesh Mishra

SUMMARY

ONGC Tripura Power Company Limited (OTPC), is operating two units of 2 x 363.3 MW (726.6 MW) Combined Cycle Gas Power Plant for providing power to the state electricity distribution companies. Each unit (Unit 1 & 2) has a configuration of 1GTG+1HRSG+1STG. Each Gas Turbine (GT) with rated capacity of 232.39 MW and each Steam Turbine (ST) 130.91 MW are installed for providing the power. Each Heat Recovery steam generator (HRSG) with rated capacity of 289 T/H is installed for recovering the heat from the exhaust by generating steam at different temperature and three pressure levels.

The combined cycle gas power station is equipped with two HRSG, two STG and two GTG along with Balance of plant is selected for conducting Energy Audit. Steps were taken to identify energy efficiency improvement areas measures and quantifiable energy saving on account of implementation of selected recommendations.

- Gap identification and analysis based on:
  - Assessment of HRSG, Gas turbine, Steam turbine & balance of plant based on data/documents collected from the plant, hot walk down survey as per the running condition of the systems.
  - Assessment of the impact of individual equipment performance's variation on overall plant working/performance.
  - Thermodynamic analysis of the unit with the help of Ebsilon® Professional
- Identification of potential areas of improvement and detailing out recommended measures for energy efficiency improvement.

Major Observations / Identified Gaps

At the time of audit unit – 1 was running in part load and unit – 2 was in base load. The focus of activities was therefore to assess the plant system and subsystem based on individual operating status. Based on audit results and gaps identified, recommendations made under short term (0 – 6 months), medium term (6 months to 2 years) and long term (> 2 years), measures. Gaps were also identified in O&M practices and recommendations in this regard were made as short term measures for improvement in energy efficiency.

Overall Performance of the Station

Description	Unit	Design	Test	
			Unit 1	Unit 2
Ambient Temperature	°C	27	33.83	30.54
Ambient Pressure	kg/cm^2 (a)	1.02	1.0044	1.0069
Relative humidity	%	77	87.8	87.8
Gross load	kW	363300	249170	343010
LHV	kJ/kg	49328	49058.3863	49058.3863
GT exhaust flow	kg/h	2217600	1716480	2189880
Fuel flow	kg/h	48270.24	35160	46070
Gross Heat rate(NCV Basis)	kJ/kWh	6299.85	6922.6	6589.1
	kcal/kWh	1505.7*	1653.4	1573.8
Gross Efficiency	%	54.94	52.01	54.65
Specific Fuel consumption	SCM/kWh	0.187	0.198	0.190

** Guaranteed Gross Heat Rate – 1565.40 kcal/kWh.*

Summary of Recommendations

Various recommendations made in this energy audit report are summarized below.

Sr. No.	Recommendations	Annual Saving (Rs. Cr)	Investment (Rs Cr)	Payback (Month)
1	Optimize the pressure drop across HP FCS	0.16	NIL	Immediate
2	Unit - 1 HP BFP recirculation arresting	0.093	0.1	13
3	Unit - 1 CEP Optimization (By reducing head loss & internal maintenance)	0.09	NIL	Immediate
3.1	Installation of VFD for Unit - 1 CEP	0.13	0.3	27
4	Unit - 2 CEP Optimization By reducing head loss & internal maintenance)	0.08	NIL	Immediate
4.1	Installation of VFD for Unit - 2 CEP	0.14	0.3	25
5	Installation of temperature control VFD in CT fan	0.18	0.14	9
6	Replacing GRP blades with FRP blades in CT Fan	0.17	0.16	11
7	Drain flow optimization of both unit	0.102	0.05	11
8	Installation of VFD for Unit – 1 LPBFP	0.015	0.045	35
8.1	Installation of VFD for Unit – 2 LPBFP	0.016	0.045	33

9	Lighting optimization (reduction of energy consumption by operation optimization of existing lighting)	0.02	Nil	Immediate
10	Maintenance of HVAC Cooling tower(to reduce running of one CT)	0.01	0.005	12
11	Installation of VFD for AHUs to optimize the energy consumption	0.007	0.015	26
12	Instrument Air Compressor optimization	0.04	Nil	Immediate
Total		**1.253**	**1.16**	**11.11**

CHAPTER- 1

INTRODUCTION

OTPC is sponsored by Oil and Natural Gas Corporation (ONGC), Infrastructure Leasing and Financial Services Limited (IL&FS) and Government of Tripura (GoT) have implemented Combined Cycle Gas Turbine (CCGT) power plant with total installed capacity of 726.6 MW (2 X 363.3 MW) at Palatana, Tripura. The plant has 2 units each of 363.3 MW (GT+ST) Capacity. Each unit consists of 1 GTG, 1 HRSG and 1 STG along with associated plant auxiliaries. Plant also includes, river water intake system, fuel supply system, plant water system, air supply system, hydrogen plant, nitrogen plant, 400 KV & 132 KV Switch Yard, Various Laboratories, etc. Each unit is equipped with 232.39 MW GE 9351FA Heavy duty Gas turbines, three pressure level HRSG and STG with capacity of 130.9 MW. The Heat Recovery Steam generator supplies HP steam, IP steam and LP steam with different pressure and temperature to Steam turbine for generating the power and utilizes the flue gas exhaust energy.

The power plant site is located at Palatana in district Udaipur in the state of Tripura. The plant is located about 12 kms from the sub-district head quarters of Udaipur and is an about 60 Kms from the capital city of Agartala. The plant is located adjacent to the existing state highway connecting to Udaipur, with onward connectivity to Agartala by NH-44. A perennial river, namely Gumti flows near the site and it is the main water source for the power plant.

The first block (363.3 MW) of the power plant was declared under Commercial Operation from 4th January, 2014 and the second block (363.3 MW) of the two blocks was declared under commercial operation from 24th March 2015. The commissioning details of the station are shown below.

Unit No.	Capacity [MW]	Date of commissioning	Date of commercial operation
1	363.3	January 2013[1]	04-01-2014
2	363.3	November 2014[2]	24-03-2015

[1] ONGC Tripura Power Plant". Power Technology. 2011-06-15. Retrieved 2015-02-27

[2] BHEL commissions second gas-based power plant in Tripura - Economic Times". Articles.economictimes.indiatimes.com. Retrieved 2015-02-27

Gas Turbine & its Control System were manufactured by GE/BHEL. Other Major Equipments like generators, Steam Turbines, HRSG, Transformers, DCS, Major pumps, HT Motors, HT Switchgears etc. were manufactured by BHEL.

Steag Energy Services India Pvt. Ltd. (STEAG), has performed the Energy Audit in 2X363.3 MW CCGT plant of ONGC Tripura Power Corporation Limited. A field visit was carried out between 08th August 2017 to 12th August 2017 and detailed audit was carried out using the audit instruments.

1.1 Plant Performance

The performance guarantees at base reference condition as per EPC contractor is shown in Table 1.1.The past plant performance of Unit No.1 & Unit No.2 was reviewed for last 4 years for which detailed energy audit was conducted. During year 2016-17 OTPC has generated 4170.28 MU with 64.81% Plant Load factor (Table 1.2). The total generation, APC and Heat rate for the last four financial years are shown in Figure 1.1, Figure 1.2 and Figure 1.3 respectively.

Table 1.1: Performance guarantee at base reference condition

Parameters	**Unit**	**Value**
Block -1 Gross power output	MW	363.3
Block -2 Gross power output	MW	363.3
Block -1 weighted average gross Heat rate	kcal/kWh	1505.7
Block -2 weighted average gross Heat rate	kcal/kWh	1505.7
Auxillary Power Consumption for entire plant	MW	24.8
NOx for each Block	ppm	50
Reference Condition		
Ambient Pressure	Bar (a)	1.0
Dry bulb Temperature	^{o}C	27
Relative Humidity	%	77
LHV	kJ/kg	49328
CW inlet temperature	^{o}C	32

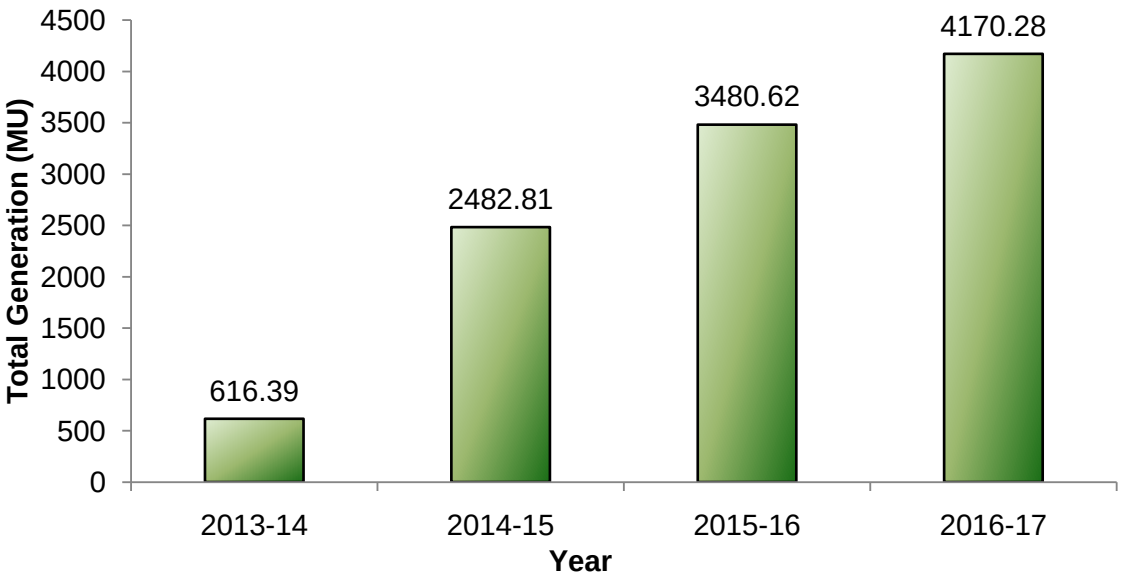


Figure 1.1: Total Station Generation

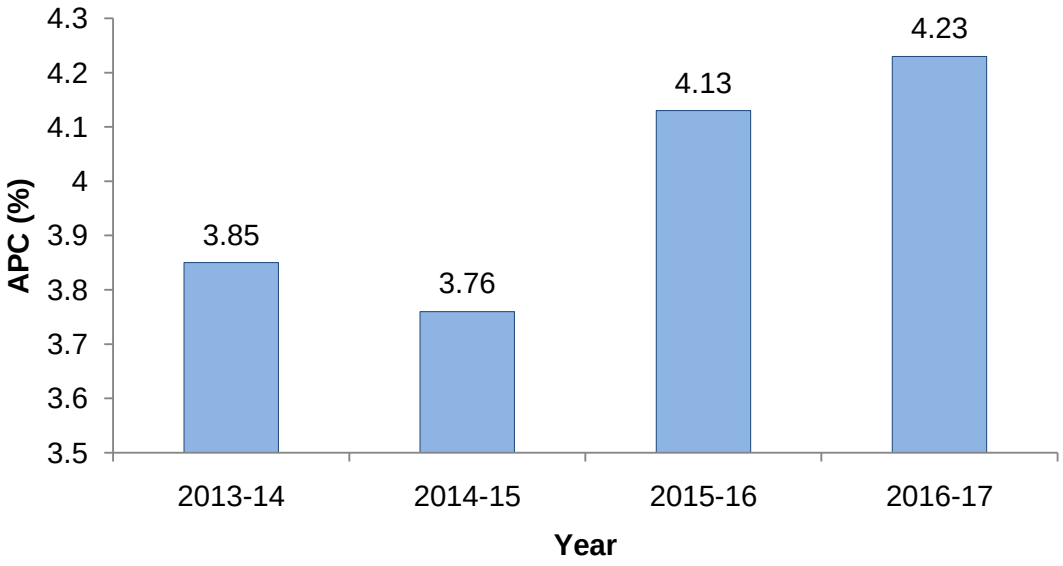


Figure1.2: Total station APC

Based on the above data, it can be seen that the APC of the plant increases from 3.76 % to 4.23 % from year 2014-15 to 2016-2017. However, the Heat rate on GCV basis has improved from1833 kcal/kWh to 1805 kcal/kWh. The overall station generation was highest in year 2016-2017 i.e. 4170.28 MU compared to last three financial years. As there is no data available for individual unit generation hence unit wise comparison is not possible.

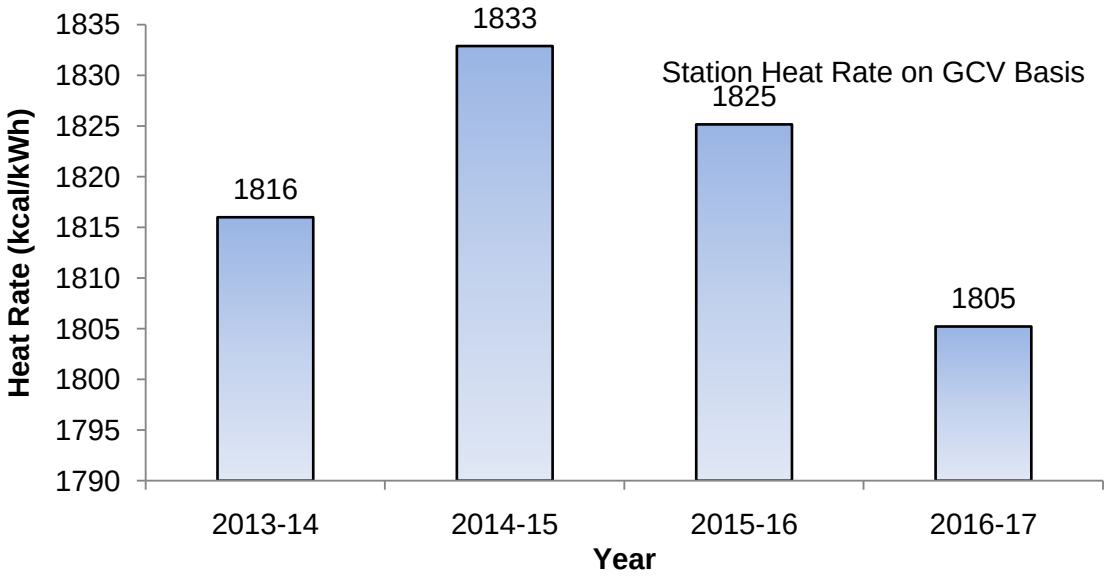


Figure 1.3: Plant Heat Rate

Table 1.2: Station performance scenario for year 2013 to 2017

Parameter	UOM	2013-14	2014-15	2015-16	2016-17
Generation	MU	616.39	2482.81	3480.62	4170.28
APC	%	3.85	3.76	4.13	4.23
PAF	%	84.96	77.29	55.74	66.39
PLF	%	81.26	79.52	54.3	64.81
MAF	%	93.24	88.30	70.63	87.40
HR on GCV	kcal/kWh	1816	1833	1825	1805

1.2 Process Description

Gross output of each GT is 232.390 MW and gross output of each STG is 130.910 MW. Plant is designed to operate only in combined cycle mode with no provision for bypass stack. HRSG is horizontal gas path type triple pressure design. STG is double casing unit with single flow high pressure/Intermediate pressure module (HP/IP Module) and double flow low pressure module (LP Module). GT generator is hydrogen cooled while ST generator is water cooled. ONGC's Fuel metering station is located within the plant boundary. Fuel Supply system consists of 3 nos. of Gas Booster compressors at site, Gas Conditioning System and fuel supply pipeline. River Water Intake system includes river water intake pump house on the Gomati river bank. A 1.8 Km long carbon steel pipeline is laid up to plant

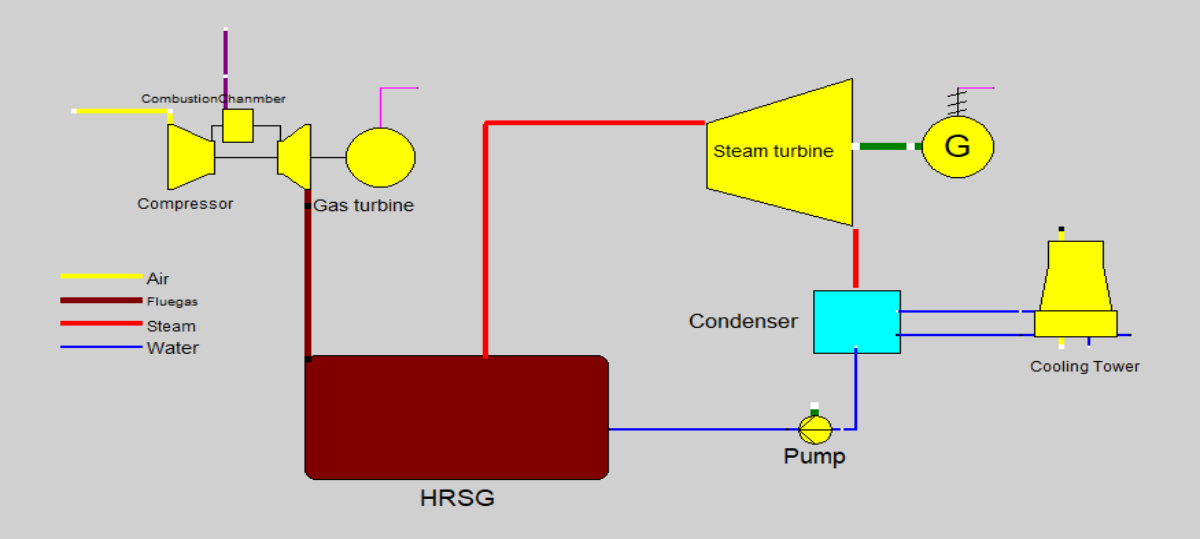
boundary and 1.5 Km long glass fiber reinforced plastic (GRP) inside the plant boundary up to raw water reservoir.

Each unit power generation cycle consists of GT compressor having 18 stage, Gas Turbine of 3 stage, 3 no's of Steam Turbine (HPT 23 stages, IPT 21 stages and LPT with 18 stages) a constant pressure De-aerator and a water cooled Surface Condenser. There are 2 nos. of Condensate Extraction Pumps (CEP), one running and one standby provided to pump condensate to De-aerator. For one unit there are 4 nos. of feed pumps consisting of two LPBFPs (1 running & 1 standby) and two HPBFPs (1 running & 1 standby).

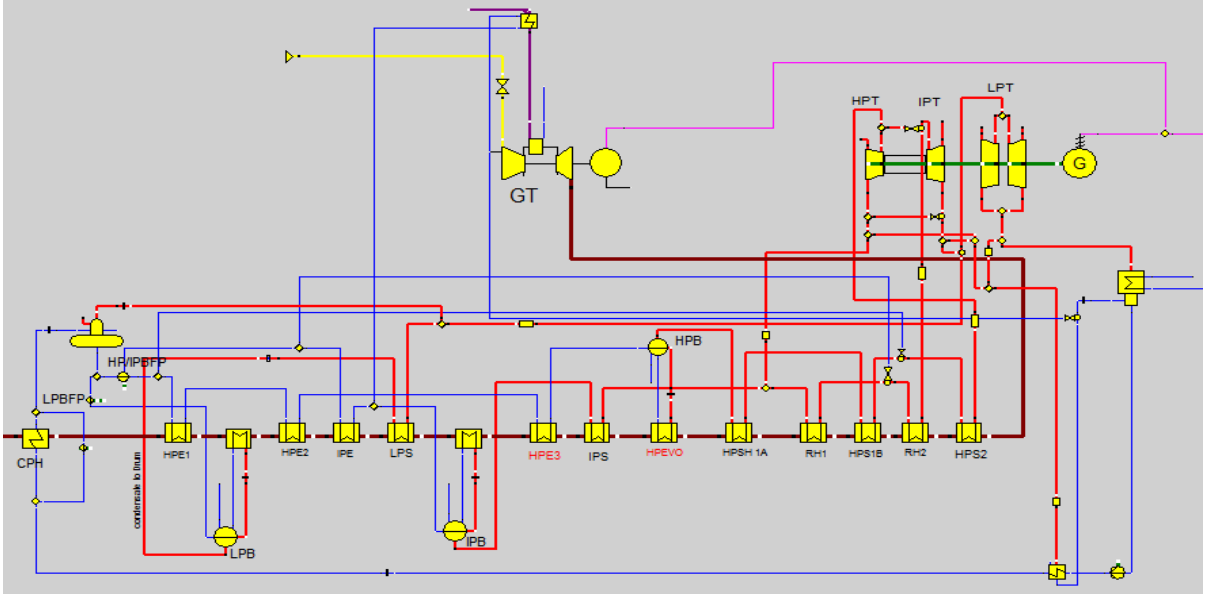
The compressed air exits through the compressor discharge casing to the combustion chambers. Combustion chamber includes the fuel nozzles, a spark plug ignition system, flame detectors. Exhaust gas from Combustor enters the three-stage turbine section and converts heat to mechanical energy. The exhaust of Gas turbine enters into HRSG section at 615°C and exits at design temperature of 103°C after giving its heat to HRSG for conversion of water to steam at different pressure levels.

The condensate from CEP discharges flows to the condensate pre-heater at the temperature of 60^{o}C for heating the condensate water before de-aerator. The design CPH inlet pressure, temperature, and flow is 25 kg/cm^2, 60°C, 444.8 TPH respectively. The same is heated in the condensate pre-heater and design outlet pressure, temperature, and flow is 25 kg/cm^2, 141.5 °C, 444.8 TPH respectively. The LP Feed water takes suction from the De-aerator Storage Tank by LP BFP. The LP BFP discharges the feed water at pressure of 10.4 kg/cm^2 and enters the LP drum. The IP feed water is extracted from intermediate stage of HP/IP Boiler feed pump and passed to the IP economizer then enters the IP Steam Drum through the feed water inlet nozzle. Natural circulation is maintained in the IP Evaporator by means of down comers. From the IP steam drum the saturated steam passes to the IP super heater. The IP main steam from the IP super heater combines with CRH from HP turbine and passes to the Re heater for further heating. HP feed water is supplied to the HP pressure section via the HP stage of the feed water pump, which extracts feed water from the De-aerator Storage Tank.

The steam after expanding through HP turbine is reheated in the re-heater at HRSG and returned to the IP turbine. Before returning to the IP turbine as HRH, addition IP steam is mixed with the CRH and heated in re heater then passes to the IP turbine. Then the reheated steam after expanding through IP and double flow stages of LP turbine is exhausted to the condensers at the exhaust part of the LPT. LP steam is also mixed with the IP exhaust and passed to the LP turbine.



(a)



(b)

Figure 1.4: (a) Block diagram, (b) Overall Process Flow Diagram

During field testing for energy audit the performance /efficiency test was carried out for GT, STG, HRSG and their auxiliaries at part load operation for Unit 1 and at full load operation for Unit 2. Flow, temperature, flue gas parameters and electrical parameters of motors were measured using digital instruments available with STEAG. Readings were also taken from OTPC instruments from panel & UCB as per the requirement. The behaviour of plant at different load conditions was studied. Name plate/design data were taken from respective sections and the performance of equipment is compared with actual operating data.

The thrust areas studied during detailed Energy Audit includes:

- Gas turbine and Compressor
- HRSG
- Steam Turbine
- Electrical System
- Pumps
- Insulation study

All these areas are critically analyzed to recommend suitable energy saving measures and are discussed in the report.

CHAPTER- 2

ENERGY AUDIT METHODOLOGY

An energy audit comprehensively will identify the degraded area in the plant system and subsystems and their respective contribution to overall thermal efficiency. Therefore these will be valuable inputs into the next inspection maintenance scope to implement the necessary corrective actions. Having established the baseline performance the energy audit can easily be extended to studying the feasibility of potential improvements to the plant. Energy Audit is a systematic search of energy conservation opportunities as well as systematic approach to measure energy consumption levels of the equipment/plant in a limited time frame by a team of energy experts.

2.1 Objective

Objective of work

- To evaluate the current level of performance of the station as well as individual Units.
- Comparing the actual performance with the reference/guaranteed performance.
  - Assessment of plant equipment/system based on data/document and field measurements, hot walk down survey and comparing different conditions of units.
  - Thermodynamic analysis of the equipment/system.
- To identify the degraded plant components and their respective contribution to overall energy efficiency loss and therefore will be valuable input into the next inspection maintenance scope to implement the necessary corrective action.
- Identification of potential areas of improvement and detailing out recommended measures for energy efficiency improvement to the level of design with application of current technologies and cost effectiveness methods.

The major objectives of conducting Energy Audit in OTPC, Tripura for GTG, STG and HRSG are to:

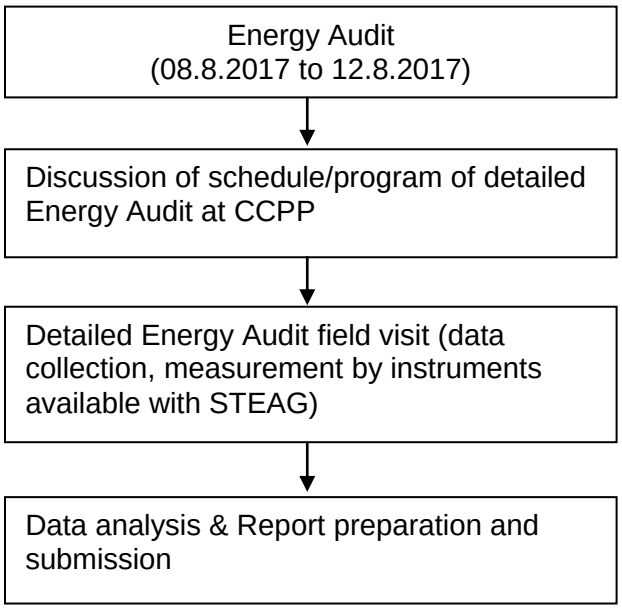
1. Study the HRSG and its Auxiliaries.
2. Study the Gas turbine and its Auxiliaries
3. Study the Steam turbine and its Auxiliaries.

4. Study the Electrical systems
5. Reduce Auxiliary power consumption
6. Improve Overall performance of power plant.
7. Reduce Specific fuel & Electrical energy consumption
8. To measure power consumption for the following major systems

   ⇒ HP/LP Feed Pumps
   ⇒ Condensate Extraction Pumps
   ⇒ CW pumps
   ⇒ Air Compressors
   ⇒ Air Conditioning System
   ⇒ Lighting System
   ⇒ CPH Pumps

2.2 Methodology

The methodology of conducting Energy Audit & Energy Conservation study at CCPP OTPC, Tripura. is given in the form of flow chart below.



The audit adopts the method of measuring field data using calibrated instruments and thermodynamic simulation based analysis to evaluate the performance of individual major components in the plant and also to assess the overall plant efficiency. The performance assessment typically applied to:

- Comparing actual performance to Design performance
- Comparing different conditions of the systems and subsystems
- Analyzing the impact of individual equipment performance's variation on Overall plant efficiency
- Assessing different retrofit or energy efficiency measures implementation options

The field measurements were carried out with calibrated instruments as per the availability of approaches at CCPP of OTPC, Tripura plant. For analysis of the collected data the standard formulas as per ASME Standards and BEE Guidelines were used.

Improvement in energy efficiency of units through EE Measures/improved O&M practices, to be made by undertaking the following steps:

- Assessment of unit based on data/documents collected from the plant
- Walk down survey
- Thermodynamic performance analysis (comparing operating parameters with design) to evaluate the current status of the plant including heat rate and other efficiency parameters of the concerned unit
- Subsequent discussions with plant personnel
- Gap identification and analysis
- Identification of potential areas of improvement
- Detailing out action plan for introduction of identified energy efficiency measures including improved O&M practices

2.3 Instruments Used

Following instruments were used for measurement during field studies of Energy audit,

1. Testo flue gas analyzer : For temperature, CO (ppm) & O_2 % of Flue Gas, excess air
2. Digital temperature indicator : For measuring the temperature at HRSG, Turbine & Condenser, Flue gas temperature. etc.

3. Hygrometer : For measuring Temperature, Humidity during the study of AHU' and Cooling tower.
4. Power analyzer - KRYKARD ALM-36 : For complete electrical Energy management (V, I, kW, kVA, KVAR, P.F., etc.) during the study of transformer, electrical motors, distribution system.
5. Portable clamp on multimeter : For measurement of V, I, kW, kVA, P.F. etc.
6. Lux meter : For measuring the illumination level.
7. Ultrasonic Flow meter : For measuring flow of water for study of Feed pump, Main condensate pump, DMCW & D.M. water pump etc.
8. Non contact infrared digital thermometer : For measuring surface temperature during insulation audit.

2.4 Data Analysis and Report Preparation

Data analysis done after the field visit includes:

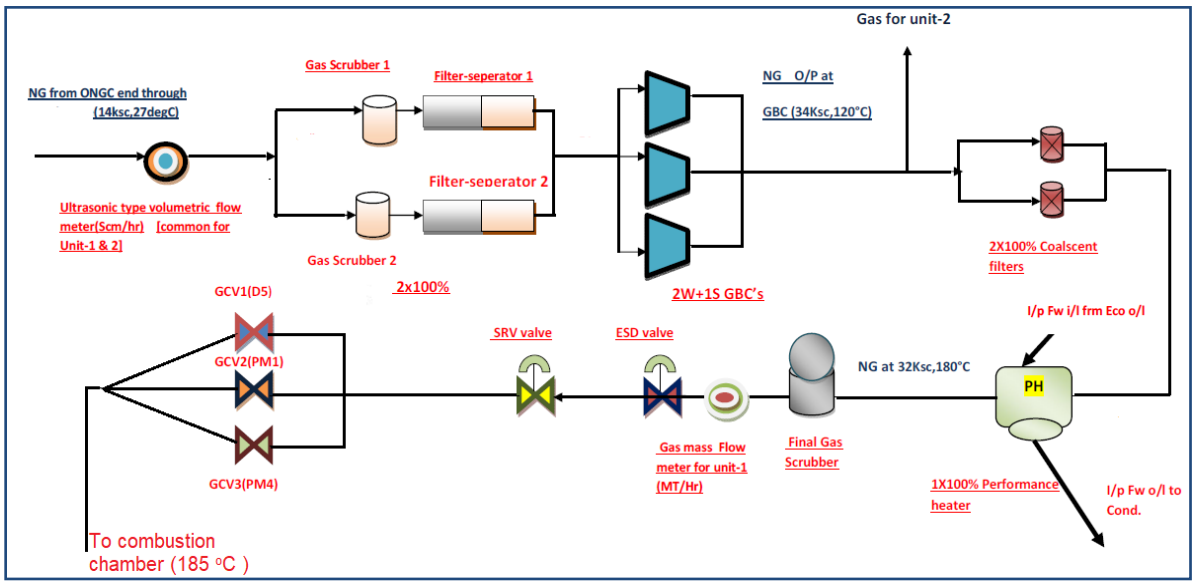
- Brain storming and search of energy saving options by Energy Audit team.
- Analysis of the measured and UCB data collected during field visit from individual equipments like HRSG, Turbines etc.
- Quantification of efficiency & associated losses in the equipment.
- Techno-Economic benefits calculations for the cost effective recommendations.

Based on the data (both designed & measured) collected from site, has been used for subsequent analysis by experts. Report has been prepared to submit to OTPC which contains measured & designed data of electrical and thermal equipment along with Recommendations & Analysis. The report also contains observations & analysis; Recommendations in thrust areas of energy conservation like HRSG, Turbine & auxiliaries, electrical system and station auxiliaries. Energy Management and Implementation plan is also provided in this report to assist OTPC, Tripura for effective energy management & smoother implementation of recommendations provided in the report.

CHAPTER- 3

NATURAL GAS SOURCE & QUALITY

ONGC supplies Natural Gas to the OTPC through a dedicated gas pipeline from the natural gas reserves located in Tripura. ONGC's Fuel metering station is located within the plant boundary. Fuel Supply system consists of 3 nos of Gas Booster compressors at site, Gas Conditioning System and fuel supply pipeline. The supplied Natural gas is properly treated in the fuel feeding system for removing sludge, liquid and other impurities before feeding into the combustion chamber. Natural Gas sample is analyzed online by chromatograph on daily basis. Below diagram shows the NG flow process from source to combustion chamber.



3.1 Design Gas Analysis

Table 3.1 depicts the gas composition at rated reference condition.

Table 3.1: Natural Gas analysis (reference condition)

Natural Gas Analysis Design (Volume)		
Description	**Unit**	**Design**
CH_4	%	96.956
C_2H_6	%	1.87
C_3H_8	%	0.409
C_4H_{10}	%	0.209
C_5H_{12}	%	0.064
C_6H_{14+}	%	0.14
N_2	%	0.216
CO_2	%	0.276

Total	%	100.14
LHV	kJ/kg	49328
H/C	ratio	3.93

3.2 NG Gas Analysis during Energy Audit

Based on Online Gas Chromatograph Report

Natural gas samples online chromatograph analysis provided by OTPC, Tripura is depicted in Table 3.2.

Table 3.2: Natural Gas analysis report (Test condition)

Description	Un Norm (%)	Norm (%)	Ideal (kcal/m^3)
Propane	0.3785	0.3775	84.783
Hidrogen Sulfide	0.0000	0.0000	0.000
IsoButane	0.1141	0.1138	33.032
Butane	0.0604	0.0602	17.539
NeoPentane	0.0000	0.0000	0.000
IsoPentane	0.0283	0.0282	10.061
Pentane	0.0000	0.0000	0.000
Hexane+	0.1424	0.1420	0.000
Nitrogen	0.3333	0.3324	0.000
Methane	96.8817	96.6124	8710.072
CarbonDioxide	0.3698	0.3688	0.000
Ethane	1.9702	1.9648	310.362
Hexane	0.0000	0.1420	60.279
Heptane+	0.0000	0.0000	0.000
Heptane	0.0000	0.0000	0.000
Octane	0.0000	0.0000	0.000
Nonane+	0.0000	0.0000	0.000
Nonane	0.0000	0.0000	0.000
Decane	0.0000	0.0000	0.000
Undecane	0.0000	0.0000	0.000
Dodecane	0.0000	0.0000	0.000
Ethane-	0.0000	0.0000	0.000
Pentane-	0.0000	0.0000	0.000
Oxygen	0.0000	0.0000	0.000
Water	0.0000	1.7407	0.000
Total	100.2787	100	9226.128

Table 3.3: Natural Gas Analysis Comparison (Design vs Test condition)

Description	Unit	Design	Actual (norm)	Deviation
CH_4	%	96.956	96.6124	0.4
C_2H_6	%	1.87	1.9648	-5.1
C_3H_8	%	0.409	0.3775	7.7
C_4H_{10}	%	0.209	0.174	16.7
C_5H_{12}	%	0.064	0.0282	55.9
C_6H_{14+}	%	0.14	0.142	-1.4
N_2	%	0.216	0.3324	-53.9
CO_2	%	0.276	0.3688	-33.6
Total	%	100.14	100.0001	

Observations and Recommendations

- ISO-6976-1995 methods have been followed for the calculation of superior calorific value and the inferior calorific value, density, relative density and Wobbe index of dry natural gas and other combustible gaseous fuels. However, ISO-6976-1995 is withdrawn by International Organization for standards and revised by ISO-6976-2016.
- The density of Natural gas is found to be 0.0444 lbm/ft^3. The same is converted into kcal/kg and found to be 0.7112 kg/m^3.
- Based on the sample report collected form plant site, it is found that inferior CV and superior CV of natural gas is 8333.6357 kcal/m^3 and 9246.2363 kcal/m^3 respectively. Based on the natural gas density the operating inferior CV and superior CV is found to be 11717.3847 kcal/kg (49058.39 kJ/kg) and 13000.5332 kcal/kg (54430.63 kJ/kg). Present report considered the inferior CV as supplied by plant for further calculation.
- The chemical components of natural gas is analyzed during energy audit and design chemical components are almost similar and the same is depicted in the Table 3.3.

CHAPTER- 4

GAS TURBINE MODULE

Each unit of OTPC, Tripura has one GTG; each capacity at base load is 232.39 MW at 27^{o}C ambient condition and 77 % relative humidity. In normal condition, the air is compressed by a compressor and passed to the combustor, there fuel is supplied from fuel feeding system and burnt in the combustion chamber. The burned high temperature fuel – air mixture passes through the turbine. A part of the work developed by the gases passing through the turbine is used to run the compressor and generate the electrical energy through the generator coupled on the same shaft of the gas turbine. Air is admitted to the Gas Turbine compressor via an inlet filter house, ducting/silencing section and air inlet valve. The heat exhaust from the GT is used in HRSG to generate steam. Steam is passed to the STG for each unit to produce Electrical Power.

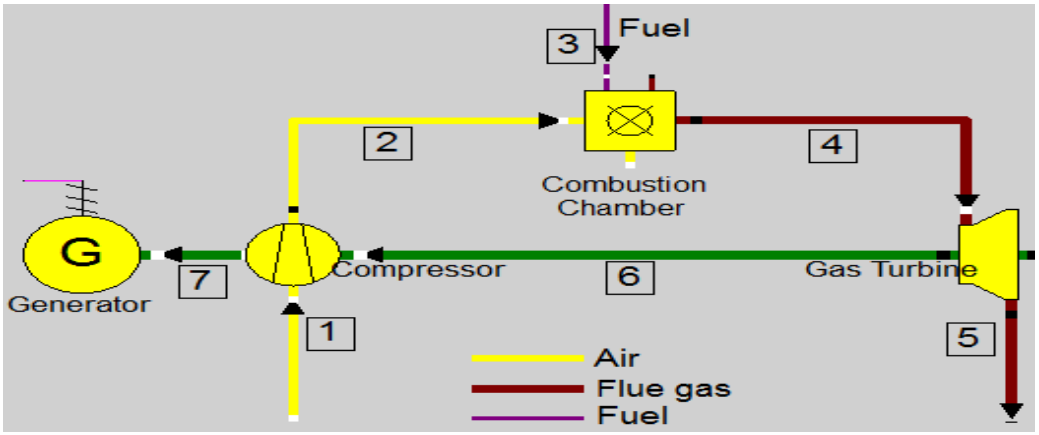


Figure 4.1: Schematic diagram of Gas turbine cycle

Figure 4.1 shows a schematic diagram of GT 9351FA machine with 100% output (232.39 MW site condition, 235.40 kW at ISO condition) at ambient temperature of 27^{o}C and air pressure at compressor inlet 1.02 at. The conversion of heat released by burning fuel into mechanical energy in a gas turbine is achieved by first compressing air in an air compressor, then injecting and burning fuel at (ideally) constant pressure, and then expanding the hot gas in the Gas turbine. The waste heat in flue gas exits from GT at temperature of 616.1^{o}C. The turbine provides the necessary power to operate the compressor. Whatever power is left is used as the mechanical output of the engine. This

thermodynamic cycle is called as Brayton cycle. To represent the physical parameters of working fluid at different state is marked as 1, 2, 3…7 as shown in Figure 4.1.

4.1 Design Specification

The design specifications of the Gas turbine are shown in Table 4.1

Table 4.1: Design Specification of Gas Turbine

Make	General Electric
Type	9351FA
Machine No.	298967,298872
Inlet Air Temperature	27°C
Inlet Air Humidity	77%
Altitude	114.9 m
Fuel	Natural Gas
ISO output with natural Gas	256900 kW
ISO heat rate with natural gas	9745 kJ/KWh
ISO exhaust flow	663 kg/s
ISO exhaust temperature	602.2 °C

Main design parameters of GT at different load are given below in Table 4.2:

Table 4.2: Comparison of Gas Turbine parameters

Description	Unit	Design				
Loading	%	100	90	80	70	60
Gas Turbine output	MW	232.99	205.3	174.9	147.9	120.6
GT exhaust flow	t/h	2217.6	1986.2	1811	1675.8	1539.8
GT Exhaust flue gas temperature	^{o}C	616.1	633.1	648.9	648.9	648.9
HRSG exhaust flue gas temperature	^{o}C	103	101	90	98	97

4.2 Gas Turbine Module Performance Evaluation

In this section, following system and subsystems have been analyzed to assess their operating condition performance, power consumption pattern and compare with reference condition. The one hour average values for calculating the performance assessment of gas turbine and compressor was taken from the DCS. During Audit the GT1 was running at part load and GT2 was running at base load. During audit equipment changeover was not performed and makeup & de-superheating was in controlled mode.

The systems includes,

- GT compressor efficiency
- GT Module efficiency & Heat rate
- Station efficiency & Heat rate
- Gas performance heater analysis
- Flue gas analysis

4.2.1 GT compressor Efficiency

The OTPC, Tripura has axial flow compressor with 18 numbers of stages. The design compression ratio is 1:16.5 and further details is provided in table 4.3

Table 4.3: Compressor Design details

Compressor Type	**Axial flow**
Number of Compressor Stages	18
Compressor Blade Attachment	Dovetail
Direction of rotation	CCW viewing towards air flow direction from compressor end
Compression ratio	1:16.5
Compressor rated speed	3000rpm
Extractions	9th and 13th stages,18th stage for IBH

The GT compressor was tested for both the unit at operating load of 149.24 MW (unit #1) and 220.55 MW (Unit #2). The compressor adiabatic efficiency was derived based on the data collected during field study and the results are shown in Table 4.4.

Table 4.4: GT Compressor efficiency

Description	**Unit**	**Design**	**Test**	
GT Compressor (Test on 09.08.2017)			Unit 1	Unit 2
GT Load	MW	232.39	149.24	220.55
Air inlet Pressure	bar (a)	1.0003	1.0044	1.0069
Air outlet Pressure	bar (a)	16.5	11.53	14.99
Air inlet temperature	°C	27	33.83	30.54
Air outlet temperature	°C	410*	378.88	415.13
DP air filter	inH2O		1.17	1.19
Pressure Ratio (P2/P1)	-	16.5	11.48	14.89
(k-1)/k	-	0.286	0.286	0.286
Efficiency	%	92.41	89.71	91.85
Air flow	kg/s	602.59	467.03	595.50

Expected Compressor Work	kW	235408.4	164372.8	233604.9
Expected Gas turbine work output	kW	496816.32	327858.17	481472.49
Percentage work required by compressor	%	47.38	50.14	48.52

**value assumed as design information is not available*

Observation and Analysis

- GT compressor efficiency as per test data is found to be 89.71% and 91.85% for unit #1 and 2 respectively. During test, unit#1 and unit #2 was operating at 149.24 MW and 220.55 MW respectively against the design load of 232.39 MW.
- The pressure ratio during test condition is calculated to be 11.48 and 14.89 respectively against design of 16.5 bar. The air flow through compressor was calculated based on the flow of GT exhaust and natural gas, for unit #1 and unit # 2 found to be 467.034kg/s and 595.50 kg/s respectively against design of 602.59 kg/s. The expected power consumption of compressor is around 45 % for unit #1 and 48 % in unit#2. This may be due to higher air temperature as compared to the design of 27^{o}C.
- As the air temperature is higher about 3 to 5^{o}C as compared to design, warm air needs more energy to compress, hence removing more work from the compressor, increasing internal losses. The work required by the compressor is increased by 2.75 % in unit 1 and 1.14% in unit 2 of the total turbine power.
- During field test compressor Inlet guide vane for unit – 1 and unit – 2 is at 60.34 DGA and 88 DGA respectively for controlling the GT power output.
- Overall performance of the compressor is found to be satisfactory.

Recommendation

- It is suggested to maintain the compressor clean by maintain GT intake air filter DP as per requirement by periodic pulsation cleaning.
- Recommended to follow the PM schedules & steps for sustaining the efficiency.

4.2.2 GT Module efficiency and Heat rate

Each Gas turbine is of 3 stages with rated shaft speed at 3000rpm. Open cycle heat rate has been calculated based on the natural gas flow and power output. Details of natural gas flow, NCV, heat rate and efficiency are shown in Table 4.5.

Table 4.5: GT heat rate

Description	Unit	Design	Test	
GT (Test on 09.08.2017)			Unit 1	Unit 2
GT Gross Load at generator terminal	kW	232390	149240	220550
Fuel flow	kg/s	13.41	9.77	12.80
LHV	kJ/kg	49328	49058.39	49058.39
GT Efficiency	%	35.14	31.15	35.13
GT Heat rate (gross)	kcal/kWh	2447.66	2761.04	2448.05
Expected Gas turbine work output	kW	496816.32	364428.73	486217.23

Observations and Analysis

- The Gas turbine module heat rate for unit #1 & 2 has calculated based on the data collected during the field visit and found to be 2761.04kcal/kWh and 2448.05kcal/kWh against design of 2447.66 kcal at ambient temperature of 27^{o}C. The GT efficiency of unit 1 &2 is found to be 31.15 % and 35.13 % against design of 35.14% respectively.
- Based on the efficiency test the unit 2 GT operates better than the unit1 GT. The poor performance of unit 1 GT is due to part load operation. The specific fuel consumption is found to be 0.33 SCM/kWh and 0.29 SCM/kWh (open cycle) for Gas Turbine 1 and Gas Turbine 2 respectively as compared with the design value of 0.29 SCM/kWh.
- The GT exhaust temperature of unit #1 and 2 is recorded as 649^{o}C and 645.36^{o}C respectively. The exhaust temperature of GT 1 is close to the expected value of 647.4^{o}C (based on thermodynamic balance), where as exhaust temperature of GT2 is expected to be 620.84^{o}C. The higher recorded value of GT2 may due to measurement uncertainty.
- Overall performance of GT is found to be satisfactory.

4.2.3 Station Efficiency & Heat rate

The combined cycle efficiency and heat rate has been calculated based on the data collected during field test. The results are depicted in Table 4.6.

Table 4.6: Overall station performance

Description	Unit	Design	Test	
			Unit 1	Unit 2
Ambient Temperature	°C	27	33.83	30.54

Ambient Pressure	kg/cm^2 (a)	1.02	1.0044	1.0069
Relative humidity	%	77	87.8	87.8
Gross load	kW	363300	249170	343010
LHV	kJ/kg	49328	49058.3863	49058.3863
GT exhaust flow	kg/h	2217600	1716480	2189880
Fuel flow	kg/h	48270.24	35160	46070
Gross Heat rate	kJ/kWh	6299.85	6922.6	6589.1
	kcal/kWh	1505.7	1653.4	1573.8
Gross Efficiency	%	54.94	52.01	54.65
Specific Fuel consumption	SCM/kWh	0.187	0.198	0.190

Observation and Analysis

- Overall combined cycle efficiency of unit 1 is calculated to be 52.01 % and unit 2 is found to be 54.65 % against design value of 54.94%. Corresponding gross heat rate based on LHV is calculated as 1653.4 kcal/kWh and 1573.8 kcal/kWh for unit #1 & 2 (against the design value of 1505.7 kcal/kWh).
- Based on the correction curve the corrected heat rate is calculated as 1617.96 kcal/kWh and 1541.36 kcal/kWh for unit 1 & 2. The operating heat rate is affected by higher ambient temperature, Relative humidity and CW temperature. Deteriorated heat rate in unit 1 is due to part load operation.
- The specific fuel consumption for unit 1 and unit 2 is calculated and found to be 0.198 SCM/kWh and 0.190 SCM/kWh against the design value of 0.187 SCM/kWh.

4.3 Flue gas analysis

Flue gas composition is measured using the Testo flue analyzer at the HRSG exhaust and the findings are depicted in Table 4.7 and Table 4.8 for both the units

Table 4.7: Measured Flue gas parameter at HRSG outlet (unit #1)

Parameter	Unit	2nd Port		3rd Port		4th port		Average
		2m	1m	2m	1m	2m	1m	
O_2	%	13.6	13.56	13.52	13.49	13.5	13.59	13.54
CO_2	%	4.19	4.23	4.2	4.24	4.2	4.2	4.21
CO	PPM	1	1	1	1	1	1	1.00
NOx	PPM	9	8	8	7	7	6	7.50
Temp	˚C	95.1	95	94.9	94.8	90.5	90.5	93.47
SO_2	PPM	0	0	0	0	0	0	0.00

Table 4.8: Measured Flue gas parameter at HRSG outlet (unit #2)

Parameter	Unit	2nd Port		3rd Port		4th port		5th port		Average
		2m	1m	2m	1m	2m	1m	2m	1m	
O_2	%	14.1	14.13	14.15	14.03	13.95	13.79	13.75	13.6	13.94
CO_2	%	3.92	3.94	4	3.95	4.2	4.1	4.2	4.2	4.06
CO	PPM	15	15	12	12	11	11	8	8	11.50
NOx	PPM	7	6	7	7	8	8	6	6	6.88
Temp	˚C	88.9	88.4	91	87.9	90	88.5	92	91.8	89.81
SO_2	PPM	0	0	0	0	0	0	0	0	0.00

During the same period the exhaust flue gas has recorded in DCS using online analyzer for unit – 1 and unit – 2. The average data for unit – 1 and unit – 2 are depicted in Table 4.9

Table 4.9: Flue gas parameters (DCS data)

Parameter	Unit	Unit – 1	Unit – 2
O_2	%	11.6	11.5
CO	PPM	1.3	12.9
NOx	PPM	19.3	17.1
Temperature	˚C	86.9	87.9
SO_2	PPM	0.1	0.2

Observation and Analysis

- The flue gas analyzer has measured at 2nd, 3rd, 4th and 5th port (unit – 2) of HRSG exhaust. Percentage of O_2 and flue gas exhaust temperature measured using Testo flue gas analyzer is nearly similar with DCS value.
- The CO measured in Unit – 2 is more than the unit – 1 CO. This may be due to Gas turbine combustor problem. Hence it is requested to check in next CI inspection.
- The CO_2 percentage is measured for unit – 1 and unit – 2 and found to be 4.21 and 4.06 respectively.

4.4 Performance gas heater analysis

The plant has installed shell and tube performance gas heater for heating the natural gas to 185^{o}C before supplying to the gas turbine. The design details of the performance gas heater is shown in the Table 4.10

Table 4.10: Performance gas heater design details

Type	TEMA "AEL"
Number of coolers	Two in series
Gas flow	51520 kg/hr
Inlet temperature of Gas	112^{o}C
Outlet temperature of Gas	190^{o}C
Operating pressure of Gas	31.4 Bar(g)
Pressure drop on Gas side	0.6 Bar
Heat Duty	2565000 kcal/hr
Heat Transfer Coefficient	302.56 kcal/Sq.m-hr-°c
Total number of tubes	358 (Per cooler)

The performance gas heater was tested for unit – 1 and unit – 2 and the results are depicted in Table 4.11.

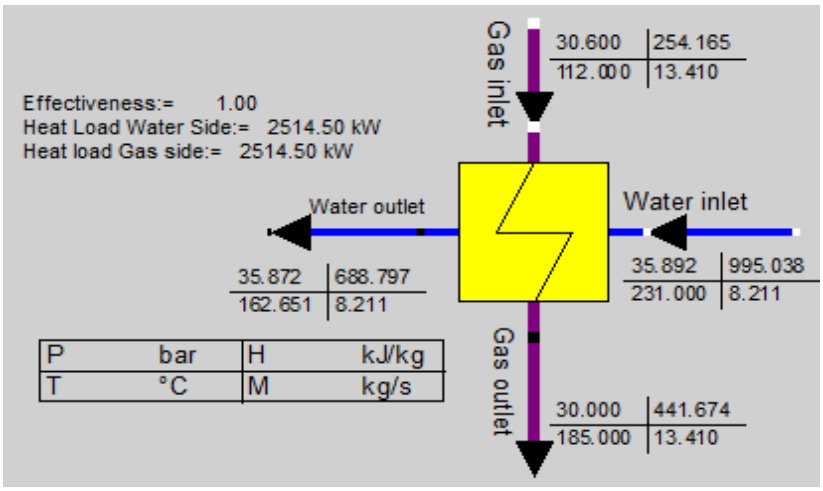
Table 4.11: Gas heater performance

Particulars	Unit	Design*	Unit – 1	Unit – 2
Gas flow	kg/s	13.41	9.77	12.80
Gas inlet temperature	ºC	112.00	135	132.55
Gas outlet temperature	ºC	185.00	187.88	181.54
∆ T of Gas	ºC	73.00	52.88	48.84
Feed water inlet temperature	ºC	231.00	225.4	233.99
Feed water outlet temperature	ºC	162.65	135.84	148.99
Feed water flow	kg/s	8.21	3.86	3.79
∆ T feed water	ºC	68.35	89.56	85

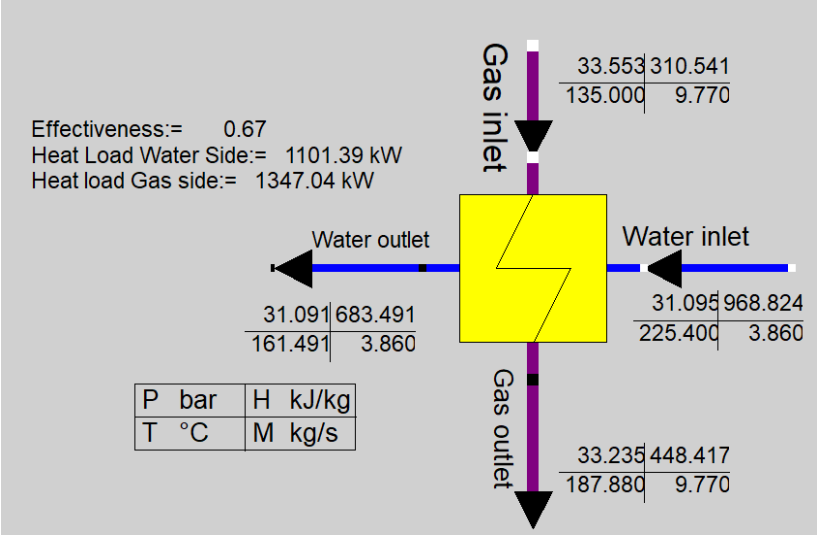
**Based on heat and mass balance diagram for 100 % load, Tamb=27 ^{o}C*

The energy and mass balance of the gas pre-heater for unit #1 & 2 is shown in the figure 4.2

Design



Unit 1



Unit 2

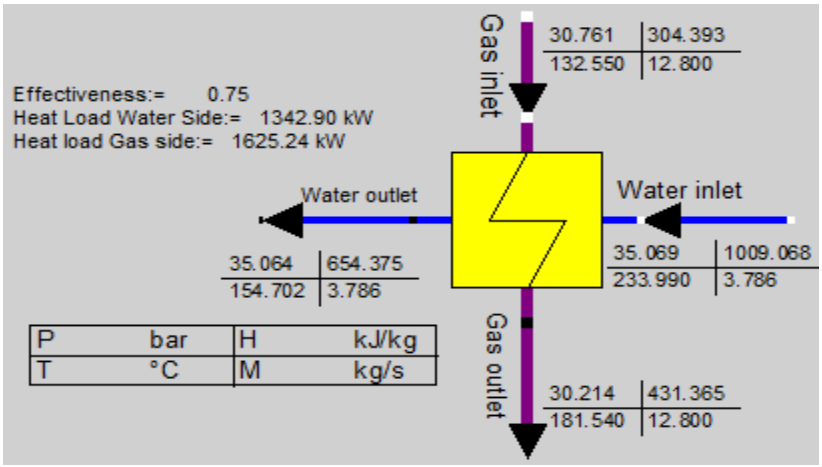


Figure 4.2: Performance heater Energy & Mass Balance

Observation and Analysis

- The gas heater is evaluated based on the data collected from site during field testing and the results are as shown in above table.
- Effectiveness of gas pre-heater is found to be 0.67 and 0.75 for unit 1 & 2 against design value of 1(considering no loss in design). This indicates the deterioration of the performance of the gas heater. Based on the data collected the feed water outlet temperature from the heat exchanger is 135. 84 ^{o}C for unit 1 and 148.99 ^{o}C for unit 2. Whereas as per mass and energy balance the calculated temperature of feed water outlet will be 161.49 and 154.72 for unit 1 & 2 respectively as shown in Figure 4.2.

- The available heat load of feed water in unit 1 heat exchanger is 1101.38 kW (947023 kcal/hr), where as the required heat load to increase the gas temperature from 135 ^{o}C to 187.88 ^{o}C is around 1347.04 kW (1158249 kcal/hr). This indicates the energy imbalance across the heat exchanger. This leads to lower effectiveness of the heater. To achieve the required balance the minimum feed water flow rate should be 5.14 kg/s, which will improve the effectiveness to 0.75. The feed water outlet temperature will be around 166 ^{o}C and the heat loss will be minimize to 1.25 kW (1075 kcal/hr). Similarly the required feed water flow in unit 2 heat exchanger should be 4.86 kg/s, with improved effectiveness of 0.82 and heat loss reduced to 3.15 kW. Feed water temperature at the outlet of heat exchanger will be around 159.2 ^{o}C.

Recommendation

- The temperature from the gauge has been considered for performance calculation of unit 1 gas Preheater and mentioned in Table 4.11.
- The drain from the gas heater is at temperature of around 140 ^{o}C and flows to the condenser and the heat energy in the heater drain is un-utilized. Hence it is suggested to pass the drain from gas heater to the deareator. Expected saving by implementing this measure is workout to be,

Parameter	unit	Unit 1	unit 2
Present condenser load	kcal/hr	122373948	137927690
proposed condenser load	kcal/hr	120514298.1	135896956.7
Percentage of saving	%	1.5	1.5
proposed energy saving in CWP	KW	28.74	27.795
Annual running hours	hrs/yr	5606.4	5606.4
power saving	kWH	161127.936	155829.888
Energy cost	Rs/kWh	2.75	3.75
Annual Energy Saving	Rs.Cr	0.044	0.058
Investment	Rs.Cr	0.025	0.025
Payback	Month	7	5

CHAPTER – 5

HRSG PERFORMANCE

HRSG is the component of bottoming steam cycle in CCPP process and it absorbs waste heat that is exhaust from the GT for producing steam at rated parameters suitable for electricity generation by STG. In a typical CCPP plant ST is selected according to the condition of the steam delivered by HRSG. Hence, HRSG performance will critically affect the closed cycle heat rate, overall system efficiency and power output. Each unit of OTPC has one HRSG of horizontal, natural circulation, water tube, top supported, fully drainable, triple Pressure with reheat type. The design detail is shown in Table 5.1 and process flow & arrangement of pressure parts/ heat exchangers are shown in Figure 5.1.

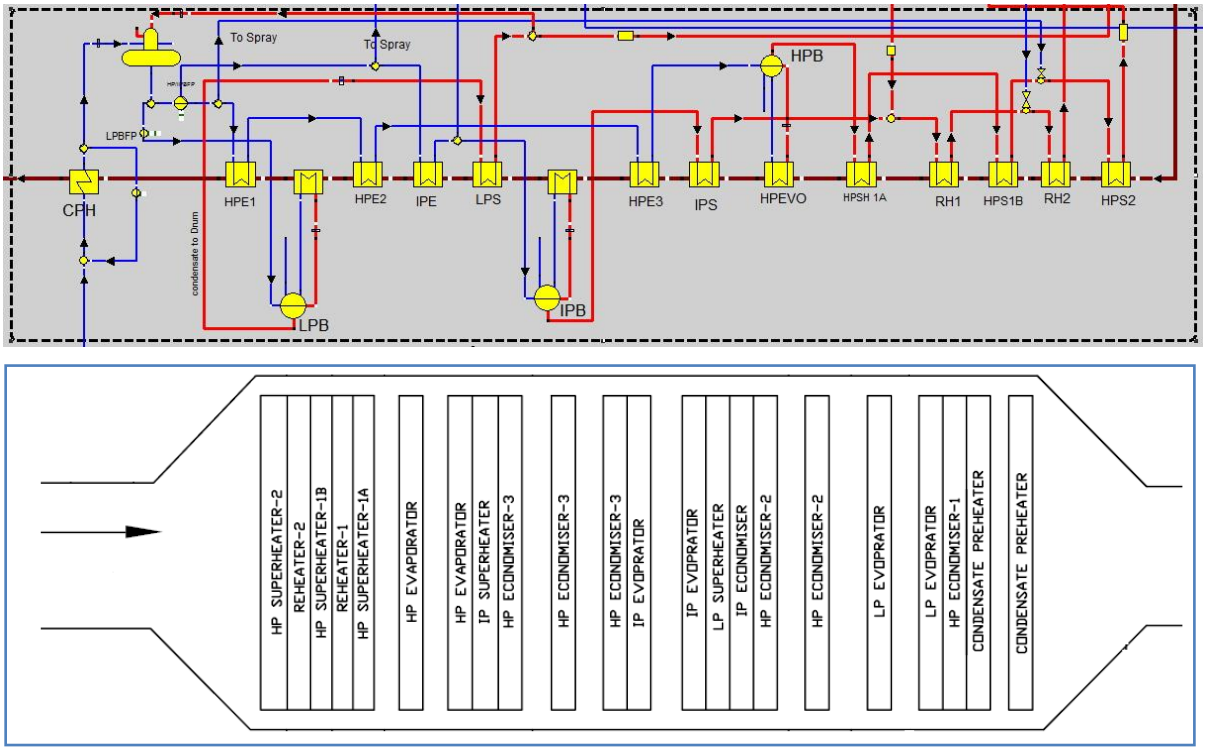


Figure 5.1: HRSG process flow and arrangement diagram

The design & actual measured parameters are taken during HRSG 1 & 2 in operation having generating capacity of 238.22 t/h and 288.3 t/h and the analysis are depicted in below sections. Actual operating parameters were taken from DCS in CCR as well as from local. Local measurement was taken for flue gas analysis using flue gas analyzer.

Temperature measurement was taken using infrared thermometer & digital temperature indicator at local.

Table 5.1: HRSG Design specification

HRSG Type	Horizontal, natural circulation, water tube, top, supported, fully drainable, modular design, triple pressure with reheat type waste heat boiler.
GT fuel	Natural Gas
HRSG fuel	Unfired
Heat source	GT Exhaust gas
Maximum Capacity	289TPH

5.1 HRSG Performance

Both the units are having one horizontal type HRSG each capacity of 289 T/h. The unit is designed to generate 130.91 MW from each steam turbine. The main operating parameters in design condition are shown in Table 5.2.

Table 5.2: critical design parameters of HRSG

Parameters	Value
HP Feed Water Pressure, temperature, flow	158 kg/cm^2,152.1°C ,289.6 TPH
HP Drum Pressure, temperature ,level	145 kg/cm^2,339°C,MWL 100mm Above CL
HP Drum Metal Temperature	339 °C
HP DESH Inlet Pressure, Temperature	139 kg/cm^2,449 °C
HP DESH Outlet Pressure, Temperature	138.5 kg/cm^2,449 °C
HP SH Metal Temperature	580°C
HP Main Steam Pressure, temperature, flow	134 kg/cm^2,540°C,289.6 TPH
CBD Pressure, Temperature, level	3.8 kg/cm^2,540°C,600mm
HPSH Spray Water Inlet Pressure, temperature, flow	91 kg/cm^2,152.1 °C,20 TPH
IP Feed Water Pressure, temperature	100 kg/cm^2,150.2 °C,65TPH
IP Feed Control Station inlet Pressure, temperature, flow	36.6 kg/cm^2,236 °C,30.8 TPH
IP Feed Control Station inlet Pressure, temperature, flow	36.6 kg/cm^2,236 °C,30.8TPH
IP Drum Pressure, temperature, level	36.6 kg/cm^2,246°C,NWL at CL
IP Main Steam Pressure, temperature, flow	34.6 kg/cm2,330°C,35.6 TPH
LP Feed Water Pressure, temperature, flow	6.6 kg/cm^2,149.6 °C,36.7 TPH
LP Drum Pressure, temperature, level	5.1 kg/cm^2,159 °C,36,NWL at CL
LP Main Steam Pressure, Temperature, Flow	4.4 kg/cm^2,230°C,36.7 TPH
RH DESH Inlet Pressure, Temperature	33.9 kg/cm^2,461°C

RH Metal Temperature	570°C
CRH Inlet Pressure, Temperature	34.8 kg/cm^2,345°C
CRH Outlet Pressure, Temperature	33.2 kg/cm^2,540°C
HRH Outlet Pressure, Temperature	33.2 kg/cm^2,540°C
RH Spray Pressure, Temperature ,flow	22 kg/cm^2,150.2°C,12TPH
CPH Inlet Pressure, Temperature, flow	65 kg/cm^2,60°C,444.8 TPH
CPH Outlet Pressure ,Temperature, flow	65 kg/cm^2,141.5 °C,444.8 TPH
HRSG Inlet Pressure, temperature, flow (flue gas)	266.71mmWC,700 °C,2217.6 TPH

During energy audit the HRSG operation was observed and HRSG operating parameters from DCS of CCR were taken for both HRSG's running at 238.22 t/h (HRSG-1) and 288.3 t/h (HRSG-2) is presented in this report. Local measurements were also taken to measure flue gas parameters, temperature at various locations so as to estimate the HRSG efficiency. The thrust areas covered in this chapter including observations and analysis are:

- HRSG Efficiency
- Condensate Pre-heater performance
- LP circuit performance
- IP circuit performance
- Re-heater circuit performance
- HP circuit performance
- Observation & analysis

5.1.1 HRSG Efficiency

HRSG efficiency is calculated by both direct and indirect method with a steam generating rate of 238.22 t/h and 288.3 t/h in unit 1 & 2. The calculation is performed based on design & actual data collected during field testing is presented in Table 5.3.

Table 5.1: HRSG efficiency (a) Direct Method (b) Indirect method

(a)

Description	**Unit**	**Design**	**Test**	
Direct Method (Input/output)			HRSG-1	HRSG-2
HRSG inlet flow	kg/s	616.00	476.8	608.3
Energy input	kW	424430.16	347115.1	423169.98
Energy Out	kW	67310.14	50639.5	69005.55

Energy Used	kW	357120.02*	296475.7	354164.43
HRSG efficiency	%	84*	85.41	83.69

**Design details are calculated based on the design data available in technical diary and heat balance diagram.*

(b)

Description	Unit	Design	Test	
Indirect method (loss)			HRSG 1	HRSG 2
HP steam Flow	t/h	289.6	238.22	288.3
HP steam Enthalpy	kcal/kg	821.8	830.63	823.44
IP steam Flow	t/h	35.6	27.72	36.29
IP steam Enthalpy	kcal/kg	730.25	709.45	729.83
LP steam Flow	t/h	36.7	28.4	36.75
LP steam Enthalpy	kcal/kg	696.9	696.76	699.46
FW temp at HP BFP Outlet temp	°C	152.1	143.74	149.42
FW temp at IP BFP Outlet temp	°C	150.2	142.39	147.75
FW temp at LP BFP Outlet temp	°C	149.5	149.5	144.44
HRSH inlet temperature	°C	615.1	649.06	622.15
HRSG outlet temperature	°C	103	97.49	97.79
Flue gas flow rate	t/h	2217.6	1716.48	2189.88
HRSG efficiency	%	84*	79.32	82.65

**Design details are calculated based on the design data available in technical diary and heat balance diagram.*

Observation and Analysis

- HRSG-1 & 2 efficiency is evaluated both by direct method and loss method. The operating efficiency of HRSG by loss method is found to be 79.32 % and 82.65 % against design of 84%. There is deviation between both method of calculation (6.09% & 1.05 % for HRSH 1& 2 respectively) and it may be due to heat losses in the pressure parts and measurement uncertainty. It can be observed that the HRSG efficiency in full load condition is matches from both side calculation (I,e by direct and loss method) where as there is a large deviation in part load fraction.

5.1.2 Condensate Pre-heater performance

The condensate from CEP discharge flows to the condensate pre-heater at the temperature of 60^{o}C for heating the condensate water before deaerator. The critical parameters CPH inlet pressure, temperature, flow is 65 kg/cm^2, 60°C, 444.8 TPH. The same is heated in the condensate pre-heater and Critical outlet pressure, temperature; flow is 65 kg/cm^2, 141.5 °C, 444.8 TPH. The condensate pre-heater is serrated finned tubes type with the heat

transfer surface area of 38789.6 m^2. A portion of the water from the Pre-heater outlet is taken to the Pre-heater Recirculation Pump suction. It then is being re-circulated and mixed with the feed water entering the Pre-heater inlet to increase the temperature of the incoming feed water prior to entering the deaerator. The condensate pre-heater circuit and flue gas circuit performance is provided in Table 5.4.

Table 5.2: Condensate pre-heater circuit

Particulars	Unit	Design	Unit 1	Unit 2
Water circuit				
CPH inlet flow	TPH	385.765	332.50	375.00
CPH input temperature	°C	60.00	59.76	60.00
CEP outlet pressure	kg/cm^2	25.0	24.31	22.97
CPH input energy	kcal/sec	6429.75	5519.50	6250.00
CPH output temperature	°C	141.50	135.53	143.19
Dearator pressure	kg/cm^2	4.79	3.66	4.09
CPH output energy	kcal/sec	15163.49	12517.70	14915.63
Energy gain in CPH	kcal/sec	8733.74	6998.20	8665.63
Flue gas circuit				
HRSG outlet temperature	°C	103.00	89.50	89.81
flue gas flow into HRSG	kg/sec	616.00	476.80	608.30
Specific Heat of flue gas	kcal/kg	0.28	0.28	0.28
Flue gas temperature at pre-heater inlet	°C	159.71	148.21	146.79

5.1.3 LP circuit performance

LP feed water from the suction of deaerator is discharged at a pressure of 10.4 kg/cm^2 by LP BFP to the LP drum. Rated LP feed water inlet pressure, temperature & flow is 6.6 kg/cm^2, 149.6°C, 36.7 TPH. The LP drum operates at pressure of 5.1 kg/cm^2. Design LP main steam parameters at out of HRSG is 4.4 kg/cm^2, 230°C and 36.7 TPH. The performance of LP circuit is provided in Table 5.5.

Table 5.3: LP circuit

Particulars	Unit	Design	Unit 1	Unit 2
LP feed water flow	t/h	36.7	28.17	23.566
LP feed water press	kg/cm^2	10.4	19.04	18.26
LP feed water temp	°C	149.5	140.09	144.6
Enthalpy of LP feed water	kcal/kg	150.7	141.0534	144.6
Energy from LP FW	kcal/sec	1536.303	1103.743	946.5677
LP Drum pressure	kg/cm^2	5.10	3.67	4.71
LP Saturation temperature	°C	151.85	139.84	148.87

LP main steam flow	tph	36.7	28.17	35.78
LP Steam Press	kg/cm^2	4.8	3.66	4.2
LP Steam Temp	°C	229	228.27	234.64
LP Steam Enthalpy	kcal/kg	696.9	697.77	700.414
Energy from LP steam	kcal/sec	7104.508	5460.05	6961.337
Energy gain from LP circuit	kcal/sec	5568.206	4356.307	6014.769
Approach	°C	2.246	-0.247	4.273

5.1.4 IP Circuit performance

The intermediate pressure (IP) feed water from intermediate stage of HP/IP- BFP at pressure of 43.60 kg/cm^2 enters the IP Drum through the IP Economizer (IPE). For fuel heating IP water tapping is taken from IPE inlet. Natural circulation is maintained in the IP Evaporator by means of down comers, which feed the water from the drum through distribution manifolds to the lower evaporator headers. The saturated steam from IP super heater mix with HP turbine exhaust steam and passes to the two re-heater stages for further heating before being expanded in IP turbine (IPT). The performance of the IP circuit is provided in Table 5.6.

Table 5.4: IP circuit

Particulars	Unit	Design	Unit 1	Unit 2
IP feed water flow	tph	65.159	25.83	44.03
IP feed water press(eco)	kg/cm^2	43.60	47.52	70.31
IP feed water temp(eco)	°C	150.2	142.39	147.75
Enthalpy of IP feed water	kcal/kg	151.7	143.84	149.658
Energy of FW	kcal/sec	2745.73	1032.03	1830.4
IP Drum pressure	kg/cm^2	36.60	31.3	36.90
IP Saturation temperature	°C	244.01	236.95	246.04
IP main steam flow	tph	35.8	13.69	36.29
IP Steam Press	kg/cm^2	36.6	27.95	33.77
IP Steam Temp	°C	246	288.43	327.95
IP Steam Enthalpy	kcal/kg	730.2	710.16	729.79
Energy from IP steam	kcal/sec	7261.43	2700.57	7356.689
Energy gain from IP circuit	kcal/sec	4515.71	1668.55	5526.288
IP feed water temperature from IP ECO	°C	231	225.4	233.99
Approach	°C	13.01*	11.549	12.049

**Design approach is calculated based on the design data available in technical diary and heat balance diagram.*

5.1.5 HP Circuit performance

HP feed water from HP/IP pump at a pressure of 158 kg/cm^2 and temperature of 152.1^{o}C is supplied to the HP drum via series of HP economizers (HPE) viz HPE1,HPE22 & HPE3. The saturated steam leaving the drum passes through series of HP super-heater (HPS) viz, HPS1A, HPS1B and HPS2 before being expanded in high pressure turbine (HPT) at a rated pressure and temperature of 134 kg/cm^2 and temperature of 540^{o}C. The performance of the HP circuit is provided in Table 5.7.

Table 5.5: HP circuit

Particulars	Unit	Design	Unit 1	Unit 2
HP feed water flow	tph	289.6	217.24	281.2
HP feed water press(eco)	kg/cm^2	158	125.73	141.9
HP feed water temp(eco)	°C	152.1	143.74	152.35
Enthalpy of HP feed water	kcal/kg	155.5	146.40	155.415
Energy of FW	kcal/sec	12509.11	8834.34	12139.63
IP Drum pressure	kg/cm^2	145.00	114.23	137.50
IP Saturation temperature	°C	151.85	139.84	148.87
HP main steam flow	tph	289.6	238.22	288.3
HP MS press	kg/cm^2	135	103.35	125.96
HP MS Temperature	°C	540	540.75	540
Enthalpy of HP MS	kcal/kg	821.8	830.55	824.5
Energy from HP MS	kcal/sec	66109.24	54959.34	66028.71
Energy gain from LP circuit	kcal/sec	53600.13	46124.99	53889.07

5.1.6 Re-heater Circuit performance

IP steam mix with CRH steam passes through Re heaters (RH1 & RH2). The reheated steam at a pressure of 34.2 kg/cm^2 and temperature of 540 °C leaves HRSG. The performance of the Re heater circuit is provided in table 5.8.

Table 5.6: CRH circuit

Particulars	Unit	Design	Unit 1	Unit 2
CRH flow	tph	269.45	238.22	288.30
CRH pressure	kg/cm^2	35.85	28.60	33.75
CRH temperature	°C	347.5	362.00	350.00
Enthalpy of CRH	kcal/kg	740.30	751.93	742.61
Energy of CRH	kcal/sec	55408.37	43467.64	52180.52
IP feed water flow	tph	65.16	25.83	44.03
IP feed water press(eco)	kg/cm^2	0.00	47.52	70.31

IP feed water temp(eco)	°C	0.00	142.39	147.75
Enthalpy of IP feed water	kcal/kg	151.70	143.84	149.66
Energy of FW	kcal/sec	2745.73	1032.03	1830.40
HRH pressure	kg/cm^2	33.30	27.68	31.98
HRH temperature	°C	540	540.89	536.50
Enthalpy of HRH	kcal/kg	846.00	848.33	844.99
Energy of HRH	kcal/sec	71732.58	52266.55	67892.92
Total energy into Re heater	kcal/sec	58154.10	44499.67	54010.92
Energy gain from Re heater	kcal/sec	13578.48	7766.89	13882.00

5.1.7 Flue gas performance

The flue gas exhaust from the gas turbine at the temperature around 630 deg passes through the Heat Recovery steam generator for utilizing the heat for generating the power through steam turbine. The performance of flue gas is provided in Table 5.9.

Table 5.7: Flue gas circuit

Particulars	Unit	Design	Unit 1	Unit 2
HRSG inlet temperature	°C	616.1	649.06	622.15
HRSG outlet temperature	°C	103	89.50	89.81
flue gas flow into HRSG	kg/sec	616	476.80	608.3
Specific Heat of flue gas	kcal/kg	0.25	0.25	0.28
Energy From Flue gas	kcal/sec	79017	66700	90670
Input energy to HRSG	kcal/sec	94879	77368	109920
output energy from HRSG	kcal/sec	15862	10668	15297
Energy utilized from flue gas	kcal/sec	79017	66700	94623

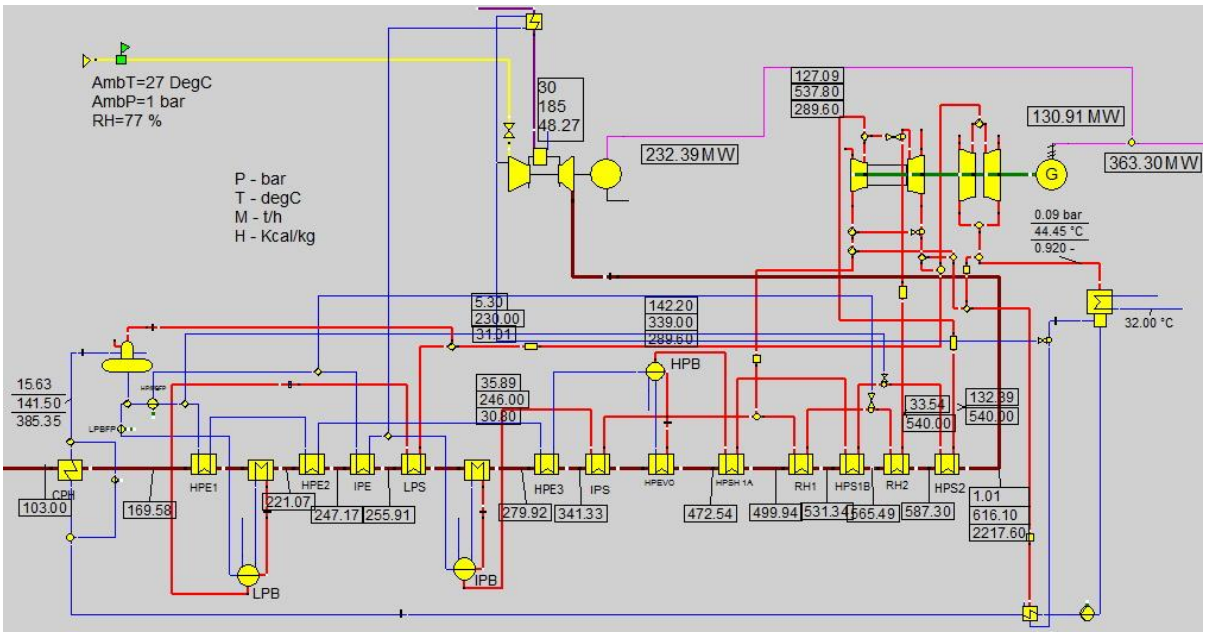
Observation & Analysis

- The energy gain in the condensate pre-heater is found to be 6998.20 kcal/sec and 8665.63 kcal/sec for unit -1 and unit –2 respectively with respect to the design value of 8733.74kcal/sec. The unit – 1 heat gain is lower side due to part load operation.
- Based on the flue gas outlet condition, the inlet flue gas temperature to CPH would be around 148.21°C and 146.79°C respectively for unit 1 and unit 2. However, the design would be around 159.71°C.
- The approach of LP circuit is calculated for both design and test condition and it shows that design approach is around 2.246°C, however unit 2 approach is 4.273°C.

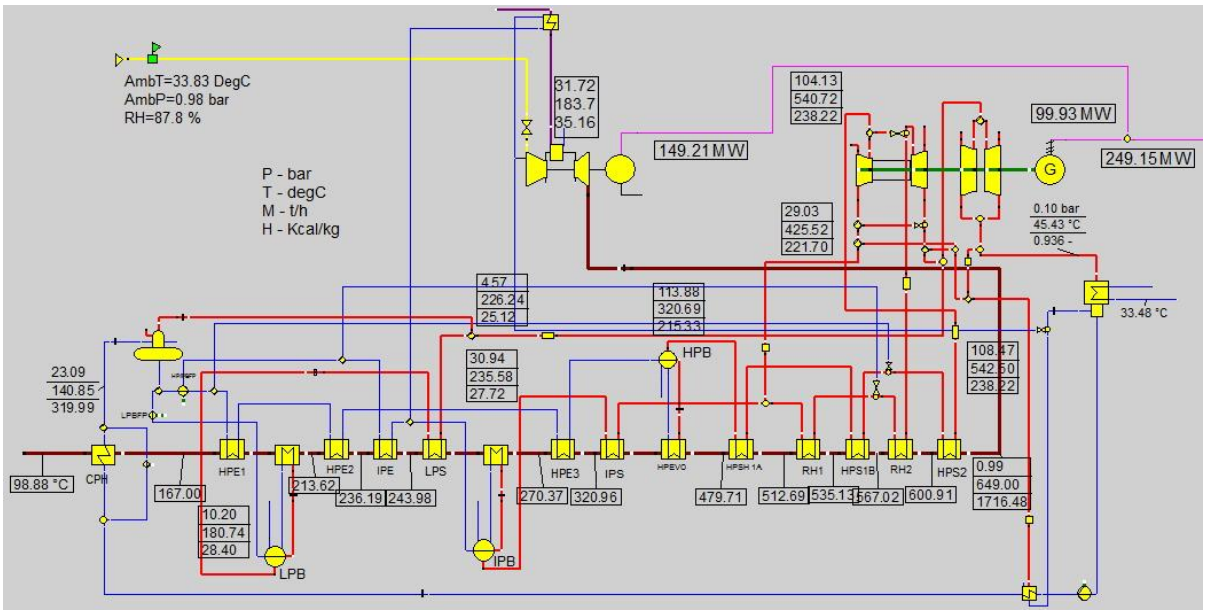
This shows that LP feed water inlet temperature that flow to the LP drum should be more to achieve the design approach.

- The LP circuit approach for unit – 1 is -0.247 and is not possible. Hence it is recommended to calibrate the temperature measurement equipments.
- The pinch is not calculated due to the non availability of temperature in flue gas side.
- The energy gain in both LP circuit and IP circuit is higher than the design for unit – 2. This shows that heat transfer in LP evaporator, super heater and IP economizer, evaporator and super heater is better.
- However, the energy gain in HP and Re-heater circuit is lower than the design value.
- To calculate the approach, pinch and details performance of HRSG, it is recommended to install temperature meter and pressure gauge.

Overall mass and energy balance diagram generated in Ebsilon® Professional platform is shown in figure 5.2, for both design and operating scenario. The flue-gas temperature profile is generated based on the design information and recorded water/steam side temperature measurements.



(a)



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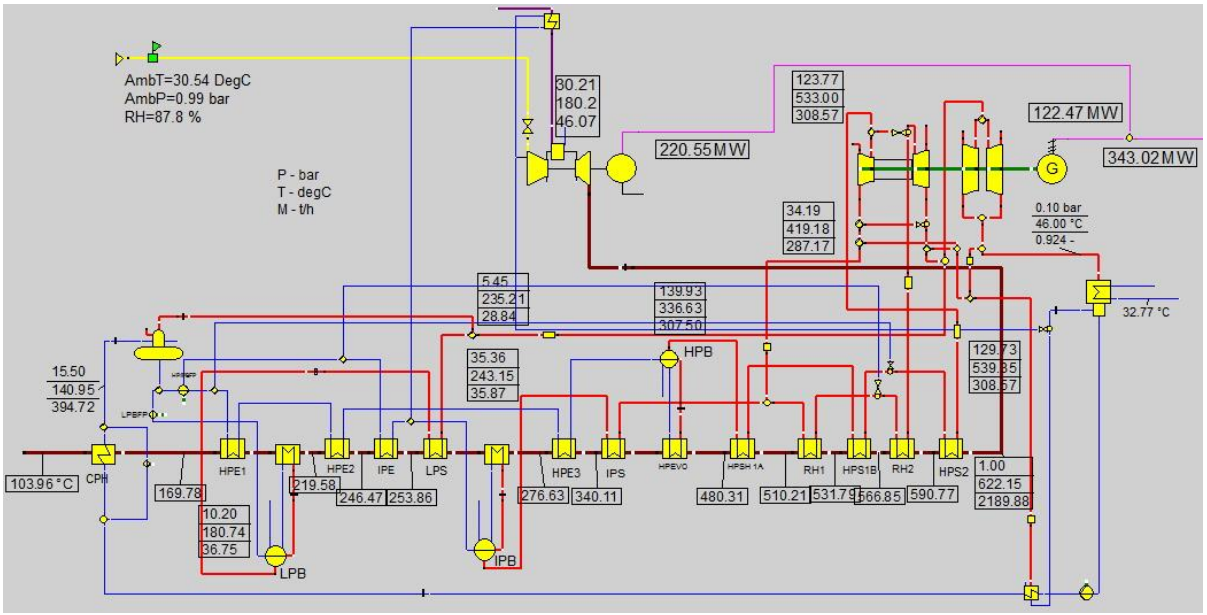


(c)

Figure 5.1: Overall mass and energy balance diagram (a) design, (b) Unit1 operating & (c) Unit 2 operating

CHAPTER- 6

TURBINE & CONDENSER PERFORMANCE

The power station consists of 2 nos of 130.91 MW capacity individual STGs connected to each HRSG. The running capacity of steam turbine is based on the steam supplied from the HRSG. In other words, the running capacity of steam turbine will directly depend on the gas turbine loading and GT flue gas exhaust.

6.1. Design Specification

The station is equipped with (2 X 130.91 MW) of two cylinders reheat condensing turbine to generate additional power by utilizing the flue gas. The steam after expanding through HP turbine (HPT) is reheated in the re-heater returned to the IP turbine (HPT). Then the reheated steam after expanding through IP and double flow stages of LP turbine is exhausted to the condensers at the exhaust part of the LPT. Additional LP steam is also mixed with the IP exhaust and passed to the LP turbine. The design details of the turbine are shown in Table 6.1.

Table 6.1: Design details of Turbine

Design Details	
Manufacturer	BHEL, Hyderabad
Type	Two cylinder reheat condensing turbine
No of Casings	2
Nominal HP steam temperature, pressure	540 °C,129.6 kg/cm^2
Nominal IP steam temperature, pressure	540 °C,34.2 kg/cm^2
Nominal LP steam temperature, pressure	261.2 °C,4.48 Kg/cm^2
HP Turbine stages	23 stages single flow
IP turbine stages	21 stages single flow
LP turbine stages	18 stages, dual flow
Rated Steam temperature, pressure HPT inlet	537.8 °C, 129.6 kg/cm^2
Before 1st HP drum stages pressure	126.8 kg/cm^2
HP cylinder exhaust temperature, pressure	347.3 °C, 35.85 kg/cm^2
IP cylinder stop valve inlet temperature, pressure	539.6 °C, 33.30 kg/cm^2
LP turbine inlet temperature, pressure	281.2 °C, 4.80 kg/cm^2
LP turbine exhaust pressure	0.095 ata

**As per plant personal, however, based on technical diary the value is different*

Parameters comparison at different load of design condition is given below in Table 6.2:

Table 6.2: Comparison of Turbine parameters

Description	Unit	Design				
Loading	%	100	90	80	70	60
Steam Turbine output	MW	130.91	121.8	115.5	106.5	97.5
HP inlet steam flow	t/h	289.6	270.6	257.4	237.8	218.2
IP Inlet steam flow	t/h	289.8*	285.779	272.896	252.67	233.102
LP Inlet steam flow	t/h	354.33	327.507	308.974	284.865	261.584
HP steam pressure	ata	129.6	121.44	115.7	107.2	98.66
IP steam pressure	ata	33.3	31.21	29.8	27.8	25.47
LP steam pressure	ata	4.8	4.44	4.18	3.86	3.54
Condenser vacuum	ata	0.095	0.0907	0.0877	0.0841	0.0807

**As per plant personal, however, based on HMBD the IP steam flow is 305.045*

6.2 Turbine Performance Evaluation

In this section, following system and subsystems have been analyzed to assess their operating condition performance, power consumption pattern and compare with reference condition. The one hour's average values for calculating the performance assessment of turbine and condenser has taken from the DCS.

The systems includes

- Turbine efficiency
- Water steam cycle efficiency and heat rate
- Turbine pressure survey
- Condensers
- Specific steam consumption

6.2.1 Turbine Efficiency

The rated output of the generator is 130.91 MW with main steam entering in the HPT with 129.60 kg/cm^2 (a) pressure and 537.8^{o}C temperature. Steam pressure and temperature at the inlet of IPT is 33.30 kg/cm^2(a) and 539.6 ^{o}C and at LPT inlet 4.80 kg/cm^2(a) & 261.2^{o}C. The HP, IP and LP turbine cylinder efficiency is computed based on the data collected during field study and the results are shown in Table 6.3.

Table 6.3: Turbine operating efficiency

Parameter	Unit	Design*	Unit 1	Unit 2
ST Load	MW	130.91	99.93	122.46
HP Turbine				
HPT inlet steam pressure	kg/cm^2 (a)	129.6	104.4	126.2
HPT inlet steam Temperature	°C	537.8	540.75	533.00
HPT inlet steam enthalpy	kcal/kg	821.8	829.86	819.7
HPT exhaust steam pressure	kg/cm^2 (a)	35.85	29.6	34.86
HPT exhaust steam Temperature	°C	347.3	362.00	350.00
HPT exhaust steam enthalpy	kcal/kg	740.3	751.446	742.08
HP turbine efficiency	%	89.1	85.28	87.72
HP shaft power	MW	26.1	20.52	24.19
IP Turbine				
IPT inlet steam pressure	kg/cm^2 (a)	33.3	28.68	32.98
IPT inlet steam Temperature	°C	539.6	540.89	537.87
IPT inlet steam enthalpy	kcal/kg	846	847.79	845.18
IPT exhaust steam pressure	kg/cm^2 (a)	4.88	3.64**	4.49**
IPT exhaust steam Temperature	°C	264.5	256.91**	256.09**
IPT exhaust steam enthalpy	kcal/kg	714.6	711.79	710.74
IP turbine efficiency	%	95.8	93.2	95.3
IP shaft power		49.19	41.12	47.77
LP Turbine				
LPT inlet steam pressure	kg/cm^2 (a)	4.8	3.97	4.56
LPT inlet steam Temperature	°C	261.2	227.09	234.64
LPT inlet steam enthalpy	kcal/kg	713.1	696.84	700.04
LPT exhaust steam pressure	kg/cm^2 (a)	0.095	0.1	0.103
LPT exhaust steam Temperature	°C	44.5	47	47.05
LPT exhaust steam enthalpy	kcal/kg	571.2	576.65	566.92
LP turbine efficiency	%	89.1	83.0	88.8
LP shaft power		57.72	46.69	56.54

**Design efficiency has calculated based on HMBD data,*

**As operating condition data was not available hence the same has been generated from the ebsilon model and validated using the curve fit from the HBD data.

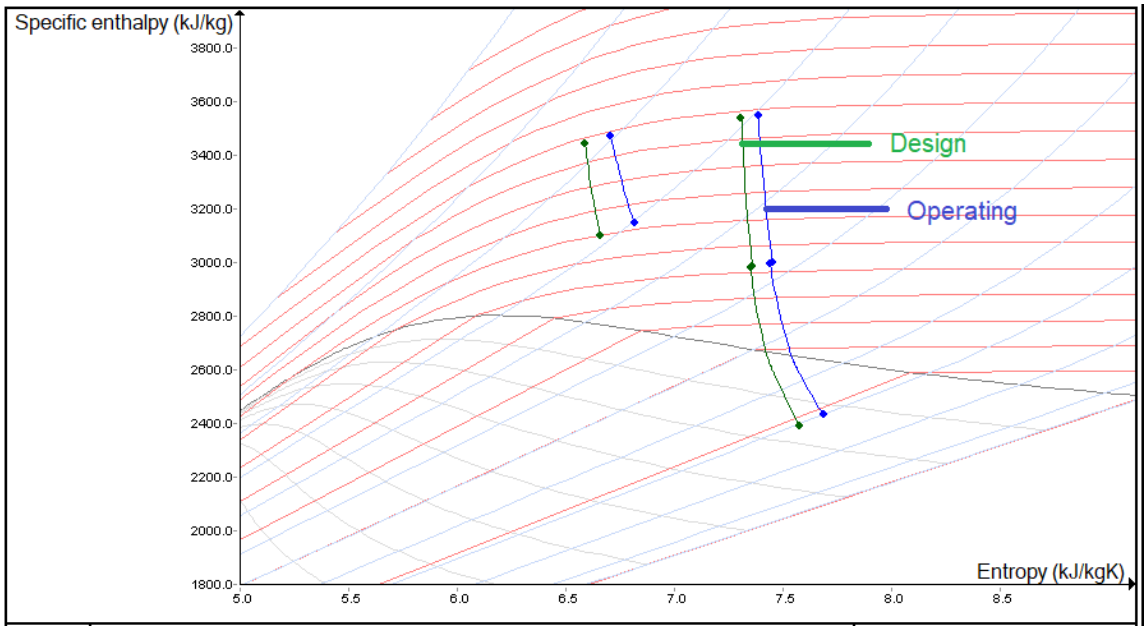


Figure 6.1: h-s diagram of turbines for unit – 1

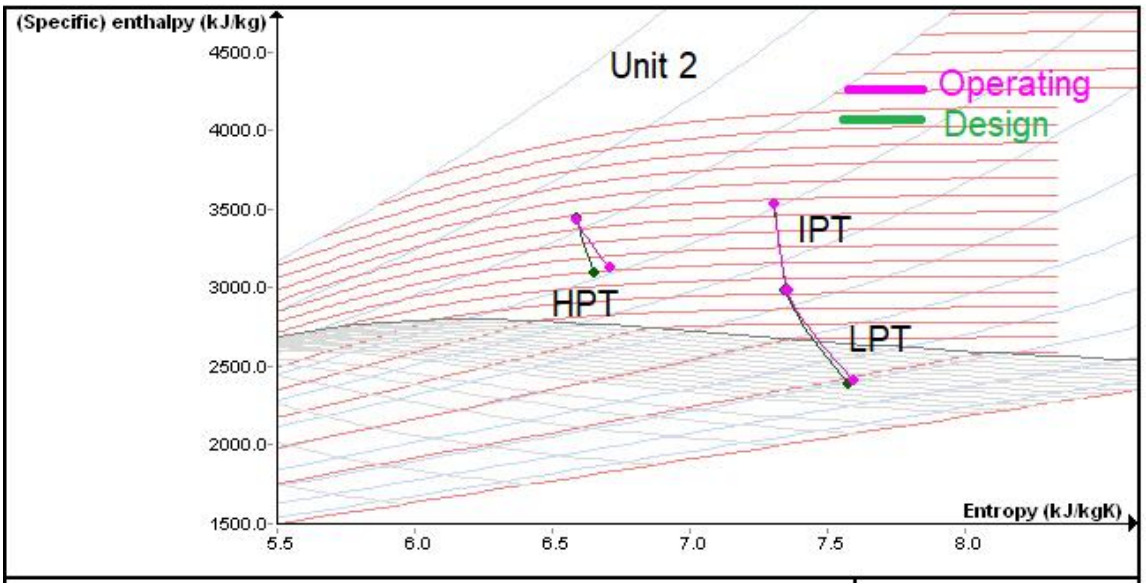


Figure 6.2: h-s diagram of turbines for unit – 2

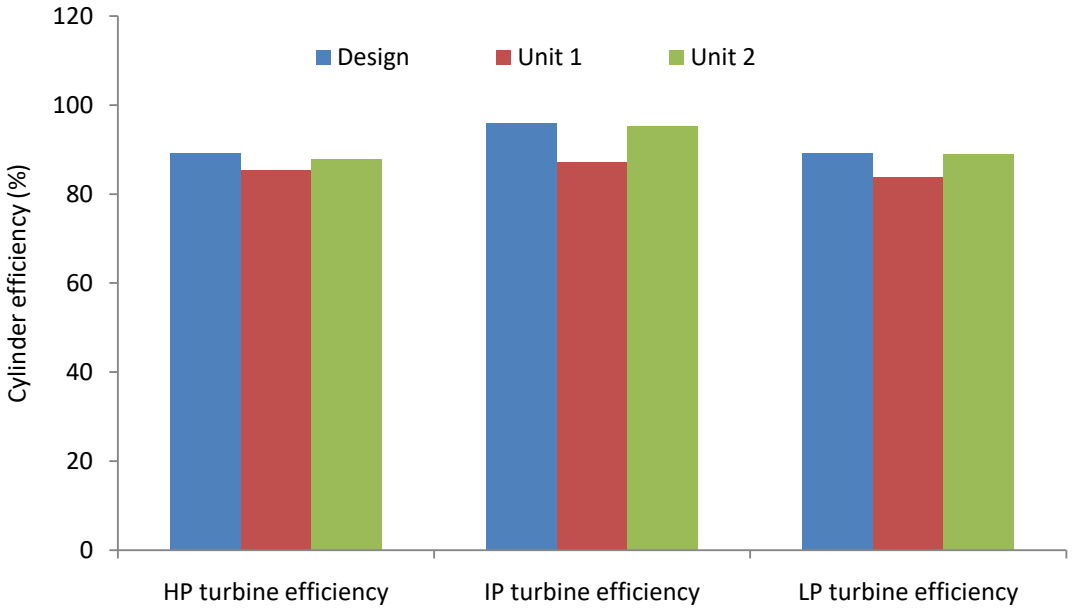


Figure 6.3: Steam turbine cylinder efficiency comparison

Observation and Analysis

- HP, IP and LP Turbine cylinder efficiency as per test data is found to be 85.28%, 93.2 % and 83.0% for unit #1 against the design value of 89.1%, 95.8% and 89.1% respectively. The unit #1 ST generation is 99.93 MW. The h-s diagram is shown in figure6.1. This shows there is a deviation occurring in the HPT against the design. The HPT delivers a shaft power of 20.52 MW from HPT. Based on this the ST is operating at 108 MW.
- Unit #2 Turbine cylinder efficiency as per test data is found to be 87.72%, 95.3% and 88.8% for HPT, IPT and LPT respectively. The unit #2 STG is operating at 128.5 MW during audit. The h-s diagram of unit 2 turbines is shown in figure 6.2. As shown in figure the HPT efficiency is deteriorated compared to design due to high enthalpy loss in the extraction stages as well as exit stage. The exit temperature of HPT in unit 2 is recorded as 350.00^{o}C against design of 347.3^{o}C.
- The turbine efficiency of both units has calculated based on the DCS details. The dryness factor for unit #1 and unit #2 is calculated and found to be 0.92907 and 0.91158 respectively.

Recommendation

- The comparison of HPT Exhaust / Throttle Pressure Ratio w.r.t. HBD is as given below for unit 1.

	HPT exhaust pressure	Throttle pressure	HPT exhaust/Throttle pressure
HBD	29.68	107.21	0.27684
Test (unit 1)	29.6	104.4	0.28366

The increase in pressure ratio in unit 1 indicates possibility of increase in turbine clearances.

- It is suggested that the gland seal / inter-stage seal strips condition as well as its clearances may be checked at the next available opportunity.
- Periodic assessment of turbine efficiency to be carried out using calibrated instruments to trend deterioration in performance and formulate corrective action plan also to monitor the extraction parameters.
- Trend the HPT efficiency (to track the degradation).
- The pressure ratio of HPT exhaust to throttle pressure should also be monitored, trend and analyze for correlating the possible changes in turbine operating condition.
- It is suggested to provide online measurement of IPT exhaust pressure and temperature which is presently not available. It is suggested that the pressure ratio of IPT exhaust to IPT inlet should also be monitored.

6.2.2 Turbine Pressure Survey

The pressure survey of turbine is compared with the design and the same is presented in Table 6.4. The plot is shown in below figure for comparing the design parameter and operating parameter.

Table 6.4: Turbine pressure survey

Parameter	Unit	Design	Unit – 1	Unit – 2
MS pressure	kg/cm^2	129.60	104.35	126.84
CRH pressure	kg/cm^2	35.85	29.60	34.75
HRH pressure	kg/cm^2	33.30	28.68	32.98
LPT inlet pressure	kg/cm^2	4.80	3.97	4.73
Condenser vacuum	kg/cm^2	0.0950	0.10	0.103

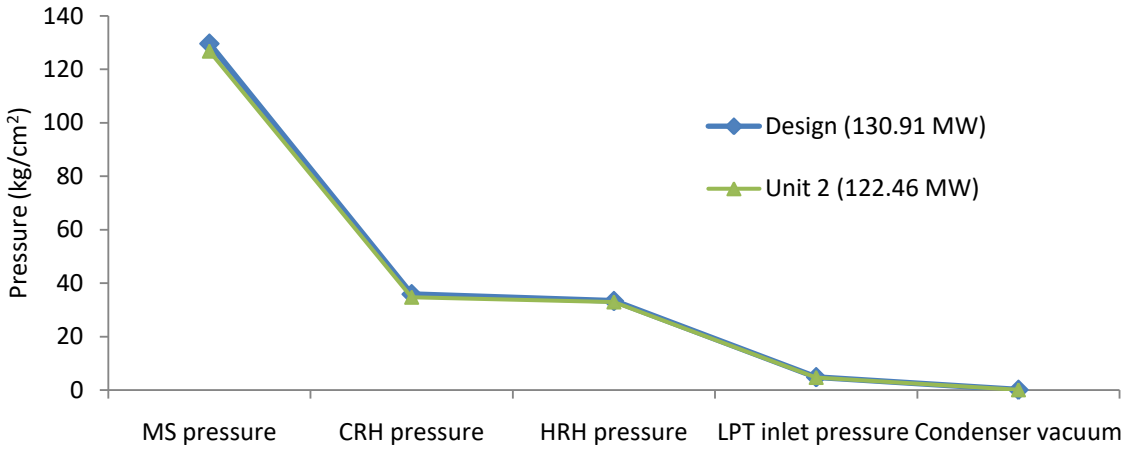


Figure 6.4: Turbine pressure survey

Observation and Analysis

- Based on the data collected a pressure drop test is carried out for operating load vis-à-vis design load and the plot is shown in above diagram. As the Unit #1 steam turbine is operated part load the analysis was carried out only for unit #2. In low pressure region the curve lies above the reference line. This may be due to some restriction to flow somewhere between two tapping points or it may happen that there is general worn/damage in the turbine internal seals or worn diaphragm seals. Also a decrease in pressure ratio as shown in below table indicates possibilities of roughness in HPT.

	HPT exhaust pressure	Throttle pressure	HPT exhaust/Throttle pressure
HBD	35.85	129.6	0.27662
Test (Unit 2)	34.86	126.2	0.27624

6.2.3 Water-Steam cycle heat rate

The heat rate of steam bottoming cycle has calculated based on the input energy and output power generation. The turbine heat rate is calculated based on the formulae,

Turbine Heat Rate = $Q_0 + (Q_1-Q_2)+(Q_3-Q_4)$/kW

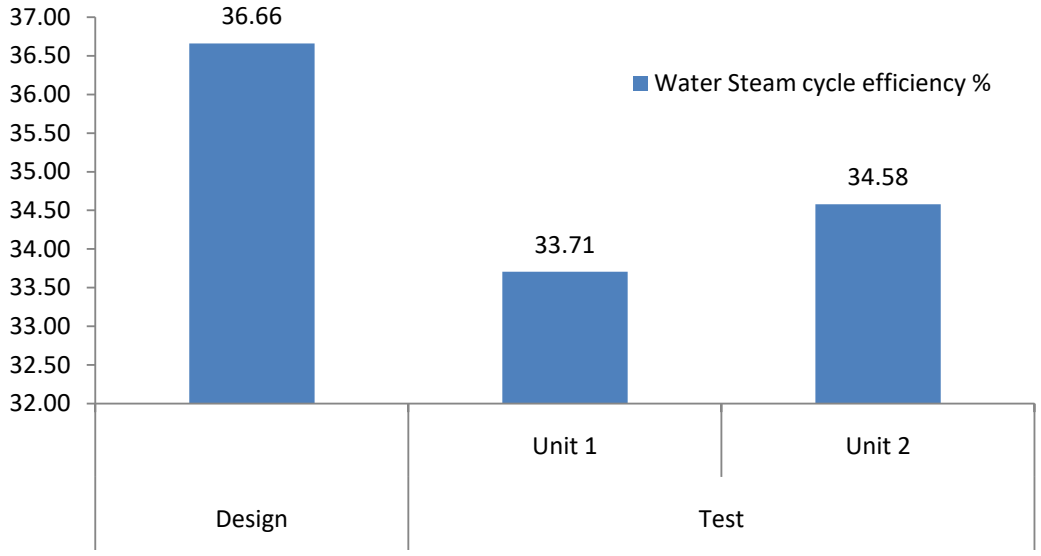
Q_0 = HP Turbine inlet energy

Q_1 = IP Turbine inlet energy

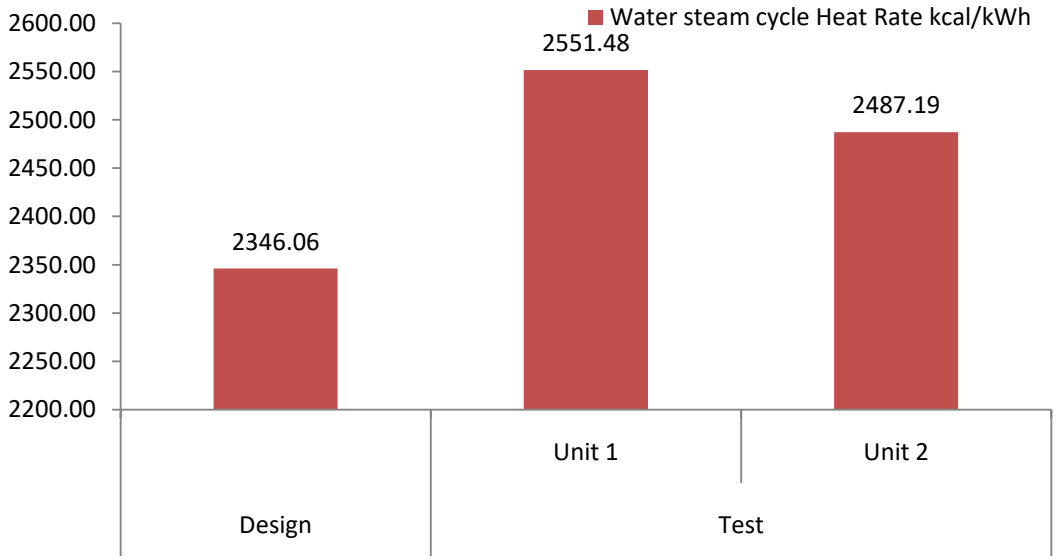
Q_2 = HP Turbine exhaust energy

Q_3 = LP Turbine inlet energy

Q_4 = LP Turbine exhaust energy
kW = Turbine output power



(a)



(b)

Figure 6.5: Bottoming cycle (a) efficiency, (b) heat rate

Observations and Analysis

- The average main steam temperature for unit – 1 and unit – 2 is recorded as 540.75^{o}C at 68.58 % loading and 533^{o}C at 94.41 % loading, against design value of 537.8^{o}C at 100 % load.
- The overall bottoming cycle efficiency is calculated to be 33.71 % and 34.58 % against design of 36.66 % for unit 1 &2 respectively.
- Water-steam cycle heat rate is calculated as 2551.48 kcal/kWh and 2487.19 kcal/kWh against design of 2346.06 kcal/kWh for unit 1 & 2 respectively. There is no correction curve available for steam bottoming cycle. The only parameter which may have impact on bottoming cycle heat rate will be CW temperature. The same will have also influence in combined cycle heat rate. Hence the impact of CW temperature is considered in the corrected CCPP heat rate.
- The reheat steam temperature in unit 1 and 2 was 540.89 ^{o}C and 536.50 ^{o}C against design value of 539.6^{o}C at full load. As per polynomial regression analysis the design reheat steam temperature at 99.93 MW and 122.46 MW is found to be 538.30 ^{o}C and 537.82 ^{o}C.
- The condenser pressure was 0.1000 kg/cm^2 in unit 1 and 0.103 kg/cm^2 in unit 2 against the design value of 0.095 kg/cm^2. This shows that efficiency of both units may affect due to poor condenser vacuum.

6.3. Condenser Performance

Each STG is provided with one two pass condenser having total cooling surface area of 10404 m^2 and 16000 number of tubes with size of 23x1x10000 mm (O.D x Thickness-Length). Design CW inlet temperature is 32^{o}C and condenser pressure is 0.095 at. The design details of surface condenser is provided in Table 6.5

Table 6.5: Design Specification of condenser

Description	Unit	Particulars
Shape		Rectangular
Type		Shell & Tube
Quantity of steam	t/Hr	355.193
Enthalpy of condensing steam	kcal/Kg.	571.2
Condenser Vacuum	at	0.095
Cleanliness factor		0.8
Size of tubes (O.D x Thickness-Length)	mm	23x1x10000

Total Number of tubes	Nos.	16000
Cooling surface area	Sq.M	10404
Quantity of cooling water	Cu.m/Hr	21000
Cooling water inlet temperature	ºC	32
Cooling water outlet temperature	ºC	41
Resistance on water side	MWCL	6
Material of tubes		Aluminum Brass
No. of water side passes	No	2

There are two particularly important relationships which should be established: the CW temperature rise with load and the terminal temperature difference (TTD) with load. For a given CW inlet temperature it follows that the back pressure in the condenser also depends in part upon the TTD. To evaluate the performance of condensers, circulating water inlet and outlet temperature, flow, have been measured and vacuum and hot well temperatures recorded form DCS. The condenser effectiveness is calculated based on DCS details and provided in Table 6.6.

Table 6.6: Condenser effectiveness

Description	Units	Design	Unit – 1	Unit – 2
Water Inlet Temperature	ºC	32.00	34.44	33.37
Water Outlet Temperature	ºC	41.00	41.98	42.46
∆ T of Water	ºC	9.00	7.54	9.09
Condenser Vacuum	kg/cm^2(a)	0.0950	0.1000	0.1030
Design average temperature	ºC	36.500		
Saturation Temperature	ºC	44.43	45.43	46.00
Hot Well Temperature	ºC	44.43	46.57	48.28
Initial Temperature Difference	ºC	12.43	10.99	12.64
Terminal Temp. Difference	ºC	3.43	3.45	3.55
Log mean Temperature Difference	ºC	6.99	6.51	7.15
Condensate Sub cooling	ºC	0.00	-1.14	-2.28
Condenser effectiveness		0.72	0.69	0.72
Condenser heat Load	kcal/hr	2219700	120514298	135896957
Heat Transfer Coefficient	kW/m^{2}K	0.72	0.57	0.71

Table 6.7: Vacuum loss due to various factors

Parameters	Unit	Design	Unit – 1	Unit – 2
Load	MW	130.9	99.93	122.46
Condenser back pressure	mmHg	69.878	73.556	75.762
CW inlet Temp	^{O}C	32.00	34.44	33.37
CW Outlet Temp	^{O}C	41.00	41.98	42.46
Delta T	^{O}C	9.00	7.54	9.09
Delta P	kg/cm^2		0.84	0.84
Sat.Temp	^{O}C	44.43	45.43	45.43
TTD	^{O}C	3.43	3.45	2.97
vacuum deviation due to CW inlet				
Expected sat temp at actual CW inlet	^{O}C		45.371	45.802
Corresponding Back pressure	mmHg		73.335	74.977
Deviation due to CW inlet	mmHg		3.457	5.099
Vacuum loss deviation due to CW Flow/ Heat load & CW rise				
Expect saturation temp	^{O}C		46.271	44.863
Corresponding Back pressure	mmHg		74.585	71.423
Deviation due to CW flow/Heat load & CW rise	mmHg		4.707	1.545
Net Loss	mmHg		8.164	6.644

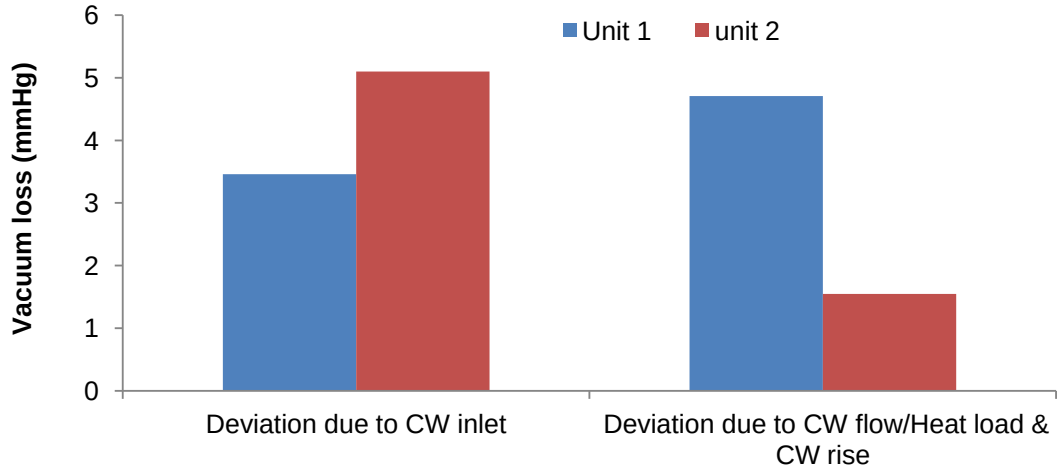


Figure 6.6: Vacuum loss variation

Observation and Analysis

- Condenser vacuum is recorded as 0.1000 kg/cm^2 (a), and 0.103 kg/cm^2(a) at inlet CW temperature 34.4ºC and 33.37ºC in Unit-1, and Unit-2 respectively against design of 0.095 kg/cm^2(a) at inlet temperature 32ºC.
- DP across condenser in both the units is around 0.84kg/cm^2 which is more than the design DP value i.e 0.6kg/cm^2 which indicated possible clogging within the condenser.
- During measurement of condenser flow in unit 2 it was observed that there is around 2000m^3/hr flow difference in between LHS side and RHS side condenser flow.
- During field visit unit – 1 was in part load operation and seven CT fan were in operation.
- Vacuum losses due to various reasons are projected in Table 6.7 and Figure 6.6. Based on the analysis the loss of vacuum mainly contributed by CW inlet temperature, which is calculated as 3.526 mmHG and 2.028 mmHG respectively in condenser of unit – 1 and unit – 2.

Recommendation

- It is recommended to increase the condenser tube cleaning frequency to get vacuum close to design.
- Based on the above analysis it can be concluded that the condenser performance is satisfactory.

CHAPTER –7

PERFORMANCE EVALUATION OF DEAERATOR

From de-aerator the feed water is pumped by feed pump to HRSG economizer section. Following performance parameters of deaerator are evaluated. The design details and performance analysis of Deaerator is provided in Table 7.1 and Table 7.2 respectively.

- Rise in condensate /feed water temperature
- TTD - Terminal temperature difference
- Heat Load
- Effectiveness
- LMTD: Log mean Temperature difference

Table 7.1: Design details of De-aerator

Description	Unit	Particulars
Make		BHEL, Hyderabad
Type		Spray-cum-Tray Type
Diameter x Thickness	mm	ID 2200x12
Header Length	mm	6676
Design Pressure	$kg/cm^2(g)$	6.5
Design Temperature	°C	330
Operating Pressure	$kg/cm^2(a)$	4.79
Operating Temperature	°C	149.5
Test Pressure	$kg/cm^2(g)$	8.45
Condensate inlet	kg/Hr	385765
Condensate Temperature	°C	141.5
Condensate Enthalpy	kcal/kg	142.5
Number of trays	Nos.	160
Number of spray valves	Nos.	28
Spray Valve capacity 15	T/Hr	15
Dissolved oxygen in feed water 0.005	cc/Lr	0.005
Inlet Steam Pressure	$kg/cm^2(a)$	4.79
Inlet Steam Temperature	°C	160
Inlet Steam Enthalpy	kcal/kg	696.9

Table 7.2: De-aerator Performance Analysis

Parameters	Unit	Design	Unit 1	Unit 2
Unit Load	MW	130.91	99.93	122.46
condensate inlet Temperature	ºC	141.5	135.56	143.27
condensate outlet Temperature	ºC	149.5	140	145.55
∆ T of Water	ºC	8	4.44	2.28
Steam pressure	kg/cm^2 (a)	4.79	4.66	5.09
Saturation temperature	ºC	149.498	148.477	151.77
Extraction Steam Temperature	ºC	226	228.27	234.64
Extraction Steam enthalpy	kcal/kg	696.9	696.8377	699.75
Drip Temperature	ºC	149.50	140	145.55
Drip enthalpy	kcal/kg	150.50	140.742	146.44
Condensate flow	tph	385.765	310.68	375.37
specific heat (at avg temp)	kcal/kg/ºC	1.02	1.02	1.02
TTD	ºC		8.477	6.22
Heat load	kcal/hr		1407007.58	872960.47
Extraction steam flow	t/h	5.69	2.53	1.58
Effectiveness			34%	27%

Observation and Recommendation

- The effectiveness is calculated to be 35% for unit 1 and 27% for unit 2. Data used for calculation purpose like temperature & pressure is taken from DCS datasheet.
- Effectiveness is found to be on lower side for both units' de-aerator. It may be due to measurement uncertainty of condensate inlet and outlet temperature. It is recommended to trend the temperature parameters and if required calibrate temperature and pressure sensor.
- Rise in temperature (TR) for unit is 4.44ºC and for unit 2 is 2.28ºC against the design TR value 8ºC. The lower temperature gain may be due to steam side fouling or may be due to low extraction steam flow than design.

CHAPTER –8

TURBINE AUXILIARY

Pumps are the major auxiliary load of the Unit. The Detailed Energy Audit in pumping system includes study of following pumps.

1. HP Boiler Feed Pumps (HPBFP)
2. LP Boiler Feed Pumps (LPBFP)
3. Condensate extraction pumps(CEP)
4. Cooling water pumps (CWP)
5. ACW pumps
6. DMCW pumps

Electrical power measurements in motors using Power analyzer, flow measurement using ultrasonic flow meter along with pressure reading were taken for all pumps and performance evaluation of pump was conducted to estimate overall efficiency and pump efficiency. To assess the performance of pumps following performance parameters have been evaluated,

- Flow
- Loading
- Efficiency
- Power consumption
- Specific energy consumption

8.1. Boiler Feed Pump

Total 8 numbers of BFPs (4 HPBFPs & 4 LPBFPs) provided for both the units, in which 2 HPBFP and 2 LPBFP runs in normal condition for the both units. In single unit 1 HPBFP and 1 LPBFP run. Design details of pump are depicted in Table 8.1.The process flow diagram of Boiler Feed pump is shown in the Figure 8.1

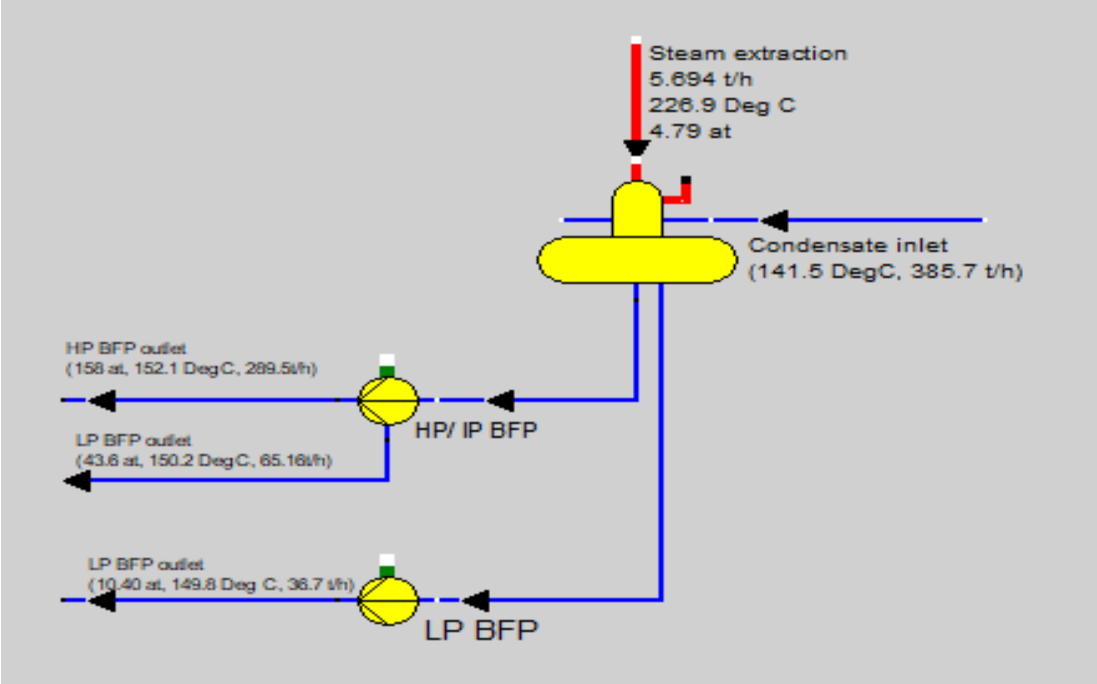


Figure 8.1: Process flow diagram of BFP

Table 8.1: Design details of HP/IP BFP

Description	Unit	Boiler Feed Pump Particulars
Pump Type		Radial flow, Single suction ,FK6D30
manufacturer		BHEL
Flow Rate	m^3/hr	500
Inlet water pressure	kg / cm^2	5.2
Outlet water pressure	kg / cm^2	183.48
Head	m	2000
No. of pumps per unit	Nos.	2
No. of Stages		6
Feed water temperature	°C	149.5
Pump efficiency at design point	%	80
Pump speed rated	RPM	4850
Motor Power	kW	4000

8.1.1 HP/IP BFP Performance Analysis

Towards the assessment of boiler feed pump performance the efficiency of running pump is evaluated based on the measured flow, power and pressure and provided in Table 8.2.

Table 8.2: HPBFP efficiency calculation

HP BFP	Unit	Design	Unit 1 (HPBFP –A)	Unit 2 (HP BFP – B)
Pump flow	M^3/hr	500	312.684	372.997
Total Head Developed	m	2000	1221.5	1476.0
Input Motor Power	kW	4000	1871	2229.00
Motor Efficiency	%	97.0	97.0	97.0
Pump Hydraulic power	kW		961.7	1381.7
Combined Overall Efficiency	%		51.40	61.99
Pump Efficiency	%	80	52.99	63.91
Percentage loading of flow	%		62.99	74.89
Percentage loading on motor	%		45.37	54.05
Specific consumption	kW/TPH	10.38	6.476	6.489
Percentage loading on head	%		61.075	73.8

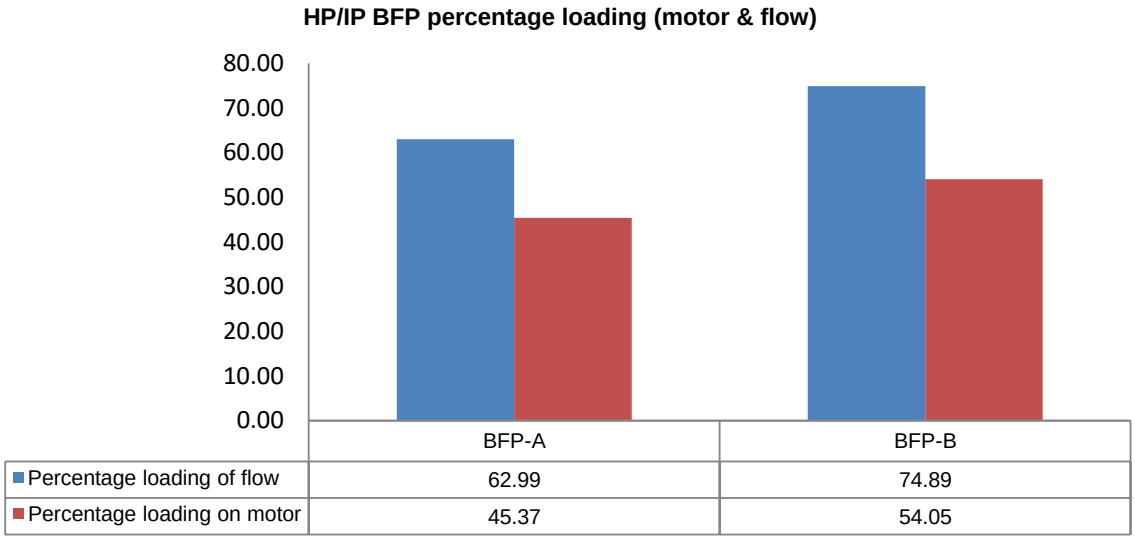


Figure 8.2: HP/IP percentage loading (motor & flow)

Observation & Recommendation

- Detail comparison of flow measured, value taken from DCS and mass balance is provided in Table 8.3

Table 8.3: HPBFP Mass Balance

Parameter	unit	Unit 1	Unit 2
HP Steam	TPH	238.22	288.3
IP Steam	TPH	27.6	36.29
IP Flow to gas preheater	TPH	13.69	13.63
IP FW spray to gas preheater	TPH	9.41	5.31
Total BFP suction flow	TPH	288.92	343.53
DCS suction flow	TPH	385	441.28
Measured suction flow	TPH	298.2	345
Recirculation flow	TPH	9.28	1.47

- Based on the HP/IP mass balance and measured water suction flow, the recirculation has calculated and found to be 9.28 TPH and 1.47 TPH for unit – 1 and unit – 2 respectively. This shows that the recirculation in unit – 1 is more as compared to unit – 2. Hence it is recommended to check the recirculation passing and control the passing. The saving calculation by arresting the recirculation passing is provided in the below table 8.4

Table 8.4: HPBFP Recirculation arresting saving calculation

Description	Units	Unit 1
No. of pump running		1
Specific Power consumption (average of two pumps)	kW/TPH	6.476
Total feed water flow	TPH	288.92
Total BFP Flow	TPH	298.2
Difference	TPH	9.28
Total Power Consumed	Kw	1871
Total Power saving after Changing recirculation v/v	kw	60.096
Annual Running Hours	hrs	5606.4
Annual Energy Saving	Kwh/Yr	336921.12
Energy Cost	Rs./kwh	2.75
Annual Energy Saving	Rs Cr	0.093
Investment	Rs.Cr	0.100
Payback	month	13

Actual investment cost to be verified with Vendor

- BFP efficiency for unit 1 and unit 2 is found to be 52.99 % and 63.91 % respectively against the design value 80 %

- As per the figure 8.2 the percentage loading of flow is better than the motor power percentage loading. This may be due to flow control by hydro coupling control system.
- The flow and power of unit – 2 BFP is measured and found to be 343.53 TPH and 2229 KW. As per the characteristic curve shown in Figure 8.3 at normal operating condition the head for the measured flow is calculated as 1700 MWC against the measured head of 1476 MWC.
- Similarly, for unit – 1 the flow and power is measured and found to be 288.92 TPH and 1871 KW. As per the characteristic curve provided in Figure 8.3, at normal operating condition the head for the measured flow is calculated as 1790 MWC against the measured head of 1221 MWC.
- From the pressure profile it is evident that pressure drop along HP line of unit – 2 is found to be around 16 kg/cm^2 across the HP Feed control station and HP Economizer. This may be verified by comparing HP discharge pressure (151.7 kg/cm^2) and HP drums (135.72 kg/cm^2). The energy saving is shown in Table 8.5

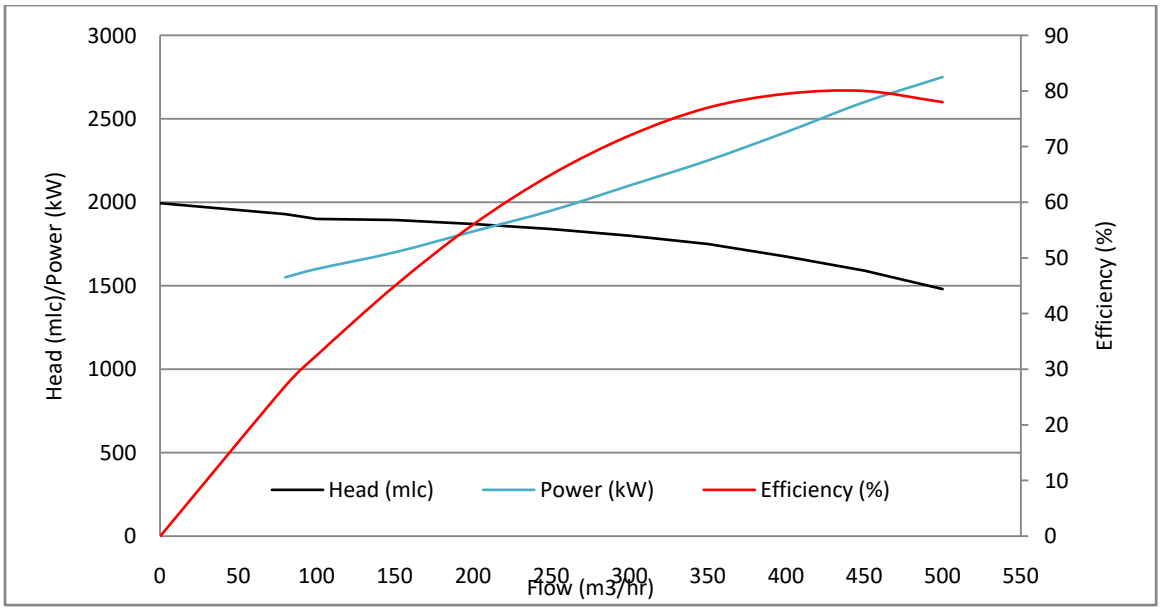


Figure 8.3: BFP Characteristic curve

- Likewise, the pressure drop along IP line of unit – 2 is found to be around 36 kg/cm2 across IP Economizer and IP feed control station. This shows that there is a huge

pressure drop across IP Feed control station. Hence it is recommended to optimize the IP pressure drop across the FCS.

Table 8.5: HP Line FCS pressure optimization

Particulars	Unit	Unit 1	Unit 2
Number of HP BFP Running		1	1
DP across HP FCS	kg/cm^2	6	6
Proposed DP at HP FCS	kg/cm^2	1	1
Reduction	kg/cm^2	5	5
Power reduction	kW	50	50
Annual running hours	hrs/yr	5606.4	5606.4
Annual energy saving	kWh/yr	280320	280320
Energy cost	Rs/kWh	2.75	2.75
Annual Energy Saving	Rs.Cr	0.08	0.08
Investment	Rs.Cr	Nil	Nil
Payback	Month	Immediate	Immediate

8.1.2 LPBFP Performance Analysis

The plant has installed two LPBFP for each unit (one is running and another standby). The LPBFP absorbs water from the dearator and passes the water to LP Economizer with higher pressure. The design details of LP BFP is provided in below Table 8.6

Table 8.6: Design details of LPBFP

Description	Unit	Particulars
Flow Rate	m^3/hr	45
Head	mlc	130
No. of pumps per unit	Nos.	2
Motor Output Power	kW	32.61

The performance of the LP BFP has calculated based on the measured details and the same is provided in the Table 8.7

Table 8.7: LPBFP Performance

Particulars	Unit	Design	LP BFP – 1 A	LP BFP – 2 A
Pump discharge flow	M^3/hr	45	30.36	38.76
Total Head Developed	m	130	154.6	141.7
Input Motor Power	kW	32.61	21.92	23.74
Motor Efficiency	%	97.0	97.0	97.0

Pump Hydraulic power	kW		11.87	13.82
Combined Overall Efficiency	%		54.14	58.20
Pump Efficiency	%		55.81	60.00
Percentage loading of flow	%		67.46	85.68
Percentage loading on motor	%		65.20	70.62

Observation & Recommendation

- There is two LPBFP pump in each unit, one in running and one in standby. Flow was measured at the suction of individual pump. For calculating head, suction and discharge pressure is taken from DCS.
- The pump efficiency of LP BFP for Unit – 1 and unit – 2 is calculated and found to be 55.81 % and 60 % respectively.
- The discharge pressure of LP BFP is found to be approx 19 kg/cm^2 for both units however; the design FW temperature to HRSG and LP drum pressure is 6.6 kg/cm^2 and 5.1 kg/cm^2 respectively. During audit the LP drum pressure is 4.74 kg/cm^2. This shows that there is huge loss across LP FCS.
- Based on the pressure survey through, the loss across the LP FCS will be reduced by installing the Variable Frequency Drive control for LP BFP. The plant may operate by installing VFD and 100 % opening of FCS. The payback for VFD is provided in Table 8.8

Table 8.8: LP BFP VFD Installation

Description	Unit	Unit1	Unit2
Design flow	m^3/hr	45.00	45.00
Actual flow	m^3/hr	30.36	38.76
LP drum pressure	kg/cm^2	4.52	4.74
Actual discharge head	kg/cm^2	19.04	18.26
present power consumption	kW	21.92	23.74
Proposed power consumption	kW	12.06	13.06
Power saving	kW	9.86	10.68
Annual operating hours	hrs/yr	5606.40	5606.40
Annual Energy Saving potential	kWh	55279.10	59876.35
Energy Cost	Rs./kWh	2.75	2.75
Annual Monetary Saving	Rs. Cr	0.02	0.02
Investment for VFD	Rs Cr	0.05	0.05
Payback	Months	35.52	32.79

Actual investment cost to be verified with Vendor

8.2 Condensate Extraction Pumps (CEPs)

There are two CEPs and one is in operation in each of the unit. The performance of CEPs of both the units has been analyzed by measuring the flow, discharge pressure, power consumption and recording the condenser vacuum. Based on the measured data operating efficiency of pump have been compared with design. The CEP absorbs water from hot well of condenser and supplies water to the Condensate header and supplied to de-aerator. The rated capacity of pump is 410.00m^3/h with head of 250 m and power of 417 kW. The design detail of CEP is provided in Table 8.9.

Table 8.9: Design details of CEP

Description	Unit	CEP Particulars
Pump Type		EN5J40/210(Last stage dummy)
Flow Rate	m^3/hr	410
Head	m	250
No. of pumps per unit	Nos.	2
Feed water temperature	°C	54.9
Pump efficiency at design point	%	66
Pump speed rated	RPM	1486
Motor Output Power	kW	600

8.2.1 CEP Performance Analysis

The performance of condensate extraction pumps of both the units have been analyzed by measuring the flow, pressure developed and power consumption of the pumps and it is shown in Table 8.10. The CEP pressure survey also carried out and provided in Table 8.11

Table 8.10: CEP performance

Particulars	Unit	Design	Unit- 1 (CEP – B)	Unit – 2 (CEP A)
Pump discharge flow	M^3/hr	410.00	332.96	391.95
Total Head Developed	m	250.00	252.10	238.67
Input Motor Power	kW	417.00	437.00	468.00
Motor Efficiency	%	0.95	0.95	0.95
Combined Overall Efficiency	%		51.74	53.84
Pump Efficiency	%	80	54.25	56.46
Percentage loading of flow	%	100.00	81.21	95.60
Percentage loading on motor	%	100.00	104.8	107.09
Specific consumption	kW/TPH	0.92	1.33	1.21
Percentage loading on head	%		100.84	95.47

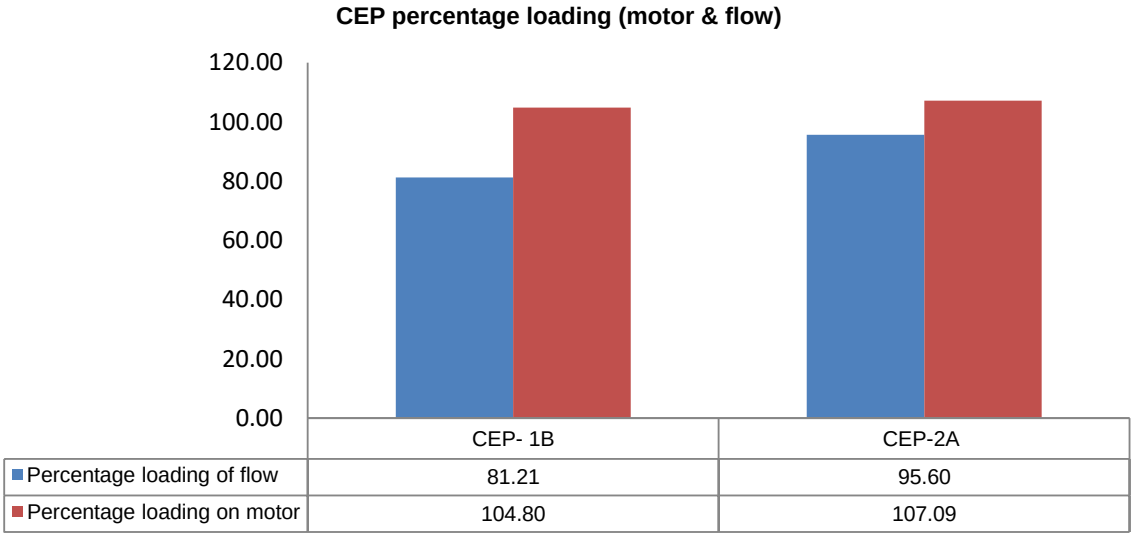


Figure 8.4: CEP percentage loading (motor & flow)

Table 8.11: CEP Pressure survey

	Units	UNIT 1	UNIT 2
CEP Suction Press.	Kg/cm^2	0.10	0.10
CEP dish. Press.	Kg/cm^2	25.31	23.97
De-aerator Press.	kg/cm^2	4.66	5.09

Observation and Analysis

- There are two CEP's for each unit, one in running and one in standby. Flow was measured at the suction of individual pump. For calculating head suction and discharge pressure is taken from DCS.
- CEP efficiency of unit#1 is found to be 54.25%, CEP of unit#2 is found to be 56.46 % respectively against design of 80%.
- As per the Figure 8.4, the percentage loading of CEP based on motor power and flow shows that the motor power consumption is higher however, the flow is less.
- The specific energy consumption of pump in both units is on higher side compared to design of 0.92.
- In unit – 1 CEP – B at flow $333m^3/hr$ and head 252M, measured power consumption is 437 kW, but As per the characteristic curve provided in Figure 8.4 the power consumption of CEP 1A at said flow and said head should be 380 kW as against the measured value of 437 kW. Thus the pump is consuming 57kW more power as

compared to characteristic curve which can be saved. Similarly For Pump - 2A, at flow 391m^3/hr measured power consumption is 468 kW, but as per the Curve motor is consuming 54 kW more for the same flow. This can be achieved by maintaining the pump internals and reducing the head loss. Saving calculation is provided in table 8.12.

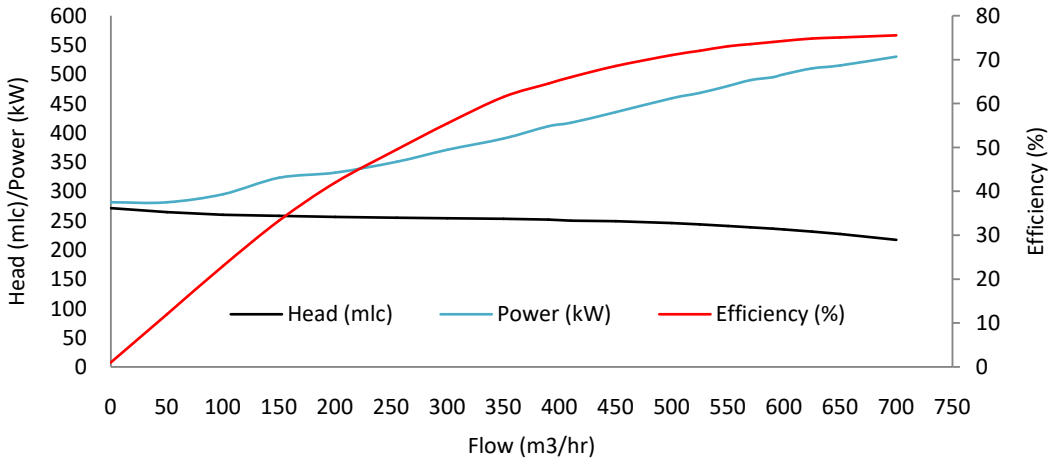


Figure 8.5: CEP Characteristic curve

Table 8.12: CEP Optimization saving

Power consumption as per curve	kW	380	414
Power consumption as measured	kW	437.00	468.00
Extra power consumption	kW	57.00	54.00
Annual operating hours	hrs/yr	5606.4	5606.4
Annual Energy Saving potential	kWh/yr	319564.8	302745.6
Energy cost	Rs/kWh	2.75	2.75
Annual Monetary Saving	Rs.Cr	**0.09**	**0.08**

- In operating condition one CEP is running. From the pressure profile in above table 8.11 it is evident that there is substantial pressure drop across the control valve. However, the variable speed option for the pump could be explored to save considerable amount of power. The discharge pressure of condensate pump varies from 25-23 kg/cm² where as De-aerator pressure is around approx 5.0 kg/cm² Throttling losses can be reduced effectively by employing variable speed option

Table 8.13: CEP VFD Installation

Description	Unit	Unit1	Unit2
Design flow	m^3/hr	410.00	410.00
Actual flow	m^3/hr	332.96	391.95
present power consumption	kW	437.00	468.00
Proposed power consumption	kW	350	374
Power saving	kW	87.00	94.00
Annual Energy Saving potential	kWh	487756.8	527001.6
Annual Monetary Saving	Rs.Cr	0.13	0.14
Investment for VFD	Rs Cr	0.3	0.3
Payback	Months	27	25

Actual investment cost to be verified with Vendor

8.3 Cooling Tower

The cooling towers performance was tested when the unit – 1 and unit – 2 was operating at part load and base load respectively. Table 8.14 depicts the design details of cooling tower. Parameters measured for performance test are:

- Hot water temperature
- Cold water temperature
- Makeup water temperature
- Air wet bulb temperature

Table 8.14: Design details of cooling tower

Description	Unit	Particulars
CT Basin Capacity	m^3	7000
No of Cooling Tower		2 for 2
No of Cells for each Tower		8(7 W+1 S)
Capacity for each Cell	m^3/hr	3428.57
CT inlet temperature	ºC	41
CT outlet temperature	ºC	32
Design Wet Bulb Temperature	ºC	27.25
Evaporation Efficiency	%	85
Calculated Blow down + Drift	m^3/hr	94
Calculated Makeup Water Flow Rate	m^3/hr	442.48
Calculated Makeup Water Flow Rate	m^3/hr	442.48
No of blades in each Fan		8
Blade Type		Aerofoil

Fan Speed	RPM	114
No of fans		8 x 2 = 16 Nos. plus 1 No. spare
Motor	kW	110

Cooling tower operating parameters have been measured to analyze the performance of pumps. The results are as follows:

The cooling tower range is calculated using following expression:

Range= T_1- T_2 ^{0}C

Where,
R Cooling range, ^{0}C
T_1 Hot water temperature, ^{0}C
T_2 Cold water temperature, ^{0}C

Cooling Approach

The cooling tower cooling approach is calculated as follows:

Approach= T_2- T_3 ^{0}C

Where,
A Cooling approach, ^{0}C
T_2 Cold water temperature, ^{0}C
T_3 Ambiant air wet bulb température, ^{0}C

$$\text{Effectiveness} = \frac{\text{Range}}{(\text{Range} + \text{Approach})} \times 100$$

Cooling tower operating parameters have been measured to analyze the performance of cooling tower. The results are provided in Table 8.15.

Table 8.15: Cooling tower performance

Cooling tower evaluation				
Parameters	**Unit**	**Design**	**Unit 1**	**unit 2**
Condenser vacuum	kg/cm2 (a)	0.0950	0.1000	0.1030
CT inlet temperature	ºC	41.00	41.98	42.46
CT outlet temperature	ºC	32.00	34.44	33.37
CW flow rate	m^3/hr	23999.99	19938.37	17872.22
Dry Bulb temperature	ºC		32.98	29.69

Wet Bulb temperature	ºC	27.25	30.35	28.58
Range	ºC	9.00	7.54	9.09
Approach	ºC	4.75	4.09	4.79
Effectiveness	%	65.45	64.86	65.51
Evaporation loss	m^3/hr	330.48	230.01	248.56
Cooling capacity	kCal/hr	215999.91	150335.31	162458.48
Power consumption of fans	kW	100.00	56.23	58.53
Flow /Cell	m^3/hr	3428.57	2848.34	2553.17
Evaporation loss/cell	m^3/hr		32.86	35.51
% Evaporation loss/cell	%		1.15	1.39

Table 8.16: CT Fans motor Loading

Cooling tower CT Fans U# 1							
Fans No.	Design (KW)	Efficiency %	amp	Voltage	P.F.	Power	% Loading
1	110	94.5	140	410.1	0.55	54.69	46.99
2			150	410	0.58	61.78	53.08
3			148	410.8	0.56	58.97	50.66
4			148	410	0.56	58.85	50.56
5			N/R				
6			130	411.4	0.54	50.02	42.97
7			150	412	0.52	55.66	47.82
8			142	411.2	0.53	53.60	46.05

Cooling tower CT fans U#2							
Fans No.	Design(KW)	Efficiency (%)	amp	Voltage	P.F.	Power	% Loading
1	110	94.5	148	418	0.54	57.86	49.71
2			150	418.5	0.57	61.97	53.24
3			149	418.5	0.53	57.24	49.18
4			146	418.6	0.51	53.98	46.38
5			150	419	0.5	54.43	46.76
6			158	419	0.53	60.77	52.21
7			162	419	0.54	63.48	54.54
8			N/R				

Observation & Recommendation:

- Effectiveness of cooling tower is calculated as 64.86% and 65.51 % for unit 1 and unit 2 respectively.

- Approach is found to be 4.09°C and 4.79°C for unit 1 and unit 2 respectively against the design approach of 4.75 °C. Range is found to be 7.54°C and 9.09°C for unit 1 and unit 2 respectively against the design range 9.
- As per the design data the evaporation loss is around 330.48 kg/hr during full load operation and the evaporation loss during audit is calculated around 230 kg/hr and 248 kg/hr for 1 and unit 2 respectively.
- Cooling tower is designed for 7 CT fans at full load .In unit 1 it is observed that unit is running at part load still 7 CT fans are in service. There is no approach available to measure CT fans Flow, hence only Power is measured for individual fans.
- For both the units, CT fans motor loading is around 50%, this is depicted in Table 8.16
- It is recommended to make proper approach for measuring the fan velocity so that fan efficiency and L/G ratio can be calculated.
- It is recommended to install VFD with automotive temperature controller, as motor loading at base load & part load operation is at 50 %. The saving calculation is shown in Table 8.17.

Table 8.17: CT Fan VFD Installation

CT Fans Saving by VFD installation		
present power consumption	kW	393.57
Proposed power consumption	kW	275
Power saving	kW	118.57
Annual Running hours	Hrs	5606.4
Energy cost	Rs/kWh	2.75
Annual Energy Saving potential	kWh	664750.85
Annual Monetary Saving	Rs.Cr	0.18
Investment for VFD	Rs Cr	0.14
Payback	Months	9

Actual investment cost to be verified with OEM/Vendor

- Cooling tower fans are of GRP type drawing 57 kW average. Replacement by efficient hollow FRP fan blades is recommended. The saving calculation is shown in Table 8.18

Table 8.18: CT Fan Blade replacement

Energy Saving by Replacing GRP blades with FRP blades in CT Fan		
No. of fans	Nos	8
Rated Power	kW	110
Rated voltage	V	415
Rated Speed	rpm	1500
Present Avg Power consumption	kW	56
Energy Savings	%	25
Avg Power consumption with FRP blades	kW	42
Avg Power Saving	kW	14
Annual Energy Savings	kWh	78489.6
Annual Monetary Saving	Rs.Cr	0.17
Investment	Rs Cr	0.16
Payback	Months	11

Actual investment cost to be verified with Vendor

8.3.1 Circulating Water Pump

Three circulating water pump (2 W + 1 S) is installed with the capacity of 12000m^3/hr for each unit in full load operation. The pump rated efficiency is 85% at total head 22mlc. Design Details and Performance analysis of pumps are shown in Table 8.19.

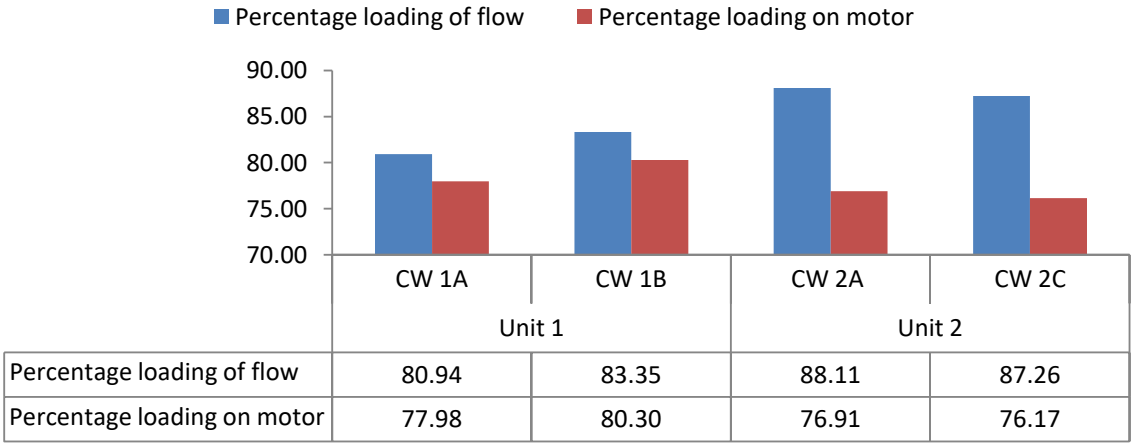
Table 8.19: CW pump Design

Circulating water pumps		
Manufacturer	BHEL (HYDERBAD)	
Number of pumps	Nos.	6 (Six)
Rated capacity	m^3/hr	12000
Total Head	MLC	22
Pump rated speed	RPM	490
Bowl efficiency at rated capacity	%	85
Pump shaft input power at rated capacity	kW	870.5
Circulating water pump Motor		
Manufacturer	BHEL	
Speed	RPM	496
KW rating	KW	1150
Current	A	128
Efficiency	%	95%
PF		0.82

The measured and analyzed parameters of the pumps are shown in the below Table 8.20.

Table 8.20: CW pump performance

CW			Unit 1		Unit 2	
Parameters	Unit	Design	CW 1A	CW 1B	CW 2A	CW 2C
Pump discharge flow	m^3/hr	12000.00	9713	10001	10573	10471
Total Head Developed	m	22.50	20.00	20.00	17.70	17.50
Input Motor Power	kW	1150.00	944.00	972.00	931.00	922.00
Motor Efficiency	%	0.95	0.95	0.95	0.95	0.95
Combined Overall Efficiency	%	63.98	56.08	56.08	54.78	54.16
Pump Efficiency	%	85.00	59.03	59.03	57.66	57.01
Percentage loading of flow	%		80.94	83.35	88.11	87.26
Percentage loading on motor	%		77.98	80.30	76.91	76.17
Specific consumption	kW/TPH	0.10	0.10	0.10	0.09	0.09



Percentage loading of flow	80.94	83.35	88.11	87.26
Percentage loading on motor	77.98	80.30	76.91	76.17

Figure 8.6: CW Percentage loading (flow & motor)

Observation & Recommendation

- Suitable approach is not available for measuring the CW flow at pump outlet, so flow has measured in each condenser outlet. Moreover, total CW pump flow has calculated by adding each measured condenser flow and ACW pump flow. As the ACW pump suction is through CW header outlet.
- As flow measurement of individual pumps were not possible, so measured flow were added and distributed according to power consumption for both CW pump

- During Flow measurement, it was observed that the LHS flow was more than RHS in both units. As difference in flow found in both units, so it may be due to the design as well as there might be some obstruction in the flow path.
- The efficiency of all CW pumps in both units is around 57 to 59 % and head developed is around 17 to 20 m, whereas the rated efficiency at rated head (22.5m) is 85%.
- Percentage loading in motor of CW 1A, CW 1B, CW 2A & CW 2B are found to be 79.98%, 80.30%, 76.91% & 76.17% respectively. This is shown in Figure 8.6
- Specific power consumption is within the design limit for all the four pumps.

8.3.2 ACW PUMP

Auxiliary cooling water (ACW) pumps takes suction from CW pump discharge header and circulates this cooling water in plate heat exchanger (PHE) to maintain the temperature of DMCW water. Two ACW pumps are installed for a single unit and in normal operating condition one pump is operated. The Pump design flow is 1950m^3/hr with developed head 14m.The flow was measured using ultra sonic flow meter and the same time power being measured with power analyzer. Suction and discharge pressure were recorded from local installed pressure gauges at the inlet and outlet of pump. The design details of pump and performance calculation data given in Table 8.21 and 8.22 respectively.

Table 8.21: Design details of ACW

Description	Unit	Data
Designation of the pump		ACW BOOSTER PUMPS
Manufacturer		FLOWIORE LIMITED
Model No.		F5821- 450X400
No of Pumps Total	Nos.	4 Nos (for 2 units)
Raled capacity	M3/hr	1950
Total dynamic head at rated capacity,	mwc	14
Pump rated speed	RPM	988
Motor rating	KW	110
Power factor	PF	0.84

Table 8.22: Pump Performance of ACW

Parameter	Unit	Design	ACW 1B	ACW 2B
Pump discharge flow	m^3/hr	1950.00	1410.00	1772.75
Total Head Developed	m	14.00	15.00	11.00

Input Motor Power	kW	110.00	97.06	93.74
Rated Motor power	kW	110.00	110.00	110.00
Motor Efficiency	%	0.95	0.95	0.95
Combined Overall Efficiency	%	67.63	59.38	56.69
Pump Efficiency	%	88.00	62.50	59.67
Percentage loading of flow	%	100.00	72.31	90.91
Percentage loading on motor	%	100.00	83.82	80.96
Specific consumption	kW/TPH	0.06	0.07	0.05

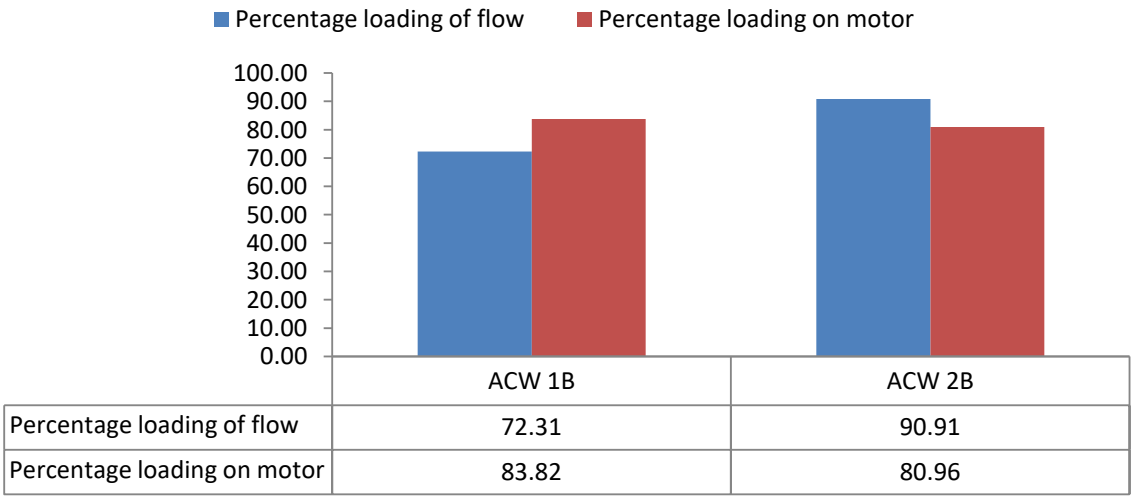


Figure 8.7: ACW percentage loading (flow & Motor)

Observation

- Flow was measured at Pump suction line in both units and pressure recorded from pressure gauges installed at inlet and outlet of pump.
- Loading comparison of ACW in respect of flow and motor power is shown in Figure 8.6. ACW 1B & ACW 2B flow are found to be 1410 m^3/hr & 1772.75 m^3/hr against the design flow 1950 m^3/hr at the developed head 15m and 11m respectively.
- Specific energy consumption for both unit pumps is near to design.
- Overall pump performance is satisfactory.

8.3.3 DMCW PUMP

The performance calculation of DMCW pump is given in Table 8.23

Table 8.23: Pump Performance of DMCW

Parameter	Unit	Design	DMCW 1 B	DMCW 2 A
Pump discharge flow	m^3/hr	1730.00	1494.60	1390.00
Total Head Developed	m	44.00	39.20	39.80
Input Motor Power	kW	300.00	269.00	263.00
Motor Efficiency	%	0.95	0.95	0.95
Combined Overall Efficiency	%	69.14	58.94	56.92
Pump Efficiency	%	84.00	62.04	59.91
Percentage loading of flow	%	100.00	85.79	79.78
Percentage loading on motor	%	100.00	85.18	83.28
Specific consumption	kW/TPH	0.17	0.18	0.19

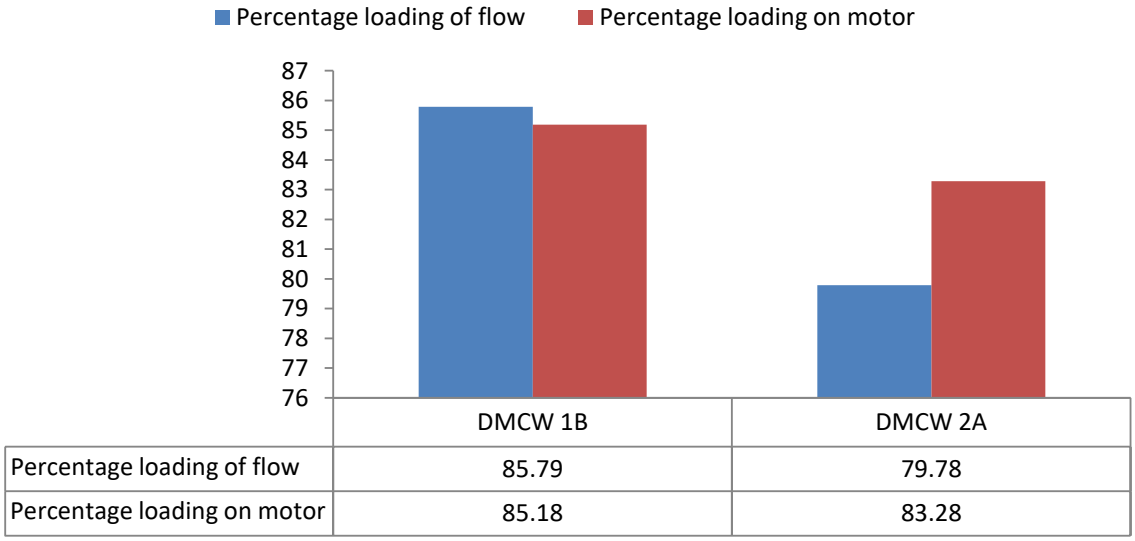


Figure 8.8: DMCW Pump loading (flow & power)

Observation

- The performance of DMCW pumps of both the units have been analyzed by measuring the flow, pressure developed and power consumption of the pumps. Flow was measured using ultrasonic flow meter and at the same time power was measured by using power analyzer. Inlet and outlet pressure of the pump was recorded from local pressure gauges installed at inlet and outlet of the pump.

- The measured flow is 1496 m^3/hr and 1390 m^3/hr for the pump DMCW 1B, & DMCW 2A respectively. However during flow measurement it was observed that there is difference of approx 400m^3/hr between flows recorded with ultrasonic flow meter and flow showing at DCS.
- It is recommended to calibrate the DCS flow meter as there is difference observed between measured flow value and DCS value.
- DMCW pump efficiency of is found to be 62.04% and 59.91% for unit 1 and unit 2 respectively, against the design value of 84%
- Percentage loading of flow of Unit 1 DMCW 1B & Unit 2 DMCW 2A are found to be 85.79% & 79.78% respectively and motor loading is found to be 85.18% and 83.28% for unit 1 and unit 2 motor respectively. This is shown in Figure 8.7
- Specific power consumption in both units pump is found to be on higher side than design.
- Unit 1 & 2 DMCW pump is running with lower efficiency as compared with design , so pumps internals to be checked for improving the efficiency

CHAPTER- 9

FUEL FEEDING SYSTEM

Natural gas is fired in the Gas turbine is coming from the ONGC Natural gas reserves located in Tripura through dedicated piping. Before feeding to the gas turbine natural gas is passed through different micron size filters to remove impurities available in gas. In addition, pressure and temperature of the natural gas has also increased by the Gas Booster compressor. As per P & I diagram, the fuel feeding capacity for each unit is 63470m^3/hr.

The natural gas from reservoir is passed through Gas scrubber and coalscent filter section for removing suspended particles and aerosols. In between, these two section, OTPC has installed three Gas booster compressors (two in operation and one in standby) for increasing the pressure. The design details of Gas booster compressor is provided in the Table 9.1

Table 9.1: Design specification of GBC

Description	Data
Number Installed	THREE (2 W + 1 S)
DRIVER TYPE	ELECTRIC MOTOR
TYPE OF COMPRESSOR	CENTRIFUGAL COMPRESSOR
GAS HANDLED	NATURAL GAS
MANUFACTURER	BHEL
MODEL	BCL 406

9.1 Gas Booster compressor

The performance of the Gas booster compressor has been calculated as per the data taken from the DCS. The adiabatic efficiency of the GBC is calculated and mentioned the Table 9.2.

Table 9.2: Gas Booster compressor analysis

particulars		GBC 2	GBC 3
inlet pressure	kg/cm^2	13.5	13.5
discharge pressure	kg/cm^2	33.47	34.00
compression ratio	R	2.48	2.52
inlet temperature	K	301.10	301.45
air isentropic exponent = k	K	1.30	1.30
(K-1)/K		0.23	0.23
Compressor isentropic exit temp.	K	370.29	372.05

Compressor actual exit temp.	K	408.20	411.95
compressor efficiency	%	64.60	63.89

Observation & Analysis

- The adiabatic efficiency of the gas booster compressor is calculated from the details taken from the DCS details and found to be 64.60 % for GBC – 2 and 63.89 % for GBC – 3.
- The power measured for the GBC – 2 and GBC – 3 is measured and found to be 3824 KW and 3800 KW against the design of 3840 KW.

CHAPTER -10

LIGHTING

Lux measurements and power measurement of LDB were taken using the power analyzer and Lux meters. The parameters were measured to estimate the lux level for each location. OTPC has installed different types of lights with variety of input power in different areas. The detail lighting system load is provided in the Table 10.1

Table 10.1: Lighting system load

AREA	28 W (Tube Light)	400 W	70 W	150 W	250 W	40 W	125 W
Switchyard	396	144	32	19	18	N/A	N/A
D.G. Building	N/A	N/A	N/A	9	N/A	N/A	N/A
I & SA Compressor House	N/A	N/A	N/A	110	N/A	N/A	N/A
D.M. Plant	104	N/A	N/A	11	N/A	N/A	N/A
GBC	26	N/A	4	30	18	N/A	N/A
Cooling Tower	24	N/A	35	29	5	N/A	N/A
RW Pump House	18	N/A	3	10	N/A	N/A	N/A
River water intake pump	40	N/A	8	33	4	26	15
4 MT Switch Gear	208	N/A	N/A	N/A	N/A	N/A	N/A
GTG-1 & STG-1 Aux Area	40	N/A	8	43	12	N/A	15
Unit Control building	516	N/A	N/A	N/A	N/A	N/A	N/A
STG-1 Hall	108	37	N/A	N/A	N/A	N/A	5
Battery, Battery charger & UPS Room	276	8	N/A	N/A	N/A	N/A	N/A
Fire water	24	N/A	N/A	14	9	N/A	N/A
Boiler & HRSG	N/A	N/A	59	25	N/A	N/A	N/A
BFP Building	102	N/A	15	22	14	N/A	8
ETP	32	N/A	N/A	19	N/A	N/A	N/A
Total	**1914**	**189**	**164**	**374**	**80**	**26**	**43**

10.1 Power & Lux Measurement

The instantaneous lighting power consumption was measured and details are as follows.

Table 10.2: Lighting power consumption

Description	28 W Tube Light	400 Watt	70 Watt	150 Watt	250 Watt	40 W	125 W
Total connected load	1914	189	164	374	80	26	43

Measured power	53592	75600	11480	56100	20000	1040	5375
KW	53.592	75.6	11.48	56.1	20	1.04	5.375

The lux level at different location has been carried out using Testo lux meter and the readings are provided in Table 10.3

Table 10.3: Lux Measurement

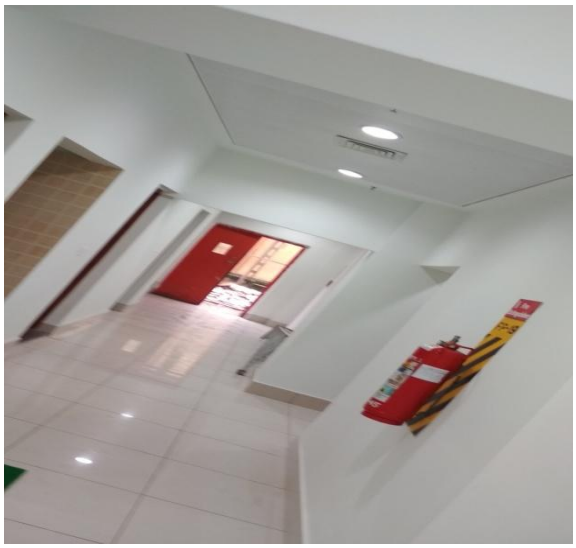
Parameter	Unit	Readings
office Building		
Entry gate hall	Lux	200
Entry to steps	Lux	100
Unit - 1		
Switch gear control room	Lux	115
Near TIE 6.6 KV (1CB = 006) feeder	Lux	20
in front of ventilation MCC - 1	Lux	5
in front of DMCW pump - B (feeder)	Lux	150
exit of unit - 1 switch gear towards GT	Lux	5
Unit - 1 TG Floor		
Towards HP turbine	Lux	110
LP turbine left side/right side	Lux	200
infront of generator	Lux	150
HP turbine	Lux	200
Near gas line @ zero meter	Lux	80
Near NGT	Lux	30
Gas turbine zero meter	Lux	25
In front of DMCW 1 B	Lux	134
In front of DMCW 1A	Lux	120
In front of plate heat exchanger	Lux	120
Hot well are	Lux	185
mall 34 valve	Lux	130
unit NGT/NGR	Lux	10
Vacuum pump area	Lux	150
unit -2		
In front of generator	Lux	100
Right side of turbine	Lux	100
Left side of turbine	Lux	90
In front of turbine	Lux	70
unit - 2 ladder near GT - 2	Lux	50

zero meter near GT -2	Lux	40
unit - 2 main oil tank	Lux	30
unit - 2 MA2L - 34	Lux	25
In front of CEP - 2A & 2 B	Lux	120
Near vacuum pump	Lux	50

Observation-

- As per the pictorial presentation shown below which was measured during the field study on the day of audit. The measured lux was found on higher recommended lux level. The BIS standard for lighting lux level is provided in Annexure.

Main control Building Entrance area



Main control Canteen walk way area

Figure 10.1: Pictorial diagram of Main control building entrance

- In Switchgear room light was switch on even when no occupancy was there during day time. Separate lighting circuit should be there for minimum lighting .As per the pictorial presentation shown below
- As per discussion with plant personal, the process of installing voltage regulator for lighting system is already initiated.

U#1 Switchgear area

U#2 Switchgear area

Figure 10.2: Pictorial diagram of Unit 1 and Unit 2 Switch gear area

Recommendation-

- Only minimum lighting should be on all time or 50% lighting should be on during day time when no occupancy is there.(All plant switchgear room) Separate switches for minimum lighting in identified area The Energy saving is calculated for optimizing the lighting is shown in Table 10.4

Table 10.4: ECM for lighting optimization

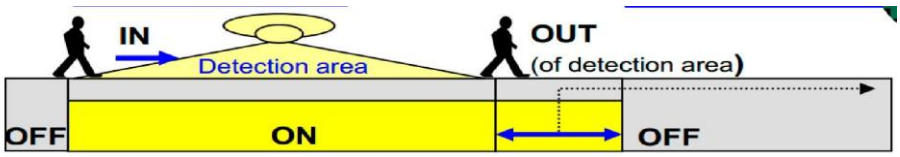
Sl. No.	Location	Fitting type	Quantity	Day time requirement	energy saving yearly (kWh)
1	Switchyard MCC Room	2x28W Tubelight Fitting	20 set	10 set	4905.6
2	Switchyard Cable Celler Room	2x28W Tubelight Fitting	19 set	10 set	4415.04
3	Switchyard battery & HVAC rooms	2x28W Tubelight Fitting	17 set	9 set	3924.48
4	Inside DG Building	150W HPSV	6 nos.	3 set	7884
5	Inside Compressor house	150W HPSV	6 Nos.	4 Nos	2628
6	DM Plant inside	2x28W Tube light	18 set	9 set	4415.04
7	DM plant MCC Room	2x28W Tube light	8 set	4 set	1962.24
9	GBC MCC Room	2x28W tubelight	13 set	6 set	3433.92
10	CT MCC Room	2x28W tubelight	12 Nos.	6 set	2943.36
11	CT pump house Room	250W HPSV	5 nos.	3 nos	4380
		70W HPSV	11 nos.	6 nos	3066

12	Raw water MCC Room	2x28W tubelight	9 set	4 set	2452.8
13	ETP MCC Room	2x28 W Tubelight	8 set	4 set	1962.24
14	BFP area MCC Room	2x28W tubelight	17 set	8 set	4415.04
15	Top floor	150W HPSV	8 nos.	4 Nos	5256
16	Fire water MCC Room	2x28W tubelight	9 set	5 set	1962.24
17	Battery& charger bank room	2x28W tubelight	38 set	19 set	9320.64
18	HVAC chiller room	2x28W tubelight	28 set	14 set	6867.84
19	HVAC room	2x28W tubelight	20 set	10 set	4905.6
20	Total energy saving in kWh				81100.08
21	Energy saving in Rs. Cr				0.022303
22	Investment				Nil
23	Payback				Immediate

- Nature switch is best solution for outdoor unit lighting system. It works on Infrared sensing which is tuned by nature itself .It works on road light and outdoor lights.
- Install timer in lighting circuit so that unnecessary lights should not glow during day time.
- Install an inductive transformer in the lighting MCC. It will reduce the APC as well as the life of light.
- Nature switch operated by illumination level(Application for outdoor lights)
- Operating luminance level

  For switching on <60 lux for> 30 sec

  For switching off >100 lux for> 30 sec
- Passive Infrared sensor (PIR) control can be installed in Administrative building and switchgear room. It works on occupancy basis. Time and distance can be set in the sensor. Diagram explaining the PIR sensor is provided in the below Figure



CHAPTER -11

AIRCONDITIONING AND VENTILATION SYSTEM

OTPC has installed Vapour compression refrigeration system of different capacity is installed to provide cooling requirement. In addition, stand alone AC unit is also installed. The Detailed Energy Audit in HVAC system includes study of following equipments.

1. Chiller plant
2. AHU
3. Chilled water pump
4. Condenser water pump
5. Cooling tower

11.1 Chiller plant

The design detail of chiller plant is provided in the Table 11.1

Table 11.1: Design details of HVAC

Description	Data
Make	Voltas – Kolkata
Location of the system	Main control Room building
HVAC Capacity	150 TR
Type	Water cooled screw compressor
MANUFACTURER	BHEL
Chiller Model	GSWCDXR170-1

During audit, the chiller B was running. Measurements of chiller pump, condenser pump and cooling tower were collected from the daily log sheet. The parameters were measured to estimate the performance of chiller. The results presented in below Table.

Table 11.2: Performance evaluation of Chiller system

Description	Unit	Design	Data
Chilled water pump flow	m^3/hr	91	95
Chilled water inlet temperature	^oC	12	12
Chilled water outlet temperature	^oC	7	7
Chiller B delivered	TR		157.08
Chiller B power consumption	KW	138	123.44
Specific power consumption			0.785

11.2 AHU

The plant has installed various rating Air handling units at different location to supply cool air to the room. The power measurement was carried out for AHU at different location. The results of the power measured is shown in below table

Table 11.3: AHU Power measurement

AHU	Unit	Power
0 meter	kW	3.69
4.5 meter	kW	6.26
11.5 meter	kW	8.04
17.5 meter (unit - 1)	kW	6.14
17.5 meter (unit - 2)	kW	6.14

11.3 Chilled water pump

The HVAC system has two chilled water pump (one running and one standby). The design details of Chilled water pump is provided in table 11.4

Table 11.4: Chilled pump design details

Description	Data
Make	KIRLOSKAR BROTHERS LTD.
Motor KW	9.3 KW
Pump efficiency	77 %
Total head	21 M
Discharge Flow	91 CMH
pump Model	**CE80/26**

The performance of the chilled pump is calculated and provided in the Table 11.5

Table 11.5: Performance evaluation of Chilled water pump

Description	Unit	Design	Chilled water pump B
Pump discharge flow	m^3/hr	91.00	95.00
Total Head Developed	m	21.00	18.00
Input Motor Power	kW	9.30	7.94
Motor Efficiency	%	0.95	0.95
Combined Overall Efficiency	%		58.72
Pump Efficiency	%	71.00	61.81
Percentage loading on motor	%		85.33
Specific power consumption	kW/TPH		0.08

percentage loading on head	%		85.71

11.4 Condenser water pump

The HVAC system has two condenser water pumps (one running and one standby). The design details of condenser water pump is provided in table 11.6

Table 11.6: condenser pump design details

Description	Data
Make	KIRLOSKAR BROTHERS LTD
Motor KW	18.5 KW
Pump efficiency	71 %
Total head	24 M
Discharge Flow	143 CMH
pump Model	DB100/32

The performance of the condenser water pump is calculated and provided in the Table 11.7

Table 11.7: Performance evaluation of condenser water pump

Description	Unit	Design	Condenser water pump B
Pump discharge flow	m^3/hr	143.00	145.00
Total Head Developed	m	24.00	11.00
Input Motor Power	kW	18.50	14.09
Motor Efficiency	%	0.95	0.95
Combined Overall Efficiency	%	50.55	30.85
Pump Efficiency	%	71.00	32.48
Percentage loading on motor	%	100.00	76.15
Specific consumption	kW/TPH	0.13	0.10
percentage loading on head	%		45.83

11.5 Cooling Tower

The HVAC plant has two cooling tower for cooling the condensed water. One cooling tower for each Chiller. The performance evaluation of cooling tower has calculated and provided below

Table 11.8: Performance evaluation of Cooling tower

Parameters	Unit	Data
CT inlet temperature	^oC	31.10
CT outlet temperature	^oC	29.00
Condensed water flow rate	m^3/hr	

Dry Bulb temperature	ºC	26.50
Wet Bulb temperature	ºC	26.40
Range	ºC	2.10
Approach	ºC	2.60
Effectiveness	%	44.68

Observation-

- The specific power consumption of the water cooled screw chiller is calculated and found to be 0.785 KW/TPH.
- The chilled pump and condenser pump efficiency has been evaluated and found to be 61.81 % and 32.48 % respectively against the design value 71 %.
- The condenser pump efficiency is very low. This may be due to low operating head. Based on the pump performance curve, head should be around 22 M for the operating parameter. But the operating head is around 11 M. Hence it is recommended to check the piping and pump internal.
- The chilled water pump works satisfactory.
- The cooling tower of Chiller 1 and Chiller 2 has evaluated and effectiveness of the plant is around 44.68 %.
- During audit one chiller was in operation and another was in standby. In the same manner, one cooling tower is dedicated to one chiller. Hence one cooling tower should run during audit. However, two cooling tower was in operation.
- The cooling tower fills is not in good condition. Hence it is recommended to maintain the cooling tower properly and stop one CT fan. The energy saving calculation is provided below.

Parameter	Unit	Data
Number of CT Fan running		2
power consumption of HVAC CT Fan B	KW	3.28
power consumption of HVAC CT Fan A	KW	3.4
Power saving	kW	3.28
Annual running hours	hrs/yr	5606.4
Annual energy saving	kWh/yr	18388.99
Energy cost	Rs/kWh	2.75
Annual Energy Saving	Rs.Cr	0.01
Investment	Rs.Cr	0.005

Payback	Month	12

Actual investment cost to be verified with Vendor

- The AHU provided for each floor is working in partial load. Cooling load of AHU may vary frequently and there is no control to optimize the energy consumption. It is proposed to install Variable Frequency Drive for all AHUs with temperature feedback system to optimize the energy consumption

Parameter	Unit	Data
Number of AHU running	No	5
Power consumption of AHU	KW	30.27
power saving	KW	4.5405
Annual running hours	hrs/yr	5606.4
power saving	kWH	25455.86
Energy cost	Rs/kWh	2.75
Annual Energy Saving	Rs.Cr	0.007
Investment	Rs.Cr	0.015
Payback	Month	26

Actual investment cost to be verified with Vendor

CHAPTER -12

AUXILIARY PUMPING

Performance of following pump has evaluated during audit by conducting flow measurement and power measurement using ultrasonic flow meter and power analyzer

1. Raw water pump
2. Hydrant pump
3. Degasser pump

12.1 Raw water pump

The Raw water pump is the main equipment for providing the necessary water to the plant from the water reservoir. The performance of the raw water pump has been evaluated based on the reading measured using ultrasonic flow meter and power analyzer. The result of the raw water performance is provided in Table 12.1

Table 12.1: RAW water pumps performance

Parameter	Unit	Design	RAW A	RAW B	RAW C
Pump discharge flow	m^3/hr	585.00	565.80	579.00	503.20
Total Head Developed	m	20.00	21.00	20.00	22.00
Input Motor Power	kW	45.00	49.25	48.32	46.00
Rated Motor power	kW	45.00	45.00	45.00	45.00
Motor Efficiency	%	0.933	0.933	0.933	0.933
Combined Overall Efficiency	%	70.85	65.74	65.31	65.58
Pump Efficiency	%	84.00	70.46	69.99	70.29
Percentage loading of flow	%	100.00	96.72	98.97	86.02
Percentage loading on motor	%	100.00	102.11	100.18	95.37
Specific consumption	kW/TPH	0.08	0.09	0.08	0.09

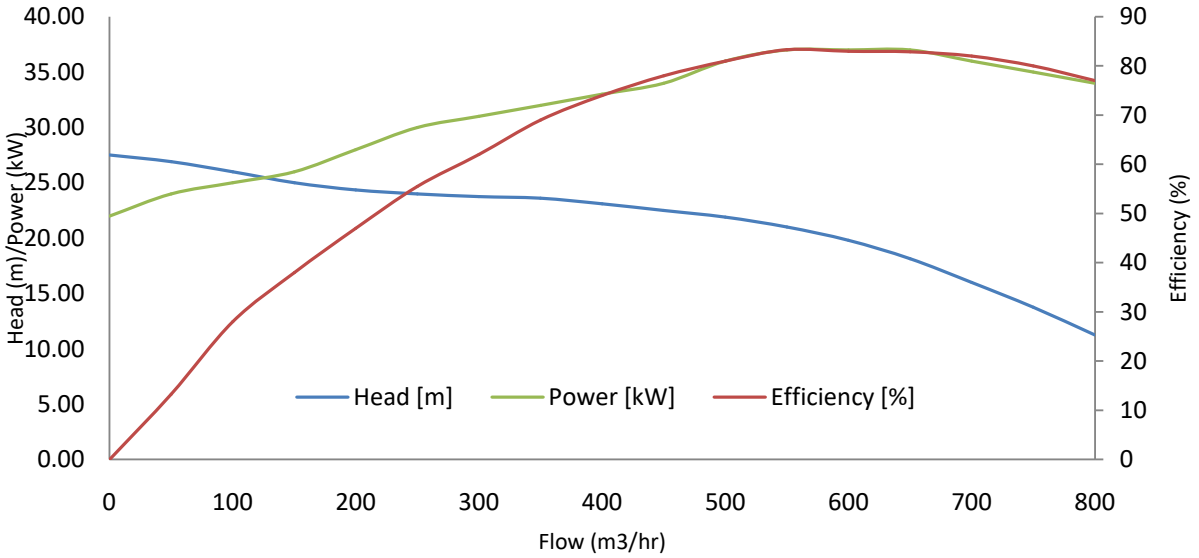


Figure 3: Raw water pump characteristic curve

Observation & Recommendation:-

- The performance of raw water pumps have been analyzed by measuring the flow, pressure developed and power consumption of the pumps. Flow is measured using ultrasonic flow meter and at the same time power is measured by using power analyzer. Head is calculated from pressure transmitter installed at outlet of pump.
- The measured flow is 565m^3/hr, 579m^3/hr and 1390m^3/hr for the pump A, B & C respectively at the developed head between 20 to 22m for all the three pumps.
- It is recommended to calibrate the pressure gauge installed at the outlet of pump, pressure fluctuation was observed during flow measurement.
- Pump efficiency is found to be 70.46%, 69.99% and 70.29% for pump A, B & C respectively, against the design value of 84%
- Specific power consumption is found to be on higher side than design.
- From the pump characteristic curve shown in Figure 12.1, power consumption for all the three pumps should be approx in between 35kw to 38kw at the measured flow and head. But the actual consumed power is in between 46 kW to 49 kW.
- It is recommended to check the internals of the pump as it taking more power than the design kW.

12.2 Hydrant pump

The performance of the hydrant pump has been evaluated based on the reading measured using ultrasonic flow meter and power analyzer. The result of the motor hydrant & spray pump performance is provided in Table 12.2. Meanwhile, the performance of diesel hydrant & spray pump is shown in Table 12.3.

Table 12.2: Hydrant pumps performance

Parameter	Unit	Design	Motor hydrant 1	Motor hydrant 2	Motor Spray
Pump discharge flow	m3/hr	273.00	225.0	196	222
Total Head Developed	m	94.34	92.00	94.00	88.00
Input Motor Power	kW	110.00	75.52	68.98	84.52
Rated Motor power	kW	110.00	110	110	110
Motor Efficiency	%	0.95	0.95	0.95	0.95
Combined Overall Efficiency	%		74.69	73.06	63.13
Pump Efficiency	%	80.00	78.62	76.91	66.45
Percentage loading of flow	%		82.42	72.07	81.50
Percentage loading on motor	%		65.22	59.57	72.99
Specific consumption	kW/TPH	0.40	0.34	0.35	0.38

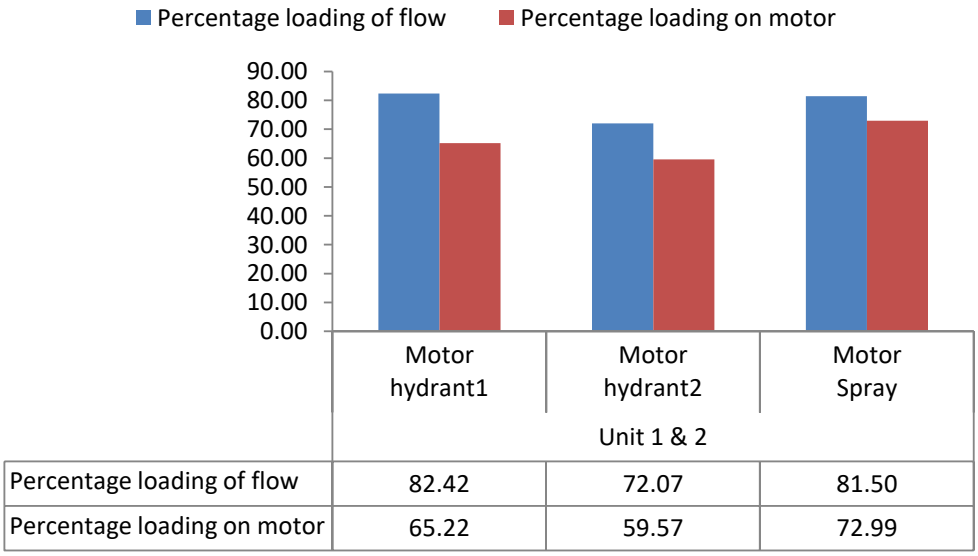


Figure 4: Hydrant pump percentage loading (motor & flow)

Table 12.3: Diesel Hydrant pumps performance

Parameter	unit	Design	Diesel hydrant	Diesel Spray
Pump discharge flow	m3/hr	273.00	221.25	210.00
Total Head Developed	m	94.34	98.00	98.00
Input Bowl Power	kW	90.53	88.00	86
Rated Bowl power	kW	90.53	90.53	90.53
Bowl Efficiency	%	80.00	80.00	80.00
Pump Hydraulic power		70.18	59.08	56.08
Total Bowl power	kW	90.65	88.12	86.12
Input power	kW	92.50	89.92	87.88
Combined Overall Efficiency	%	75.87*	65.71	63.82
Pump Efficiency	%	80.00	67.05	65.12

**Design combined overall efficiency is calculated based on the design data*

Observation: -

- Overall pump performance is satisfactory.
- During the time of audit it was observed that the Diesel hydrant was getting too hot within 5 mins of running, that must be kept under observation.
- Flow measurement of diesel Hydrant pump and diesel hydrant spray has carried out and found to be 220 m^3/hr and 210 m^3/hr. Discharge pressure was 9.8 kg/cm^2.
- The Diesel hydrant and Diesel spray pump efficiency has calculated based on the measured flow and pressure and it is found to be 67.05% and 65.12 respectively against the design value of 80 %.
- As per the hydrant pump loading figure shown in Figure 12.2, the percentage loading with respect to flow & motor power for hydrant pump 1, hydrant pump 2 and spray is found to be 82.42% & 65.22%, 72.07% & 59.57% and 81.50% &72.99% respectively.

12.3 Degasser water pump

The performance of the degasser pump has been evaluated based on the reading measured using ultrasonic flow meter and power analyzer. The result of the degasser water performance is provided in Table 12.4

Table 12.4: Degasser pumps performance

Parameter	Unit	Design	DGWTP A	DGWTP B
Pump discharge flow	m3/hr	21.00	13.36	10.49
Total Head Developed	m	35.00	33.59	36.00
Input Motor Power	kW	5.50	5.17	5.74
Rated Motor power	kW	5.50	5.50	5.50
Motor Efficiency	%	0.86	0.86	0.86
Combined Overall Efficiency	%	36.42	23.65	17.93
Pump Efficiency	%	49.40	27.50	20.85
Percentage loading of flow	%		63.62	49.95
Percentage loading on motor	%		80.84	89.75
Specific consumption	kW/TPH	0.26	0.39	0.55

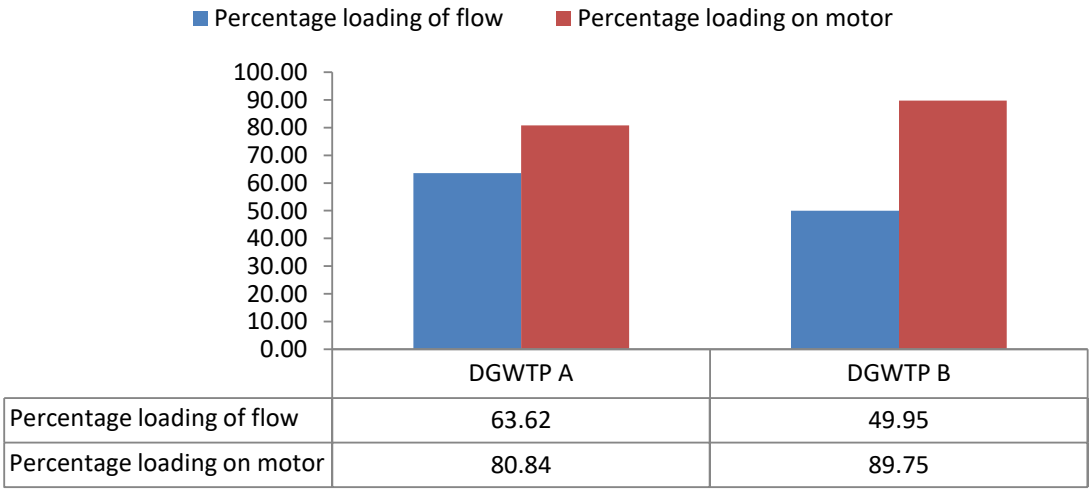


Figure 5: Degasser water pump percentage loading (motor & flow)

OBSERVATION:-

- The performance of Degasser pump have been analyzed by measuring the flow, pressure developed and power consumption of the pumps. Flow is measured using ultrasonic flow meter and at the same time power is recorded. Head is calculated by Pump law.
- The measured flow is 13.36 m^3/hr, 10.49m^3/hr for the pump A and B respectively. Design flow is 21m^3/hr.
- The measured current consumption during audit is 8.25 Amp and 9.18 Amp for DGWTP A and DGWTP B respectively.

- It is recommended to calibrate the pressure gauge installed at the inlet of pump, pressure fluctuation was observed during flow measurement.
- Pump efficiency is found to be only 27.50% and 20.85% for pump A and B respectively; against the design value of 49.40%.It may be due to the low flow.
- Specific power consumption is found to be on higher side than design.
- As per the degasser water pump loading figure shown in Figure 12.3, the percentage loading with respect to flow & motor power for DGWTP A and DGWTP B is found to be 63.62% & 80.84% and 49.95% & 89.75% respectively.
- The loading percentage of flow is less; however the motor power loading is more this may be due to pump internals. Hence it is recommended to check the internals of the pump.

CHAPTER -13

INSTRUMENT AIR COMPRESSOR (IAC)

The plant has installed two instrument air screw compressor with the capacity of 15 NM^3/min for the compressor air requirement. The operating pressure of the compressor is 8.5 bar. The design details of the instrument air compressor is provided in Table 13.1

Table 13.1: Design Details of IAC

Parameter	Design specification
Make	Atlas Copco (India) Ltd.
Type of compressor	Oil Free Screw
Capacity of each Air compressor	15 NM^3/Min
Discharge pressure at rated condition	8.5 bar
KW rating of drive motor	132 kW
Total Numbers	2

The power consumption of Instrument air compressor has measured using power analyzer and provided in table 13.2

Table 13.2: Power Consumption of IAC

Parameter	Voltage (V)	Current (A)	Power Factor	Power (kW)
Instrument Air Compressor A	437.4	52.1	0.8	31.58
Instrument Air Compressor B	450	53.47	0.84	35.01

Observation & Recommendation:-

- While audit, both Instrument air compressor was in service, IAC – A in loading condition and IAC – B in unloading condition.
- Based on the Technical diary, kW input required to the compressor in loading condition and unloading condition is found to be 119 kW and 27 kW respectively.
- The power required for running the both compressor is calculated to be 146 kW. Hence the power consumption of both IAC for a particular day is calculated and found to be 3504 kWh.
- As per above analysis, it is recommended to keep one IAC in service and another IAC in standby condition.

- By keeping the one IAC in standby condition, the unloading power consumption of 27 kW will be reduced.

Description	Unit	IAC
Loading Power consumption	kW	192.00
Unloading power consumption	kW	27.00
Power saving	kW	27.00
Annual operating hours		5606.40
Annual Energy Saving potential	kWh	151372.80
Energy Cost	Rs./kwh	2.75
Annual Monetary Saving	Rs. Cr	0.04
Investment for VFD	Rs. Cr	NIL
Payback	Months	Immediate

CHAPTER -14

HT and LT MOTORS

Measurements of all HT motors of HRSG, turbine & BOP area were taken using the Power Analyzer, which measures Voltage, Current, kW, and P.F. etc. The parameters were measured to estimate the electrical loading of the motors. The measurements taken are tabulated and presented in below Table.

14.1 Power Measurement

The instantaneous power consumption was measured in all auxiliary loads and details are as follows.

Table 14.1: Common switch gear

Sl. No	Date	Equipment Name	Design	Efficiency (N)	Voltage(kV)	Current	PF	Power(KW)	TRN POWER (KVA)	% LOADING
1	9/8/2017	Admin Building 1	1600 KVA	N/A	7.12	8	0.74	76	102.70	6.42
2	9/8/2017	Admin Building 2	1600 KVA	N/A	6.93	8	0.69	73	105.80	6.61
3	9/8/2017	Gas Station 1	1600 KVA	N/A	7.12	17	0.834	175	209.83	13.11
4	9/8/2017	Gas Station 2	1600 KVA	N/A	6.92	16	0.874	176	201.37	12.59
5	9/8/2017	Gas Booster Compressor-B	3840 kW	96	7.11	338	0.919	3824	4161.04	95.6
6	9/8/2017	Gas Booster Compressor-C	3840 kW	96	6.92	16	0.874	175	200.23	4.38
7	9/8/2017	Raw water switchgear 1	1600 KVA	N/A	7.11	12	0.735	109	148.30	9.27
8	9/8/2017	Raw water switchgear 2	1600 KVA	N/A	6.92	14	0.729	122	167.35	10.46
9	9/8/2017	River water Intake 2	1000 KVA	N/A	6.93	10	0.87	106	121.84	12.18
10	9/8/2017	S.T 1	25000 KVA	N/A	7.11	389	0.91	4337	4792.27	19.17
11	9/8/2017	S.T 2	25000 KVA	N/A	6.92	411	0.90	4431	4934.30	19.74
12	9/8/2017	STN Service Transformer(TRF) 1	2000 KVA	N/A	7.12	16	0.711	140	196.91	9.85
13	9/8/2017	STN Service Transformer(TRF) 2	2000 KVA	N/A	6.94	24	0.661	191	288.96	14.45
14	9/8/2017	Switch Yard TRF 1	500 KVA	N/A	6.82	2	0.452	14	30.97	6.19
15	9/8/2017	Switch Yard TRF 2	500 KVA	N/A	6.91	5	0.2	12	60	12

Table 14.2: Unit 1 Power consumption

Equipment Name	Design	EFFICIENCY	Voltage(kV)	Current	PF	Power(KW)	TRN POWER IN (KVA	%LOADING

CT PMCC 1	1600 KVA	N/A	6.569	40	0.831	381	458.48	28.66
CW Pump A	1150 kW	95	6.567	107	0.78	944	1218.06	77.98
Excitation Transformer	2000 KVA	N/A	6.564	65	0.294	216	734.69	36.73
HP BFP A	4000	97	6.567	196	0.842	1871	2222.09	45.37
STG PMCC1	1600 KVA	N/A	6.566	34	0.727	283	389.27	24.33
UAT 1C to 1CA		N/A	6.571	434	0.756	3747	4956.35	N/A
CEP -B	600	95	6.569	46	0.837	437	522.10	69.19
CT PMCC 2	1600 KVA	N/A	6.542	31	0.856	261	304.91	19.06
CW Pump B	1150	95	6.583	109	0.781	972	1244.56	80.30
DMCW-B	300	95	6.566	27	0.855	269	314.62	85.18
GT PMCC 2	1600 KVA	N/A	6.574	34	0.799	314	392.99	24.56
STG PMCC 2	1600 KVA	N/A	6.569	8	0.77	75	97.40	6.09
UAT 1C to 1CB		N/A	6.566	255	0.818	2357	2881.42	N/A

Table 14.3: Unit 2 Power consumption

Sl. No	Date	Equipment Name	Design(KW)	EFFICIENCY	Voltage (kV)	Current	PF	Power(KW)	POWER(KVA)	% LOADING
1	9/8/2017	CT PMCC 1	1600 KVA	N/A	6.659	38	0.841	375	445.90	27.87
2	9/8/2017	CW Pump A	1150	95	6.654	105	0.769	931	1210.66	76.91
3	9/8/2017	Static Excitation	2000 KVA	N/A	6.656	90	0.388	412	1061.86	53.09
4	9/8/2017	HP BFP B	4000	97	6.675	229	0.86	2229	2591.86	54.05
5	9/8/2017	STG PMCC 1	1600 KVA	N/A	6.657	14	0.794	129	162.47	10.15
6	9/8/2017	UAT 1C to 2CA		N/A	6.657	315	0.728	1735	2383.24	N/A
7	9/8/2017	CEP -A	600	95	6.657	48	0.844	468	554.50	74.1
8	9/8/2017	CT PMCC 2	1600 KVA	N/A	6.681	29	0.843	281	333.33	20.83
9	9/8/2017	CW Pump C	1150	95	6.667	104	0.766	922	1203.66	76.17
10	9/8/2017	DMCW-A	300	95	6.651	26	0.851	263	309.05	83.28
11	9/8/2017	GT PMCC 2	1600 KVA	N/A	6.671	34	0.8	323	403.75	25.23
12	9/8/2017	STG PMCC 2	1600 KVA	N/A	6.656	29	0.709	240	338.50	21.16
13	9/8/2	UAT 1C to		N/A	6.566	255	0.8	2357	2881.42	N/A

	017	1CB					18			
14	9/8/2017	TIE from 0CA		N/A	6.656	90	0.388	412	1061.86	N/A
15	9/8/2017	UAT 1C to 2CB		N/A	6.66	420	0.822	4005	4872.26	N/A

Table 14.4: LT Motor Power consumption

S.NO.	EQUIPMENT NAME	DESIGN(KW)	EFFICIENCY	VOLTAGE	CURRENT	P.F	POWER	% LOADING
1	LP BFP 1A	30	91	409	36.41	0.85	21.92	66.50
2	LP BFP 2A	30	91	406.7	39.65	0.85	23.74	72.01
3	ACW 1A	110	95	422	160	0.83	97.06	83.83
4	VACCUM PUMP 1A	110	95	422	165	0.85	102.51	88.53
5	IAC 1	132	95	437.4	52.1	0.8	31.58	22.73
6	IAC 2	132	95	450	53.47	0.84	35.01	25.19
7	ACW 2A	110	95	410	165	0.8	93.74	80.95
8	VACCUM PUMP 2 B	110	95	410	185	0.86	112.98	97.57
9	HYDRANT WATER PUMP A	110	95	435.5	154.5	0.62	72.25	62.40
10	HYDRANT WATER PUMP B	110	95	428.5	154.9	0.6	68.98	59.57
11	SPRAY WATER PUMP	110	95	434.2	156.1	0.72	84.52	73.00
12	RWP B	45	93.3	434	75.6	0.85	48.30	100.15
13	RWP A	45	93.3	426.2	78.5	0.85	49.25	102.12
14	RWP C	45	93.3	426.3	73.3	0.85	46.00	95.38
15	DGWTP-A	5.5	86	426	8.25	0.85	5.17	80.90
16	DGWTP-B	5.5	86	425	9.18	0.85	5.74	89.81

Table 14.5: Cooling Tower 1 Power consumption

S.NO.	EQUIPMENT NAME	DESIGN(KW)	EFFICIENCY %	AMP	VOLTAGE	P.F	POWER	% LOADING
1	CT FAN1	110	94.5	140	410.1	0.55	54.69	46.99
2	CT FAN 2			150	410	0.58	61.78	53.08
3	CT FAN 3			148	410.8	0.56	58.97	50.66
4	CT FAN 4			148	410	0.56	58.85	50.56
5	CT FAN 5			N/R				
6	CT FAN 6			130	411.4	0.54	50.02	42.97

7	CT FAN 7			150	412	0.52	55.66	47.82
8	CT FAN 8			142	411.2	0.53	53.60	46.05

Table 14.6: Cooling Tower 2 Power consumption

S.NO.	EQUIPMENT NAME	DESIGN(KW)	EFFICIENCY (%)	AMP	VOLTAGE	P.F.	POWER	% LOADING
1	CT FAN1	110	94.5	148	418	0.54	57.86	49.71
2	CT FAN 2			150	418.5	0.57	61.97	53.24
3	CT FAN 3			149	418.5	0.53	57.24	49.18
4	CT FAN 4			146	418.6	0.51	53.98	46.38
5	CT FAN 5			150	419	0.5	54.43	46.76
6	CT FAN 6			158	419	0.53	60.77	52.21
7	CT FAN 7			162	419	0.54	63.48	54.54
8	CT FAN 8			N/R				

Observation and Analysis

- Installation of Energy Meter in all HT motors for accurate and reliable measurement of electrical parameters (voltage, current, power, frequency, etc.).Integrated Modbus communications capability allows easy integration with energy monitoring systems for Efficiency of Motors.
- As per Table 13.1, two transformers supplies power to the admin building and the loading of these transformers is found to be at 6.42% & 6.61%. Due to this low load operation transformer loss are high. So, to reduce the no load losses of transformer, off one transformer and put load to other transformer.
- As per Table 13.4, Voltage measured at IAC feeder MCC bus is on higher side, as the motor design or rated voltage is 415V but bus voltage was found to be 450V. This may increases magnetization losses in transformer.

Recommendation

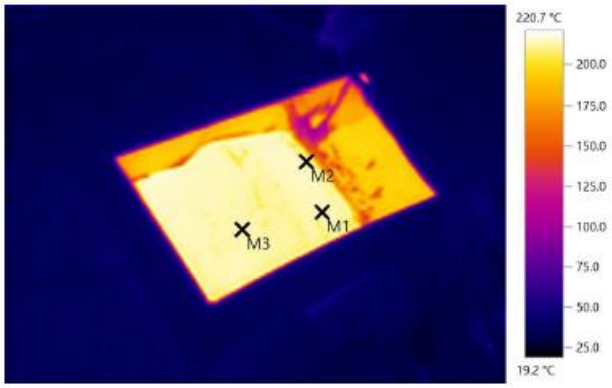
- There may be a possibility that both the Admin building Transformer feeder 1&2 can be switched off and the load can be switched to LT feeder by LT switchgear. So it reduces transformer full load losses and part load losses.
- The voltage to the IAC feeder should be reduced to the standard 415 V by tap changing. this 2.5% reduction in voltage may provide power saving of 0.65 %.

CHAPTER– 15

INSULATION SURVEY

Insulation Audit was carried out during the detailed energy audit to identify the damaged area of insulation in the boiler area, Turbine and associated steam lines. Surface temperatures were measured using non-contact infra red thermometer and the measurements are presented below. :

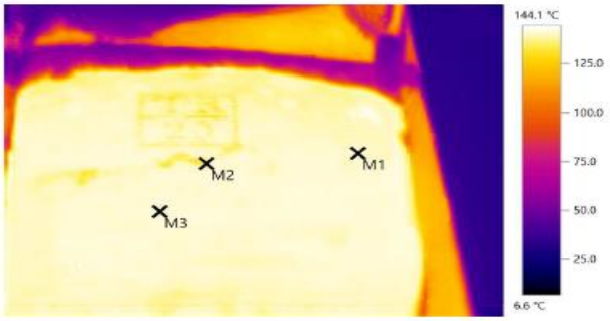
Unit 1 IP drum top name plate side



Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	213.3	0.95
Measure point 2	209.9	0.95
Measure point 3	212.9	0.95

Observation:
Insulation for the IP drum top is not provided and the tempreture is around 210°C. Thus needs proper insulation.

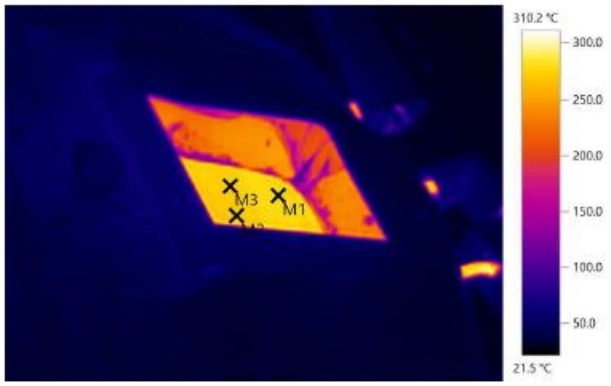
Unit 1 LP drum top area



Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	141.2	0.95
Measure point 2	138.2	0.95
Measure point 3	141.3	0.95

Observation:
Insulation is not provided on top of the LP drum and the tempreture is around 140°C. This needs proper concern and provide proper insulation.

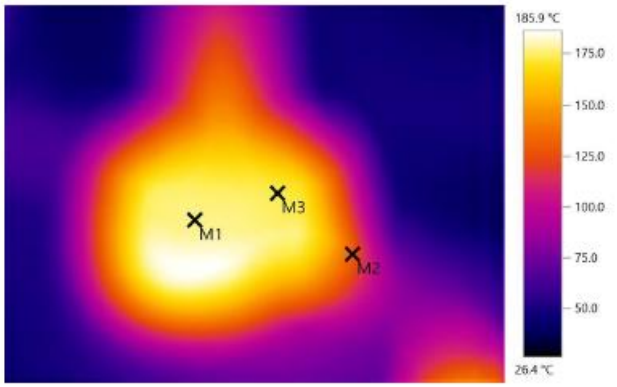
Unit 1 HP drum top area



Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	277.1	0.95
Measure point 2	269.2	0.95
Measure point 3	273.2	0.95

Observation:
There is no insulation on the top of the HP drum and the tempreture is around 270°C.

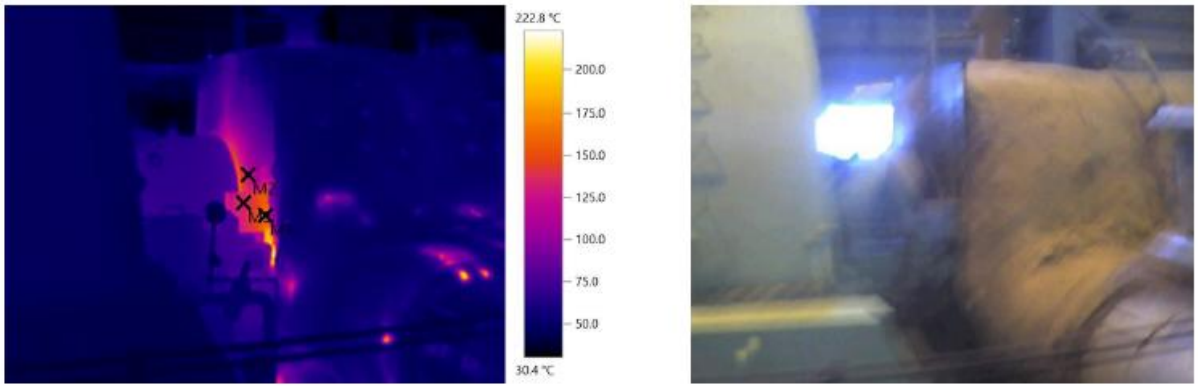
Unit 1 IP FCS valve



Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	176.8	0.95
Measure point 2	129.8	0.95
Measure point 3	172.9	0.95

Observation:
IP FCS Valve is not insulated. The tempreture was around 150°C which seems to be the heat loss. It needs proper insulation.

Unit 1 IP side cover

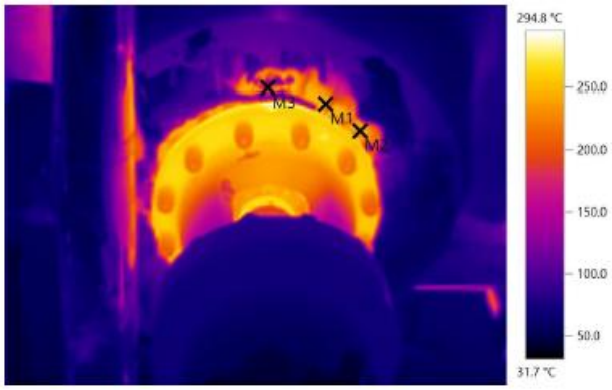


Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	160.4	0.95
Measure point 2	122.7	0.95
Measure point 3	131.9	0.95

Observation:

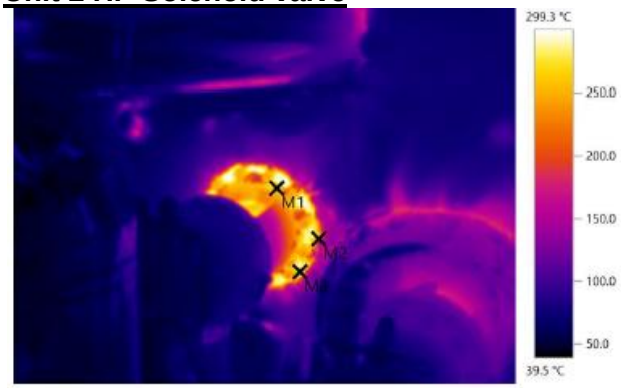
Turbine IP side is not insulated. The temperature was 140°C. However for unit -2 the temperature is within range for the same location. Hence it needs insulation.

Unit 1 HP solenoid valve HP 1



Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	247.5	0.95
Measure point 2	239.0	0.95
Measure point 3	199.0	0.95

Unit 2 HP Solenoid valve

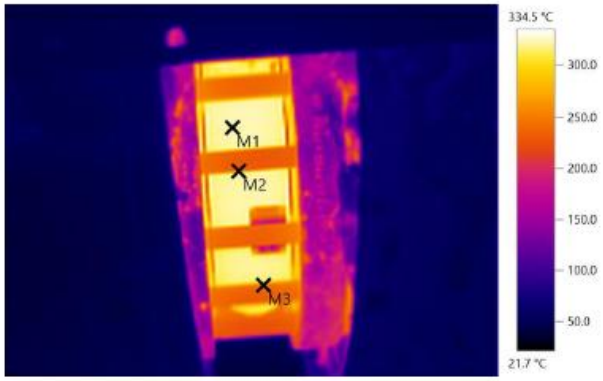


Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	268.1	0.95
Measure point 2	230.1	0.95
Measure point 3	264.8	0.95

Observation:

HP solenoid valve of unit – 1 and unit – 2 is not insulated. The temperature for unit 1 and unit 2 is found to be around 220°C and 250°C respectively. This may cause heat loss across valve. Hence it needs proper insulation.

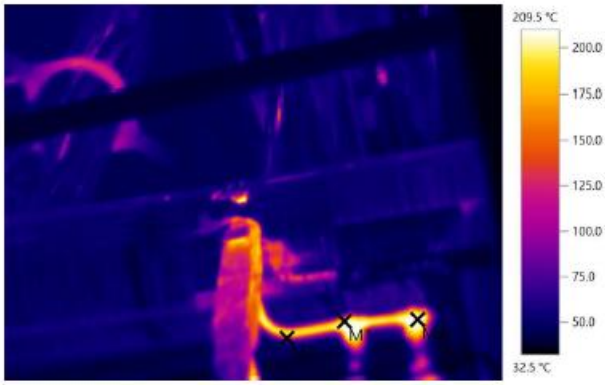
Unit 2 Compressor air inlet air purging line



Observation:

There is no insulation in compressor air pugging line to GT. Needs proper insulation to reduce the heat loss.

Unit 2 CRH line near condensed port

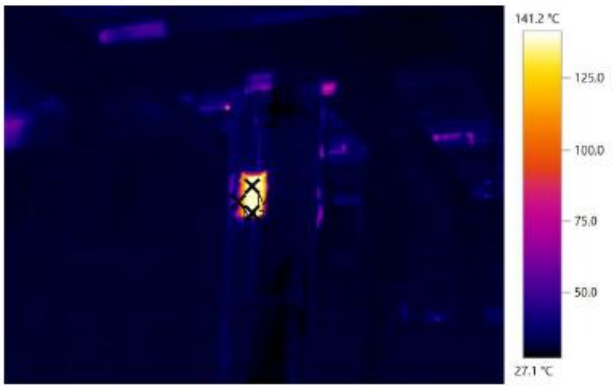


Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	191.4	0.95
Measure point 2	122.5	0.95
Measure point 3	208.1	0.95

Observation:

The temperature of CRH line near condenser port was 180°C .It need to be proper insulated.

Unit 2 LP down comer

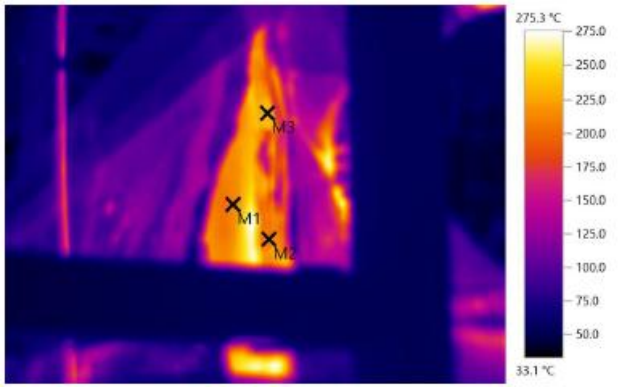


Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	139.0	0.95
Measure point 2	137.8	0.95
Measure point 3	52.8	0.95

Observation:

The insulation was damaged in LP down comer the temperature which is slightly greater than the ambient temperature.

Unit 2 near HP drum HRH and CRH line blow down

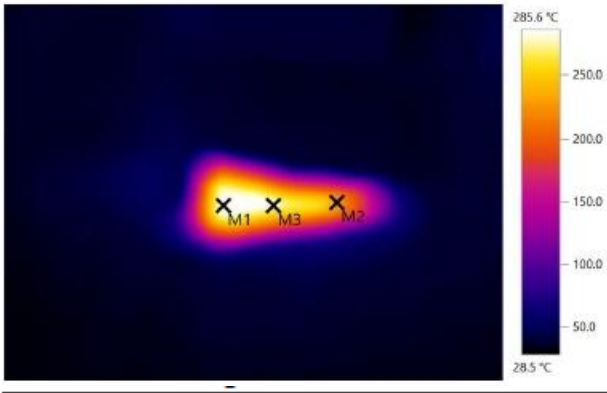


Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	211.4	0.95
Measure point 2	205.7	0.95
Measure point 3	229.8	0.95

Observation

There is insulation damage in near HP drum HRH and CRH line blow down. The average temperature is 215°C.

IP outlet line near Drum after IMS 38 MOV

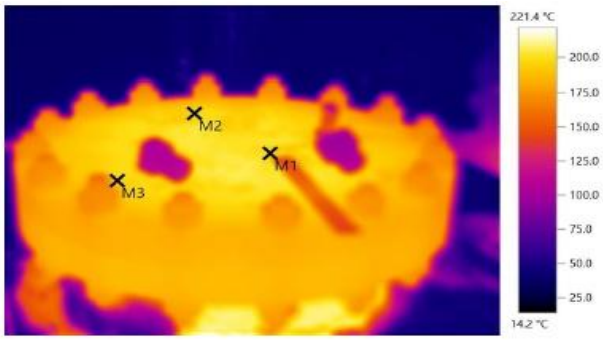


Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	282.5	0.95
Measure point 2	229.7	0.95
Measure point 3	278.4	0.95

Observation

Insulation is not for IP outlet line near drum after IMS 38 MOV. The temperature is around 240°C. It needs proper insulation.

LP main steam line near LMS 14 valve

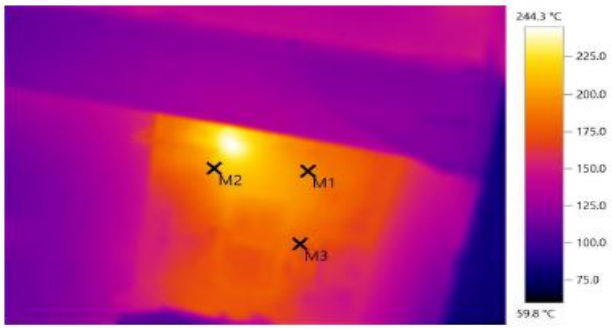


Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	197.1	0.95
Measure point 2	197.6	0.95
Measure point 3	194.0	0.95

Observation

Insulation for LMS 14 valve is not provided. Hence the surface temperature of valve is around 195^{o}C.

Unit 2 Re heater Suction main hole



Measurement Objects	Temp. [°C]	Emiss.
Measure point 1	194.0	0.95
Measure point 2	205.3	0.95
Measure point 3	178.2	0.95

Observation:
There is no coating on the man hole of reheater suction and the tempreture is around 200°C. Thus needs proper coating.

ANNEXURE

A: Formulas

Overall Station Heat Rate kcal/kWh = $\frac{Q \times H}{P} \times 100$

Where Q = Natural Gas Consumption in SCM
H = Inferior Calorific value of Natural gas in kcal/SCM
P = Total CCPP power output (GT + ST) in kWh

Air Compressor Efficiency (%)= $\frac{\text{Theoretical Temperature rise across the compressor}}{\text{Actual Temp rise}} \times 100$

GT Compressor efficiency = $\frac{(T2s-T1)}{(T2-T1)} \times 100$

$$\frac{T2s}{T1} = \frac{P2}{P1}^{\left(\frac{\gamma-1}{\gamma}\right)}$$

Where T2s = Adiabatic discharge air temp
T1 = Inlet air temperature in Kelvin
T2 =outlet air temp in Kelvin
P2 =air outlet pressure
P1 = inlet air pressure
γ =Compression coefficient.

GT EFFICIENCY

Overall Gas Turbine Efficiency (Compressor + GT) = $\frac{\text{Power Output} \times 860 \times 100}{\text{Fuel Input} \times GCV}$

Turbine efficiency (%) = $\frac{\text{Actual entalpy drop}}{\text{Isentropic enthalpy drop}} \times 100$

Turbine Heat Rate = $Q_0 + (Q_1-Q_2)+(Q_3-Q_4)/kW$

Q_0 = HP Turbine inlet energy

Q_1 = IP Turbine inlet energy

Q_2 = HP Turbine exhaust energy

Q_3 = LP Turbine inlet energy

Q_4 = LP Turbine exhaust energy

kW = Turbine output power

Condenser and heater

TTD (^oC) $= T_{sat} - T_{fwout}$

DCA (^oC) $= T_{drain} - T_{fwin}$

Temperature rise (^oC) $= T_{fwout} - T_{fwin}$

Extraction steam flow $= \frac{FWflow\ (h_{fwout} - h_{fwin}) + Drain\ in\ flow\ (h_{drnout} - h_{drnin})}{(h_{ext} - h_{drnout})}$

Heat load (kcal/hr) $= FW\ Flow * Sp.\ heat * Temperature\ rise$

Effectiveness $= \frac{T_{fwout} - T_{fwin}}{T_{sat} - T_{fwin}}$

Cooling Tower (CT)

a)	CT Range (^0C)	=	[CW inlet temp (^0C) - CW outlet temp (^0C)]
b)	CT Approach (^0C)	=	[CW outlet temp (^0C) - Wet bulb temp (^0C)]
c)	CT Effectiveness (%)	=	100×(CW temp - CW out temp) / (CW in temp - WB temp)
d)	L/G Ratio (kg/water/kg air)	=	Total CW water flow in CT (kg/hr) / Total air flow in CT (kg/hr)
e)	CT heat loading (kcal/hr)	=	CW flow (m^3/hr) × ΔT (^0C) × density of water (kg/m^3)
f)	CT evaporation loss (CMH)	=	CW circulation (CMH) × CW Temp. difference across CT in ^0C rate / 675
g)	% evaporation loss in cooling tower	=	Evaporation loss in CMH × 100 / CW circulation rate CMH
h)	Purge (CMH)	=	Evaporation (CMH) / (COC-1)

Pump

Energy Consumption (P_{pow}) $= \sqrt{3}\ V\ I\ cos\emptyset$ in kW

Fluid kW (F_{kW}) $= \frac{Q * 9.81 * H * \rho}{3600}\ x\ 100$ in kW

Where, Q is the flow (m^3/s) and H is the differential head (mmWC) and ρ is the specific gravity of fluid at operating temperature (kg/m^3)

Combined efficiency (η_c) = $\frac{\text{Fluid kW}}{P_{pow}}$ x 100 in %

or

Combined efficiency (η_c) = $\frac{Q*9.81*H}{P_{pow}}$ x 100 in %

Where , η_c is the combined efficiency of pump (%), P_{pow} is the motor power (kW), Q is the flow (m^3/s) and H is the differential head (mmWC).

Pump efficiency (η_P) = $\frac{\text{Combined efficiency}}{\text{Motor efficiency}}$ x 100 in %

Motor efficiency (η_{mot}) = given by OEM

Pump Efficiency as per performance curve = Pump Efficiency derived from performance curve of the pump at operating parameters like Flow, RPM

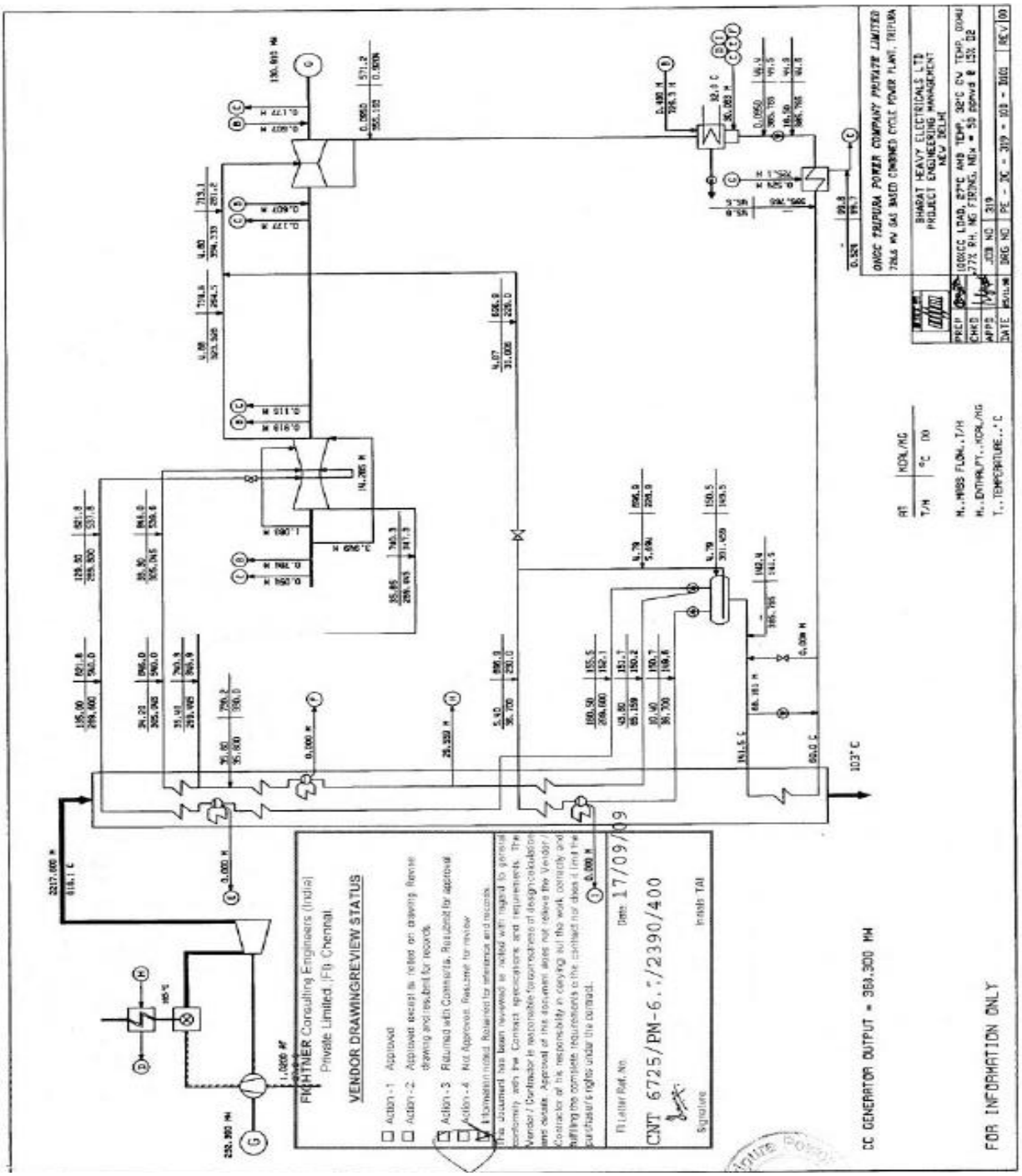
Specific Consumption = $\frac{\text{Measured kW}}{\text{flow rate}}$

Percentage loading on flow = $\frac{\text{Measured flow}}{\text{Rated flow}} * 100$ in %

Percentage loading on motor = $\frac{\text{Measured power}}{\text{Rated power} * \eta_{mot}} * 100$ in %

Percentage loading on head = $\frac{\text{Actual head}}{\text{Reference head}} * 100$ in %

B: Heat and Mass Balance Diagram



C: Operating Data

Description	Unit	Unit 1	Unit 2
GT 1 Load	MW	149.24	220.55
ST 1 Load	MW	99.93	122.46
Total Load	MW	249	343.01
GT 1 exhaust temp	°C	649.06	622.15
GT 1 inlet air temp	°C	33.83	30.54
HRSG inlet pressure	mmW	96.94	164.84
GT1 air inlet pressure	mmW	44.5	70.69
GT 1 CPD	bar	10.53	13.99
GT 1 Compressor outlet temp	°C	378.88	415.13
Fuel temp before exchanger	°C	101.29	132.55
Fuel temp after exchanger	°C	187.88	181.54
Fuel pressure before exchanger	kg/cm2	33.44	33.32
Fuel pressure after exchanger	kg/cm2	32.89	32.58
Fuel gas pressure	kg/cm2	31.35	29.81
Fuel gas temp	°C	183.7	180.23
Fuel flow rate	kg/sec	9.766	12.842
GT IGV	%	60.34	88
GT 1 exh. Mass flow	TPH	476.8	608.3
CEP outlet pressure	kg/cm2	24.31	22.99
CEP outlet flow	TPH	332.96	391.95
Condensate temp LTE inlet	°C	59.76	59.99
condensate temp LTE outlet	°C	135.53	143.08
DEA press	kg/cm2	3.43	4.09
LP drum pressure	kg/cm2	3.67	4.74
LPS outlet STM temp to LP Turbine	°C	228.27	234.64
LPs outlet STM press to LP Turbine	kg/cm2	3.66	4.56
LP turbine inlet temp	°C	227.09	257.48
LP turbine inlet pressure	kg/cm2	2.97	3.73
LP Turbine inlet steam flow	TPH	28.4	35.84
IP BFP inlet temp	°C	135.57	143.27
IP BFP inlet Pressure	kg/cm2	3.58	4.09
IP BFP Suction flow	TPH	385.36	441.28
IP BFP outlet temp	°C	142.39	147.75
IP BFP outlet pressure	kg/cm2	47.53	70.31

IP FW flow	TPH	35.25	49.34
IP drum pressure	kg/cm2	31.3	36.9
IPS1 outlet STM temp	°C	288.43	327.95
IPS1 outlet STM pressure	kg/cm2	27.95	33.77
RH 1 inlet STM temp	°C	352.38	349.76
RH 1 inlet STM pressure	kg/cm2	27.78	32.92
HPT Exh. Pressure	kg/cm2	28.6	33.75
HPT Exh. Temp	°C	425.52	358.12
RH 1 outlet steam temp	°C	471.96	448.74
RH 3 outlet steam temp	°C	540.32	536.5
RH 3 outlet steam pressure	kg/cm2	27.95	31.98
IPT inlet temp.	°C	540.89	536.4
IPT inlet pressure.	kg/cm2	27.68	31.98
HPBFP outlet temp	°C	143.74	149.42
HPBFP outlet pressure	kg/cm2	125.73	151.69
HPBFP outlet flow	TPH	238.22	285.95
HP drum pressure	kg/cm2	114.23	137.5
HPS3 outlet steam temp	°C	542.5	539.35
HPS3 outlet steam pressure	kg/cm2	104.5	125.84
Steam temp HPT inlet	°C	540.75	539.35
Steam Pressure HPT inlet	kg/cm2	103.35	125.84
HPT inlet flow	TPH		288.3
LP exh.hood temp.	°C	47	47.49
Cond. Vacuum	kg/cm2(a)	0.1	0.103
Hotwell Temp	°C	46.57	48.28
Make up flow	TPH	4.07	1.36
CW inlet temp LHS	°C	34.47	33.38
CW outlet temp LHS	°C	42.57	42.61
CW inlet temp RHS	°C	34.4	33.35
CW outlet temp RHS	°C	41.38	42.3
CW flow	TPH	19938.4	17872.2
Hotwell LVL	mm	706.08	733.42
DEA LVL	mm	698.68	815.18
Reference pressure	Bar	0.98	0.99
Reference Temperature	°C	33.83	30.54
Reference Humidity	%	87.8	87.8

D: Recommended Values of Illumination (IS 6665.1972)

S.No	Industrial Building and Process	Average Illumination (Lux)
	General factor Area	
1	Canteens	150
2	Cloak rooms	100
3	Entrance, Corridors, Stairs	100
	Electricity Generating Station: Indoor Locations	
4	Turbine halls	200
5	Auxiliary equipment; battery rooms, blowers, auxiliary generators, switchgear and transformer chambers	100
6	Boiler houses (including operating floors) platforms, coal conveyors, pulverizers, feeders, precipitators, soot and slag blowers	70 to 100
7	Boiler house and Turbine house	100
8	Basements	70
9	Conveyor houses, conveyor gentries, junction towers	70 to 100
10	Control Rooms	
	I. Vertical control panels	200 to 300
	II. Control desks	300
	III. Rear of Control panels	150
	IV. Switch houses	150
	Electricity Generating Station: Outdoor Locations	
11	Coal Unloading area	20
12	Coal Storage area	20
13	Conveyors	50
14	Fuel Oil delivery headers	50
15	Oil storage tank	50
16	Catwalks	50
17	Platforms, boiler and turbine decks	50
18	Transformers and outdoor switchgear	100

ONGC TRIPURA POWER COMPANY LIMITED

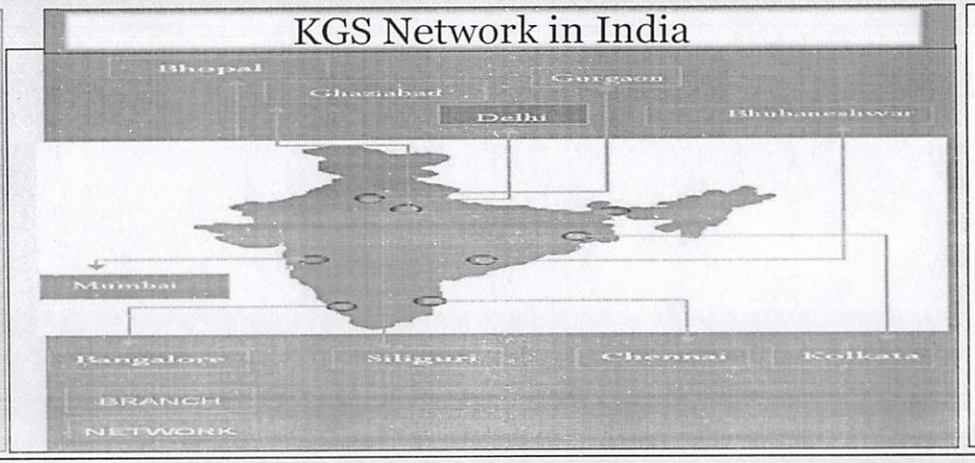
Internal Audit Report for the quarter ended 31st December 2018

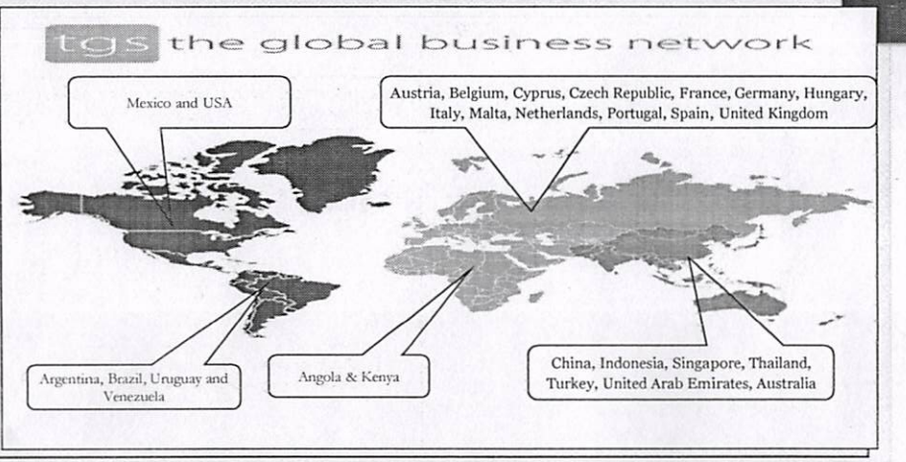
K.G. Somani & Co.
(Chartered Accountants)

About K G Somani & Co

K G Somani & Co (KGS) is a 3rd generation Chartered Accountants firm, practicing in India for over 5 decades. The Managing Partner, Mr. KG Somani is the past president of Institute of Chartered Accountants of India and has represented India on the council of International Federation of Accountants. KGS has an international presence in about forty countries being a member of TGS Global Network and it also has networking of firms under the regulation of the Institute of Chartered Accountants of India through its affiliates & offices at five major cities in India. KGS has association with ***Financial Institutions, Banks, Power Companies and Corporations, Manufacturing and Transport (including Railways & Aviation) Industry etc.*** in and outside India.

Presence





K.G. SOMANI & CO. NEW DELHI CHARTERED ACCOUNTANTS

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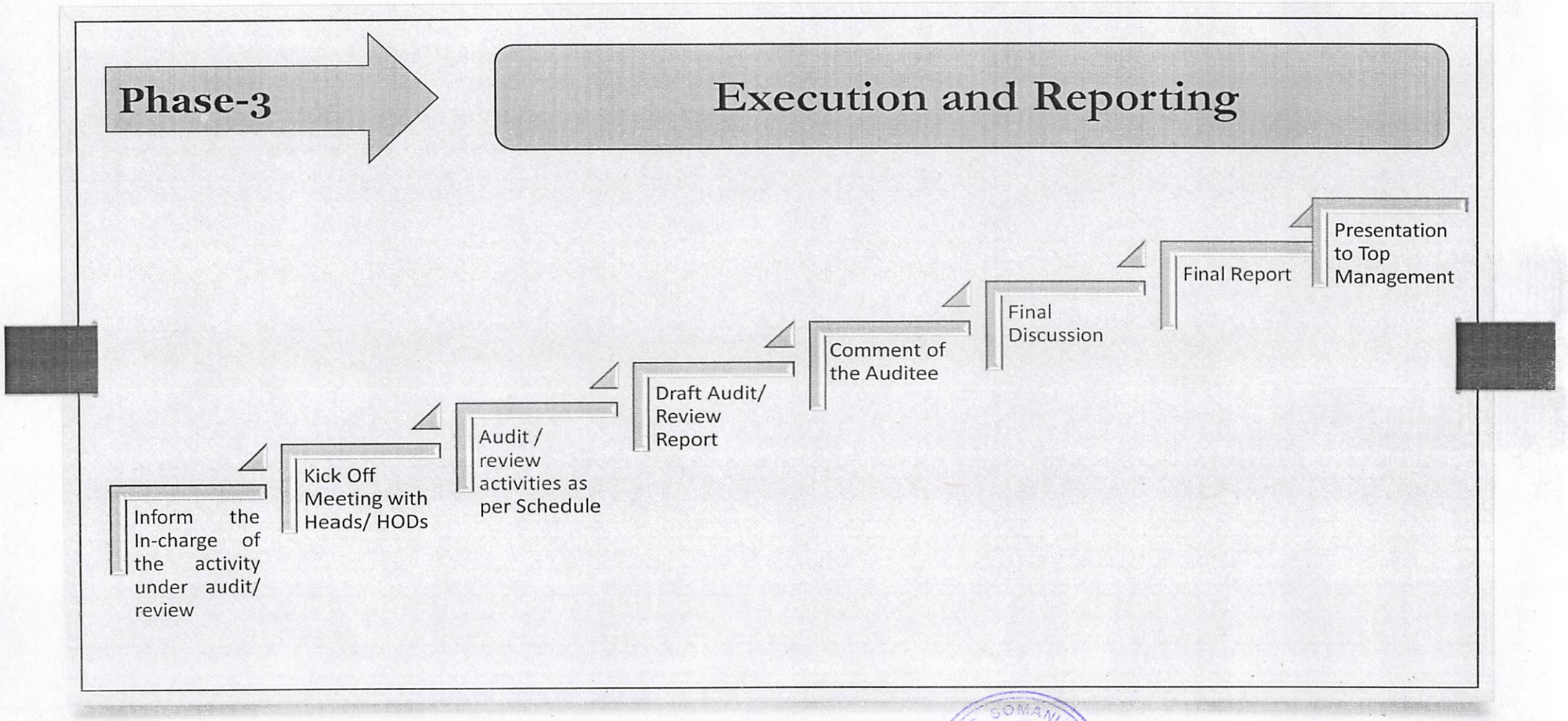
Audit Scope

Sr. No	Area
1	Payments
2	Advance to Parties
3	Payable to Parties
4	Statutory Compliance Process
5	Review of generation Parameters
6	IT Security
7	Review and checking of CSR expenses as per policy and enactment
8	Reconciliation of the reading in ONGC and OTPC gas custody meters on quarterly basis

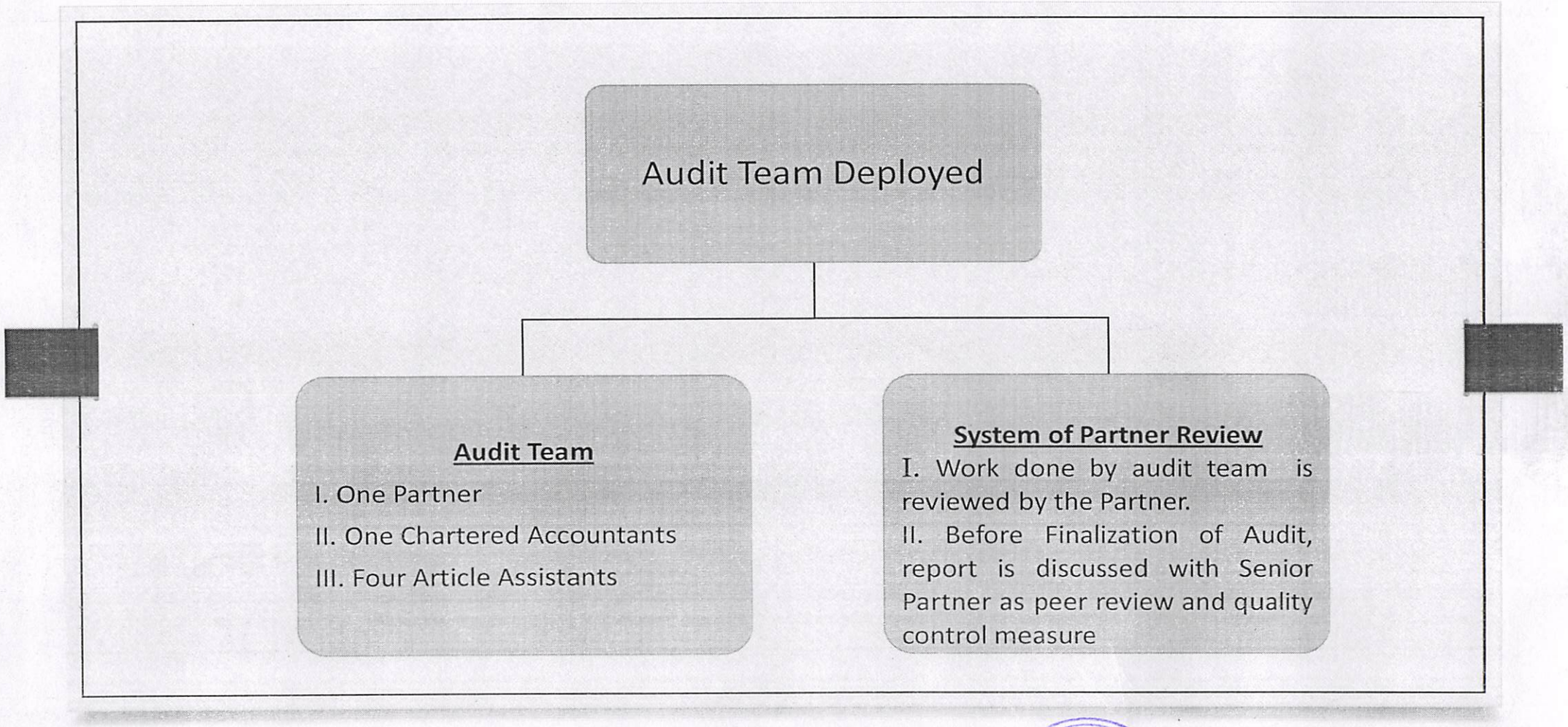
Audit Approach

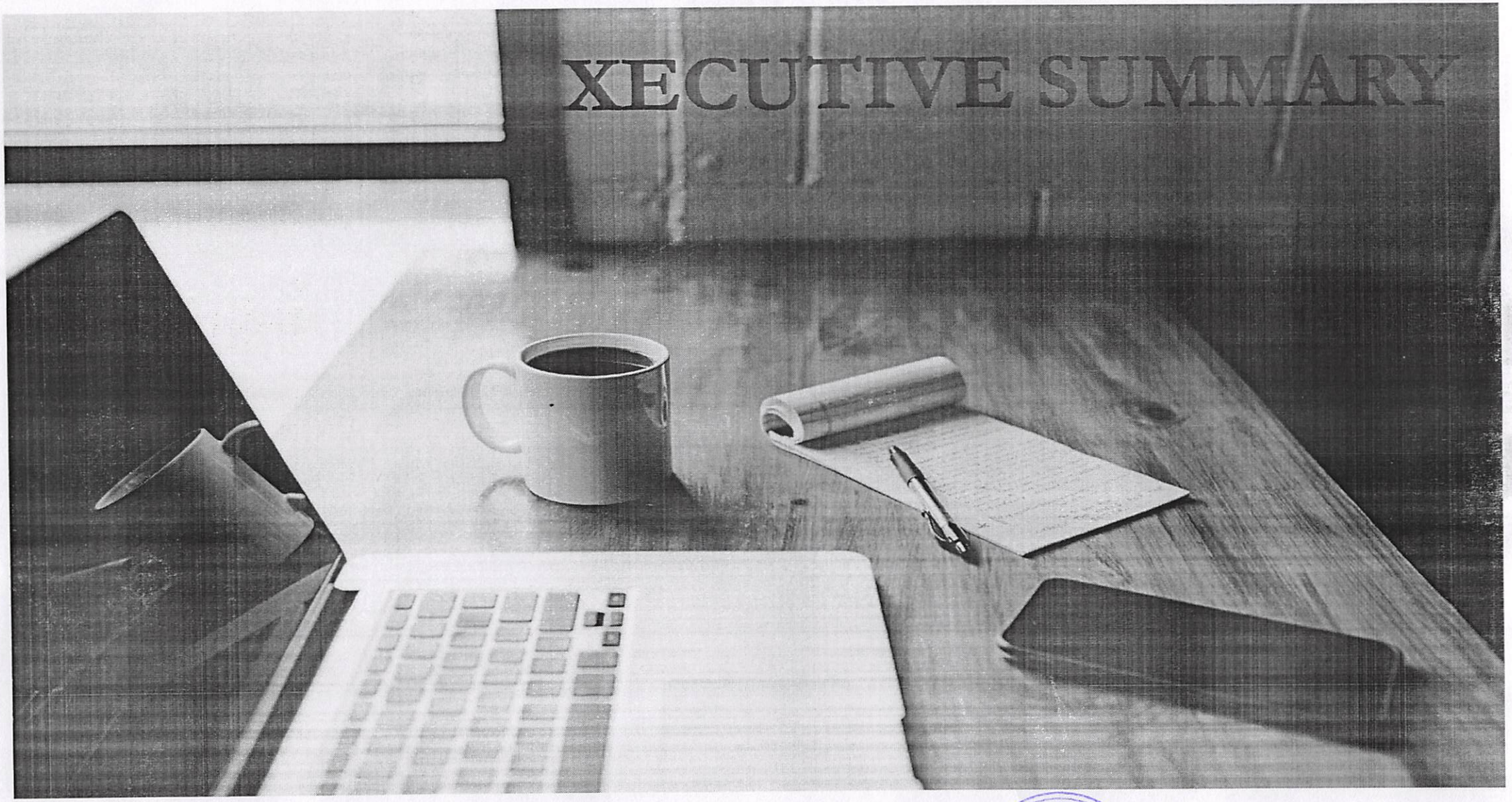
Phase-1	Understanding the Activities & Areas	➢Analyze the internal and external environment including the regulatory frame work. ➢Understand the activities and existing controls of each area. ➢Review of company's policies and operations addressing all the business risks. ➢Interacting with key managing personnel to gain insight in to each activity & area.
Phase-2	Review of Systems and Controls	➢Understanding the flow of significant transactions. ➢Identifying 'what could go wrong' and determining whether controls have been established and testing the controls identified. ➢Identifying the processes and compliance monitoring mechanism and various checks and controls in place to ensure compliance with company's policies and procedures. ➢On the basis of our perception, prepare comprehensive audit checklist.



Records Referred To

- Standard Operating Procedures.
- Internal Policy and Systems laid by company.
- Circulars & Orders issued from time to time.
- Cash Book, Journal and various other books & records maintained by the company.
- Vendors ledger and payment register
- Previous audit reports.





Sr. No.	Observations	Management Comments	Slide No
1.	**Letter of Credit expired/not taken** As per Power Purchase Agreement (PPA), every procurer/beneficiary shall provide to the seller/generator, an unconditional, revolving and irrevocable Letter of credit (LC). While reviewing the LCs provided by various beneficiaries, we have observed the followings: 1. that the State of Meghalaya has not provided LC since beginning i.e. January 2014. 2. that the LC provided by the State of Manipur has been expired on 16th October 2018 and still not renewed till the date of audit i.e. 18th January 2019. 3. that the Amount of LC is not mentioned in the LC provided by the State of Nagaland. It is suggested that the LC should be obtained from each beneficiary as per the terms and conditions mentioned in the PPA entered with the respective beneficiaries.	Persuasion for Meghalaya LC is done on regular basis through visits and official letters however Meghalaya is still unable to provide LC. After many follow-ups and visits of our officials Manipur had directed its bank for extension of LC however bank has asked for a new government approval for same. Even so the LC is expected shortly. Nagaland has extended the expiry date keeping all other terms and conditions same as in previous provided LC under reference no 0378LCO-0000005 (Same is written in provided LC letter).	Point No. 1 of Detailed Report (Commercial department)

Sr. No.	Observations	Management Comments	Slide No
2.	**Rebate allowed to Procurers but not eligible as per power purchase agreement** It is observed that in some of the cases, APDCL (Merchant Procurer) has made payment beyond the date specified in the agreement but the rebate of Rs. 160.63 lakhs was allowed by the company on having request from the customer to extend the due date. However, approval for extension of rebate was not taken from the competent authority. In the absence of approval from the competent authority, the accounting entry of rebate allowed to customer was not passed in the books of account of the company. This leads to difference in the balance of the party as per accounting books and as per commercial books. **Further Comments/Suggestion** The approval from the competent authority should be taken on timely basis so that the balance as per commercial books confirms with the books of account at a point of time.	Pending approvals pointed out by auditor have been obtained and requisite entries have also been done.	Point No. 2 of Detailed Report (Commercial department)

Sr. No.	Observations	Management Comments	Slide No
3.	**Internal control over monitoring of Bank Guarantees should be further strengthened** On review of Bank Guarantees on test check basis, we have observed the followings: • The company does not have any system of legal vetting of BGs, received from the vendors, by the competent authority in respect of its legal validity and enforceability. • The BG no. is not properly entered in SAP. In some of the cases, BG no. is entered in the Reference No. column and in some of the cases, PO no. or other value is being entered in the said column. It is suggested that there should be a separate column for entering BG No. and proper control that same number can not be entered for two BGs. • There is no functionality of getting any pop up/notification of BGs expiring in near future. The SAP should be customised to provide a notification for BGs going to expire in near future.	• The BG is being sent to the respective banks to verify the same. The process is being followed in all the cases. • The team has been advised to enter BG No's in the Doc Header Text only for uniformity. • The customisation required to provide a pop-up for BGs going to expire in near future, has been developed in SAP as per Auditor suggestion.	Point No. 4 of Detailed Report (Finance & Accounts department)

Sr. No.	Observations	Management Comments	Slide No
4.	**Debit balance appearing in vendors' account** During the course of audit, we have observed that debit balance of Rs. 23.61 lakhs is appearing in certain vendors' account as on 31.12.2018. On perusal of the vendor account, we have observed that the debit balance is appearing on account of any of the following reason(s): ❖ Bills in respect of certain expenses, like publishing of magazine, sponsorship fees, insurance, advertisement in souvnier, purchase of gift cards etc. incurred by the company, not received from the vendor/not booked in the books of account till the date of audit where advance has been paid. ❖ Advance paid to parties for more than one accounting period and expense booked only for current period. Debit balance is appearing in partys' account for the remaining amount i.e Prepaid amount. ❖ Material/item received, however, the GRN for the same is pending till date of audit where advance has been paid to the party. ❖ Amount is recoverable from the party on account of short supply of material.	Advance amounting to Rs. 10.45 lakhs has been adjusted after receipt of invoice. For the remaining amount, the bill is yet to be received from the vendor. The advance will be adjusted after receipt of the bill. Rs. 1.37 lakh is the advance paid to the DM office , Gomati district, Govt of Tripura, for hiring of vehicles during PM visit. The invoices for the same has not been received yet. Rs. 5.68 lakh is recoverable from SAIL against short supply of material for township. Balance amount shall be recovered from next payment or else refunded by the vendor.	Point No. 5 of Detailed Report (Finance & Accounts department)

Sr. No.	Observations	Management Comments	Slide No
4.	**Debit balance appearing in vendors' account** ❖ TDS deducted but recovery is yet to be made from the party. ❖ On account of any other adjustment for which necessary adjustment entry is yet to be passed in the books of account. **Further Comments/Suggestion** Proper follow up should be made with the vendor to provide bills/material on timely basis. Bills should be booked in books of account on timely basis. Where advance has been paid to the party for more than one accounting period, the amount pertaining to the subsequent period should be debited to Prepaid Expense Account instead of debiting it to party account. GRN should be made on timely basis where material has been received by the company. Proper follow up should be made with the party for recovery of amount on account of short supply/TDS deduction and necessary adjustment entry should be passed where required.	Required adjustment entry for Rs. 0.30 lakh has been done.	Point No. 5 of Detailed Report (Finance & Accounts department)

Sr. No.	Observations	Management Comments	Slide No
5.	**Credit balance in various vendors' account not settled since long** During the course of audit, we have observed that credit balance of Rs. 91.14 lakhs is appearing in various vendors' account on 31.12.2018. On perusal of the partys' account, we have observed that the credit balance is appearing on account of any of the following reason(s): ❖ EMD received from vendors long back in financial year 2016-17 not paid as the request not received from the concerned party till the date of audit. ❖ Amount payable to party not paid till date of audit. ❖ Amount on paid/kept on hold against deficiency of services/non fulfilment of terms and conditions of the contract. ❖ On account of any other reason where required adjustment entry need to be passed in the books of account. **Further Comments/Suggestion** Proper follow up should be made with the party either to resolve the defect/fulfil the terms and conditions of the contract at the earliest or else a debit note should be raised and the amount should be transferred to concerned income account after getting approval from the competent authority.	1. Out of Rs. 91.14 lakhs amount outstanding, Rs. 70.17 lakhs is against amount not paid due to various deficiencies in the services provided by the contractor. 2.Rs. 18.82 lakhs is amount payable against the EMD received from the vendor. 3-Balance amount is held against BG and retention.	Point No. 6 of Detailed Report (Finance & Accounts department)

KGS

Sr. No.	Observations	Management Comments	Slide No
6.	**No backup for files in the internal hard drive issued to employees** The backup of files/data stored in the internal hard drive of systems issued to employees is not maintained by the company. This may cause loss of important data stored in the internal hard drive of the systems issued to employees. It is observed that 2GB space per employee is available for which backup will be maintained, but the same is not being used effectively. Further, it is informed that additional storage for end users have been planned and has been proposed in this years' budget. As informed to us the same will be completed soon. **Further Comments/Suggestion** The backup of the files stored in the internal hard drives should also be maintained on periodical basis. It is suggested that adequate training should be provided to employees for maintaining/saving important files at server for which backup will be maintained.	The AFE for increase in space has been approved. Proposal from Sify Technologies has been obtained and tendering process is in process and the same shall be completed shortly.	Point No. 12 of Detailed Report (IT Department)

<table>
<tr><th>Sr. No.</th><th>Observations</th><th>Management Comments</th><th>Slide No</th></tr>
<tr><td>7.</td><td><u>Some functionalities of the SAP modules not in use</u>
We, during the course of audit, have reviewed the SAP system of company and have identified some of the functionalities of the SAP modules which are not in use:
<table><tr><th>Sr. No.</th><th>Modules to be used in SAP / Reports to be generated from SAP</th><th>Management Comments</th></tr><tr><td>1.</td><td>IT module like complaint resolution system, tracking of IT hardware issued to employees, IT security parameters etc.</td><td>SAP helpdesk is functional. The IT infrastructure helpdesk shall be functional soon, currently it is under testing.</td></tr><tr><td>2.</td><td>Vendor Ageing not implemented in SAP</td><td>The format has been received from the audit team for the creditors ageing. The same has been implemented in SAP.</td></tr><tr><td>3.</td><td>Details of obsolete / unserviceable / non-moving / surplus materials</td><td>Work of identifying such material is under progress.</td></tr><tr><td>4.</td><td>Notification through SAP for charging of LD in case of actual delivery / work completion date is beyond the delivery schedule mention in the purchase/work order.</td><td>LD charges are being deducted as per the approval of the competent authority.</td></tr></table></td><td>Point No. 13 of Detailed Report (IT department)</td></tr>
</table>

<table>
<tr><th>Sr. No.</th><th>Observations</th><th>Management Comments</th><th>Slide No</th></tr>
<tr><td>7.</td><td><u>Some functionalities of the SAP modules not in use</u>
<table>
<tr><th>Sr. No.</th><th>Modules to be used in SAP / Reports to be generated from SAP</th><th>Management Comments</th></tr>
<tr><td>5.</td><td>SAP should be made flexible for maintenance department to enable them to get the history cards of a particular machine/equipment.</td><td>We are in the process of resolving this issue with our SAP team and hopefully we can complete this by March 2019.</td></tr>
<tr><td>6.</td><td>POs prepared in SAP and the PO issued to party is not same. The PO should be issued to party from SAP itself. The PO date should be the date when the PO is approved for final issuance to the party.</td><td>Noted.</td></tr>
</table>
<u>Further Comments/Suggestion</u>
It is suggested that functionalities of the SAP modules should be effectively utilised by the company for better control.</td><td>Point No. 13 of Detailed Report (IT department)</td></tr>
</table>

Sr. No.	Observations	Management Comments	Slide No
8.	**Plant Shutdown hours** Detail of the plant shutdown and preventive maintenance from April 2018 to December 2018 is given here under: On review of the above data, it is noted that the plant remains shut down for more than 3 days in the month of September 2018 in which preventive maintenance was done and for more than 6 days in the month of June 2018. It is suggested that necessary actions should be performed so that the duration and frequency of forced outage remains at its low to reduce the start up loss and loss of revenue.	1. Major reason for loss in June is Tripping of both Units due to grid disturbance followed by barring gear jamming which is an unresolved problem even after involving industry experts. 2. Total Forced Outage – 2.88% Total Planned Outage – 2.94% Startup and Shutdown Loss – 0.46% Total Outage – 6.28% Total outage is lower than benchmark of 7% approved by Board. However, effort is being made to further reduce it	Point No. 15 of Detailed Report (Review of Generation Parameters)

Month	Total Planned Outage(Hrs)	Total Forced Outage (Hrs)
May-18	-	43.53
Jun-18	-	147.10
Jul-18	-	3.23
Aug-18	215.0	-
Sep-18	169.1	80.2
Oct-18	-	13.92
Nov-18	-	24.57
Dec-18	-	21.4
Total	**384.10**	**333.96**

<table>
<tr><th></th><th>Observations</th><th>Management Comments</th><th>Slide No</th></tr>
<tr><td>9.</td><td><u>Loss due to grid disturbances</u>
We have observed that the company is incurring financial loss on account of “generation loss” and “flaring charges” (paid to ONGC) due to grid failure, being maintained by the North East Transmission Company Limited (NETC).

During the period for April 2018 to December 2018, grid failures have occurred 4 times as detailed below:-

<table><tr><th>Sr. No.</th><th>Month</th><th>No. of times grid failure occurred</th></tr><tr><td>1</td><td>May -18</td><td>2</td></tr><tr><td>2</td><td>June-18</td><td>1</td></tr><tr><td>3</td><td>October-18</td><td>1</td></tr><tr><td colspan="2">Total</td><td>4</td></tr></table>
<u>Further Comments/Suggestion</u>
The management should analyse the financial loss incurred by the company due to grid failure and issue should be taken up with the NETC to recover the damages caused due to grid disturbances.</td><td>This issue has been taken up by the top management of OTPC with NETCL. As an immediate remedial measure vegetation infringement along Line-1 & Line-2 has been cleared. Faulty relay of line-1 has been replaced with a new one . Frequency of patrolling has been increased.

Matter taken up with POWERGRID to minimize spurious signal (which leads to line and plant tripping)

Implementation of SPS to avoid tripping of Units in case of any downstream evacuation system tripping

All the above action has resulted in no line tripping since last one in October 2018</td><td>Point No. 17 of Detailed Report (Review of Generation Parameters)</td></tr>
</table>

<table>
<tr><th>Sr. No.</th><th>Observations</th><th>Management Comments</th><th>Slide No</th></tr>
<tr><td>10.</td><td><u>Action Taken Report:</u>
There are some of the observations/issues reported in the Internal Audit Report for the quarter ended September 2018 and March 2018 against which necessary actions are yet to be taken by the management:

September 2018:
<table>
<tr><th>Sr. No</th><th>Observation</th></tr>
<tr><td>1.</td><td>No Re-Order level maintained by the plant and Blockage of Working Capital</td></tr>
<tr><td>2.</td><td>Discrepancies in stock appearing in SAP register and stock lying in store and no detail of stock of vendor available with the company</td></tr>
</table>
March 2018:
<table>
<tr><th>Sr. No</th><th>Observation</th></tr>
<tr><td>3.</td><td>Purchase orders not closed Since long</td></tr>
<tr><td>4.</td><td>Creditors ageing not maintained</td></tr>
<tr><td>5.</td><td>List of non moving, slow moving, obsolete, unserviceable not readily available</td></tr>
</table></td><td>Actions in respect of the observations reported in Internal Audit Report for the quarter ended September 2018 and March 2018 are being taken and in process and in most of the cases, will be completed shortly.</td><td>Covered in Part-II of this report</td></tr>
</table>

<table>
<tr><th>Sr. No.</th><th>Observations</th><th>Management Comments</th><th>Slide No</th></tr>
<tr>
<td>10.</td>
<td><u>Action Taken Report:</u>
There are some of the observations/issues reported in the Internal Audit Report for the period ended September 2017 against which necessary actions are yet to be taken by the management:

<table>
<tr><th>Sr. No</th><th>Observation</th></tr>
<tr><td>6.</td><td>Store inventory manual not followed in respect of creation of separate scrap ledger in SAP and its disposal through MSTC.</td></tr>
<tr><td>7.</td><td>Huge delay in replacement of material rejected upon inspection</td></tr>
<tr><td>8.</td><td>No approved list of vendors is maintained</td></tr>
<tr><td>9.</td><td>Balances appearing in Capital Work in progress since long</td></tr>
<tr><td>10.</td><td>Confirmation of Accounts not obtained on periodical basis</td></tr>
</table>
</td>
<td>Actions in respect of the observations reported in Internal Audit Report for the period ended September 2017 are being taken and in process and in most of the cases, will be completed shortly.</td>
<td>Covered in Part-II of this report</td>
</tr>
</table>

(Bhavnesh Maheshwari)
Partner

K.C. SOMANI & CO. CHARTERED ACCOUNTANTS NEW DELHI

BY SPEED POST

No. J-13011/11/2006-IA.II(T)
Government of India
Ministry of Environment & Forests

Paryavaran Bhawan
CGO Complex, Lodi Road,
New Delhi-110 003.

Dated: 7th February, 2007

To

The Chief Executive Officer
ONGC-Tripura Power Company (P) Ltd.
ONGC Tripura Assets,
Badarghat Complex, Agartala,
Tripura – 799 014

Sub: 1082 MW (3x360.8 MW) Combined Cycle Gas Turbine Thermal Power Project at Palatana village in Udaipur of South Tripura District in the state of Tripura by M/s ONGC Tripura Power Company (P) Limited-Environmental Clearance reg.

Sir,

The undersigned is directed to refer to your communications No. NIL dated 7th June, 2006 regarding the subject mentioned above. Subsequent information furnished vide letters no. Nil dated 22nd Nov, 2006 and 18th December, 2006 have also been considered.

2. The proposal is to seek environmental clearance under the provisions of EIA Notification, 1994 for setting up of a gas based power plant of 1082 MW capacity at Palatana in Tripura. The configuration of the project as proposed is 3x360.8 MW combined cycle gas turbines. The site is located within 25 km of the International border. The total land requirement for the project is 79.78 ha out of which 77.87 ha is forest land. About 8.5 ha of land will be used for storage of water which will have a storage capacity of about 7 days of water requirement. The main fuel will be gas and will be sourced from ONGC's gas wells at Baramura, Konaban, Rokhia and ADB. The site is surrounded by the reserved forests and Trishna Wildlife Sanctuary which is at 8.00 km distance in south direction. Eleven families would need to be displaced from their land. No homestead land is to be acquired. Public hearing for the project was held on 19.05.2006 and NOC was issued by Tripura State Pollution Control Board on 26.05.2006. The project cost is Rs 2960.00 crores including Rs 1.78 crores for environmental protection measures.

3. On the basis of the information submitted and after its consideration by the Expert Appraisal Committee for Thermal Power Projects, environmental clearance for the above mentioned project is hereby accorded under the provision of para 12 of the EIA Notification dated 14th September, 2006 read with sub clause (i) of clause 2.1.1 of sub para 2.1 of para 2.0 of the Circular no. J-11013/41/2006 – IA.II (I) dated 13th October, 2006 and subject to implementation of the following terms and conditions:

(i) The conditions stipulated by TSPCB vide their letter no. E.17(10)/TSPCB/W/Power/(L-Red)/2364/2174-2273 dated 26.05.2006 shall be strictly implemented

(ii) The natural gas requirement shall be limited to 5.25 MSCM per day. No fuel other than natural gas shall be used.

(iii) Necessary permission from the Chief Controller of Explosives as applicable, shall be obtained and a copy of the same shall also be submitted to this ministry.

(iv) Total land requirement for the project shall not exceed 79.78 ha for all facilities put together.

(v) Distance between HFL of river Gumti and the project boundary shall not be less than 500 m at each point.

(vi) Three stacks of 60 m height each shall be installed with continuous online monitoring system. The exit velocity of the flue shall be maintained at 15 m/sec.

(vii) Low NOx burners shall be provided. NOx emissions from individual stacks shall be restricted to less than 50 ppm.

(viii) Regular sprinkling of water in vulnerable areas of the plant shall be ensured.

(ix) Effective safeguard measures shall be taken to ensure that there are no fugitive emissions of Gas.

(x) Regular monitoring of the air quality, including HC levels both in work zone and ambient air shall be carried out in and around the power plant. Complete analysis of the recorded data shall be regularly undertaken and results shall be submitted to the Ministry and its Regional Office at Shillong every six months.

(xi) Closed Cycle Cooling System with minimum COC of 5 shall be provided.

(xii) Treated effluents conforming to the prescribed standards only shall be discharged into river Gumti.

(xiii) Rainwater harvesting shall be adopted in consultation with the Central Groundwater Authority/ Board. The plan for the same shall be submitted within a period of three months from the date of clearance.

(xiv) Leq of Noise level shall be limited to 75 dBA. For people working in the area of generator and other high noise areas, requisite personal protective equipments like earplugs etc. shall be provided.

(xv) A 50 m wide green belt shall be developed around the plant periphery covering 28 ha of area.

(xvi) Adequate safety measures shall be provided to limit the impact within the plant boundary, in case of an accident. Leak detection devices shall also be installed at strategic places for early detection and warning.

(xvii) Regular mock drills for the On-Site emergency management plan shall be carried out as per the Manufacture, Storage and Import of Hazardous Chemical Rules,

1989. Implementation of changes/improvements required, if any, in the On-Site emergency management plan shall be ensured.

(xviii) The project proponent shall advertise at least in two local newspapers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality concerned, informing that the project has been accorded environmental clearance and copies of clearance letter are available with the State Pollution Control Board/Committee and may also be seen at Website of the Ministry of Environment and Forests at http://envfor.nic.in

(xix) A separate environment management cell with qualified staff shall be set up for implementation of the stipulated environmental safeguards.

(xx) Half yearly report on the status of implementation of the stipulated conditions and environmental safeguards shall be submitted to this Ministry, its Regional Office, CPCB and SPCB.

(xxi) Regional Office of the Ministry of Environment & Forests located at ***Shillong*** will monitor the implementation of the stipulated conditions. Complete set of Environmental Impact Assessment Report and Environment Management Plan along with the additional information submitted from time to time shall be forwarded to the Regional Office for their use during monitoring.

(xxii) Separate funds shall be allocated for implementation of environmental protection measures along with item-wise break-up. These cost shall be included as part of the project cost. The funds earmarked for the environment protection measures shall not be diverted for other purposes and year-wise expenditure should be reported to the Ministry.

(xxiii) The project authorities shall inform the Regional Office as well as the Ministry regarding the date of financial closure and final approval of the project by the concerned authorities and the dates of start of land development work and commissioning of plant.

(xxiv) Full cooperation shall be extended to the Scientists/Officers from the Ministry/Regional Office of the Ministry at ***Shillong*** /the CPCB/the SPCB who would be monitoring the compliance of environmental status.

4. The Ministry reserves the right to revoke the clearance if conditions stipulated are not implemented to the satisfaction of the Ministry.

5. The environmental clearance accorded shall be valid for a period of 5 years to the start of production operations by the power plant.

6. In case of any deviation or alteration in the project proposed from those submitted to this Ministry for clearance, a fresh reference shall be made to the Ministry to assess the adequacy of the condition(s) imposed and to add additional environmental protection measures required, if any.

7. The above stipulations shall be enforced along with others as under the Water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986 and rules there under, The Manufacture, Storage and Import of Hazardous Chemical Rules, 1989, Hazardous

Wastes (Management and Handling) Rules, 1989, the Public Liability Insurance Act, 1991 and rules there under and the EIA Notification, 2006 and the amendments made therein from time to time.

(Dr. S.K. Aggarwal)
Director

Copy to:

1. The Secretary, Ministry of Power, Shram Shakti Bhawan, Rafi Marg, New Delhi-110001.
2. The Secretary, Deptt. of Environment, Science & Technology, Govt. of Tripura, Agartala.
3. The Chairman, Central Electricity Authority, Sewa Bhawan, R.K. Puram, New Delhi-110066.
4. The Chairman, Tripura State Pollution Control Board, Vigyan Bhawan, Pandit Nehru Complex, Gorkha Basti, Agaratala – 799 006 - **with a request to display a copy of the clearance letter at the Regional Office, District Industries Centre and Collector's office for 30 days.**
5. The Chairman, Central Pollution Control Board, Parivesh Bhawan, CBD-cum-Office Complex, East Arjun Nagar, Delhi-110032.
6. The Chief Conservator of Forests, Regional Office (North-eastern Region), Upland Road, Laitumkhrah, Shillong – 793 003
7. The Director (EI), MOEF.
8. Guard file.
9. Monitoring file.

(Dr. S.K. Aggarwal)
Director

Certificate Sl. No: 10911

TRIPURA STATE POLLUTION CONTROL BOARD

PARIVESH BHAWAN, Pandit Nehru Complex, Gorkhabasti,
Kunjaban, Agartala - 799 006, West Tripura.

No.F.17(10)/TSPCB/S/Power/(L-Red)/2364/Vol-IV/3213-19 Date : 02 / 05 / 2019

CONSENT TO OPERATE CERTIFICATE

Under Section 25/26 of Water (Prevention and Control of Pollution) Act, 1974 and
Under Section 21 of the Air (Prevention and Control of Pollution) Act, 1981

Reference : i) Your Application No.**419** dated : **29-06-2018**
ii) Our NOC Register Sl. No.**11021** for : **Extension of validity**
Capital Investment : **Rs. 3290.25 Crores** Production Capacity : **523.152 MU/Month**
Type : **Power Plant** Category : **Red**

With reference to the above application, a provisional Consent to Operate Certificate is hereby issued in favour of **M/s. ONGC Tripura Power Company Limited 726.6(2X363.3)MW Combined Cycle Power Plant, Managing Director, (OTPC) Vill: Dudhpushkarini, Jamjuri, Tripura(G)** to discharge its industrial and other effluents arising out of their premises into a stream/ well/ land as per section 25/26 of Water (Prevention and Control of Pollution) Act,1974 and to make emission from the plant /unit as per Section 21 of the Air (Prevention and Control of Pollution) Act, 1981 situated at **Vill: Dudhpushkarini, Jamjuri, Tripura(G)** subject to observance of other codal formalities of the Govt. of India/Govt. of Tripura/District Administration/ Agartala Municipal Corporation or concerned Nagar Panchayat or concerned Panchayat (whichever is applicable)/ Health Department/Industries & Commerce Department and subject to observance of the following terms & conditions:

i) **Only Natural Gas should be used as the main feed stock.**

ii) **No untreated liquid effluent would be allowed to be discharged in the water bodies. Treated liquid effluents to the maximum extent possible should be used/ recycled in the plant/irrigation of their green belt/agricultural field etc. All treated effluents must meet BSI standard and emission must conform to the emission standard as fixed by the Central Pollution Control Board.**

iii) **Effluent carrying drains must be segregated from the storm water drains and effluent must be disposed of in effluent pond. In no case, effluent will be allowed to be discharged into nearby Nullah/Natural Water Course etc. without treatment and bringing it within ISI permissible limit or limits fixed by the Board.**

iv) **Adequate steps should be taken for prevention and control of fire and explosion hazards likely to be caused due to storage and use of inflammable material like Natural Gas.**

v) **Families affected due to acquisition of land should be properly compensated in consultation with the State Government.**

vi) **The NOx emissions should not exceed the specified standards of 50 ppm.as the site is located within 25 km. of sanctuary.**

vii) **The gaseous emissions from various units should conform to the standards prescribed by the emission level and should not go beyond the stipulated standards. In the event of failure of any pollution control system adopted by the unit, the respective unit should be shut down and should not be restarted until the control measures are rectified to achieve the desired standards/ efficiency.**

viii) **Adequate No. of monitoring stations should be provided in consultation with the State Pollution Control Board. Further, stack emissions should be monitored periodically. The data of stack emissions and ambient air quality should be sent to the State Pollution Control Board monthly.**

ix) **To maintain the environmental and ecological balance in the area, provisions for planning selected species of trees within the compound and approaches alongwith provisions. for park, garden and fountain shall have to be made. Massive afforestation will have to be made by the Industry in the Factory and Township.The unit should submit the action plan on afforestation programme including the compensatory afforestation programme within a month of issuance of this Certificate.**

x) **An average of 50m wide green belt shall be developed around the plant periphery covering 28 ha of area.**

xi) **A separate Environment Management Cell with suitably qualified staff to carry out the various functions should be set up under the control of a Senior Executive, who will report directly to the Head of the organization.**

xii) **The unit would constitute an internal Monitoring Committee within 3 months from the date of issuance of the Certificate.**

Contd.....P/2

xiii) The unit would monitor environmental impact on parameters as envisaged in the EIA report including two more parameters namely- i) Exploitation of water from Gomati River & its effect on local irrigation needs an quality of discharged water and impact of river life. ii) Sludge and condensate generation and disposal system in the process of operation.

xiv) No Air, Water and Soil pollution shall be created by the industry beyond the permissible limits prescribed by this Board. The Industry would incorporate adequate pollution control measures before they put the plant into operation.

xv) As per provisions of Water (Prevention & Control of Pollution) Act, 1974 and Air (Prevention & Control of Pollution) Act. 1981 any officer empowered, by this Board in its behalf shall have without any interruption, the right to enter the industry at any time for inspection, to take samples for analysis and may call for any information etc. Violation of this right will lead to withdrawal of this permission.

xvi) The unit would ensure proper sludge disposal and condensate treatment facility in accordance with the provisions of the Environment (Protection) Rules, 1986 and the action plan in this regard should be intimated to the TSPCB within one month of issuance of this NOC.

xvii) Standard linings and flat embankment of effluent pond shall have to be provided in the pond to prevent and control of overflow, seepage and leakage of effluent to the nearby areas.

xviii) The unit shall have to deposit Water Cess as per the Water (Prevention and Control of Pollution) Cess Act, 1977.

xix) Gaseous pollutants due to the burning of fuel to run engine, boiler, etc. should be controlled by adopting preventive measures.

xx) Solid Wastes arising during the operation should be properly graded and disposed off scientifically without causing nuisances.

xxi) For low-lying areas, special care is to be taken by the Industry to prevent any overflow, seepage and leekage of effluent.

xxii) Fire warning systems (Alarm, Siren) is to be installed by the industry to guard against accidental pollution/mishap together with the fire fighting devices.

xxiii) All pipe connections, joint, fitting etc. in the factory and plant are to be frequently checked and kept leak proof at all the time by the industry.

xxiv) Proper housekeeping and adequate maintenance have to be ensured/ enforced as per provisions of relevant Acts.

xxv) Production process is to be monitored carefully and in the event of danger, immediate shut down is to be ensured by the industry.

xxvi) Healthy working environment for the workers must be maintained and there should not be health hazards to the workers for inadequate arrangements for ventilation, dust removal etc. Arrangements should be regularly monitored.

xxvii) The Board will be at liberty to withdraw the Consent Certificate at any time without notice if necessary steps for prevention of pollution and preservation of environment is not taken by the plant as per the mentioned conditions.

xxviii) The issuence of this Certificate does not confer any right on any realistic or personal property or any exclusive privilage nor does it authorised the Certificate folder of inflecting any injury to private properties nor any invasion right.

xxix) This Certificate does not authorise or approve the construction of any physical structure or facilities or the undertaking of any works especially instructed herein.

xxx) The unit shall have to install adequate capacity of cooling towers at suitable location before starting operation. Special care should be taken to cool down the hot water before discharge as per B.S.I. Standard (Formerly, ISI). There should not be adverse effect on aquatic lives due to water temperature at the discharge point.

xxxi) The applicant is to construct Treatment Plant to treat their domestic waste which will arise from their colony and in no case, untreated sewage and effluent shall be discharged outside their compound.

xxxii) The unit is to setup Rain Water Harvesting Plant for effective implementation of Water Resource Management Plan.

xxxiii) The applicant is to take special care so that nearby flora and fauna are unaffected due to their activities in area.

xxxiv) The Water temperature at the discharge point should not exeed 7 degree centigrade and above the ambient temperature of the recieving river.

xxxv) Height of chimney shall not be less than 30 metres.

xxxvi) Adequate care is to be taken by the applicant to the sericulture of the nearby areas. The levels of noise and vibration in the compression room turbine area and the Noise Level shall be kept below 85 dB.

xxxvii) Special care is to be taken by the applicant to preserve the sericulture of the nearby areas.

xxxviii) Environmental Audit Statement shall have to be submitted to the Board once in every financial year.

xxxix) Banning order regarding Plastic Carry Bags issued vide Notification No.F.8(30)/DSTE/ENV/Pt-II/1679-97 dated 10.03.2015 & No.F.8(30)/DSTE/ENV/Pt-II/1984-2003 dated 19.03.2015 should be strictly adhered to.

Contd.....P/3

xxxx) **Public liability insurance coverage shall have to be provided to the workers of the Unit.**

xxxxi) **A copy of the Consent Certificate should be displayed in the office of the unit.**

xxxxii) **Compliance report may be submitted to the TSPCB once in a year.**

xxxxiii) **The unit will have to follow other norms & standards issued by TSPCB from time to time.**

xxxxiv) **Violation of any of the above conditions could lead to withdrawal of the certificate.**

This Certificate is valid upto 02.05.2024. Application for extension of validity of Consent Certificate shall have to be made one month before the date of expiry of validity of this Certificate

To
M/s. ONGC Tripura Power Company Limited
726.6(2X363.3)MW Combined Cycle Power Plant
Managing Director (OTPC)
Vill: Dudhpushkarini, Jamjuri, Tripura(G)

02/05/19

(Aparajita Das)
Asst. Environmental Engineer
Tripura State Pollution Control Board

Copy to:

1) Commissioner & Secretary, Power Department, Tripura.
2) Chairman cum Managing Director, Tripura State Electricity Corporation.
3) District Magistrate, GomatiTripura.
4) SDM, Udaipur, Gomati, Tripura
5) CEO, Udaipur Municipal Council, Gomati, Tripura
6) District Scientific Officer, DST&E, Tripura (Gomati)

Asst. Environmental Engineer
Tripura State Pollution Control Board

Bharat Heavy Electricals Limited
(A Govt of India Undertaking)
Power Sector – Marketing
BHEL House, Siri fort, New Delhi – 110 049

Tel: 011-6633-7814
Fax: 011-26493561
E-mail: alok@bhel.in

Ref.No.MS-1-06-0051 Dated- 01st May 2020

Mr. Avininder Gupta
CFO
ONGC –Tripura Power Company Ltd.
6th Floor, A – Wing, IFCI Tower
61- Nehru Place, New Delhi-110019

Sub: 726 MW ONGC Tripura CCPP at Palatana, Tripura.

Ref: (i) Supply Contract no. OTPC/EPC/GEN/001 dated 11.08.2008
(ii) Services Contract no. OTPC/EPC/GEN/002 dated 11.08.2008
(iii) MOM of Joint Committee held on 18.12.2019

Dear Sir,

With reference to above Contracts and MOM of Joint Committee held on 18.12.2019, we confirm that balance payment in line with above referred MOM has been received on 24th March'2020 and no further payment is due from OTPC against the subject Contracts.

OTPC is requested to discharge the original Bank Guarantees along with extension letters and furnish duly signed original invoices towards Liquidated Damage claimed by OTPC for further necessary action at our end. An early action shall be highly appreciated.

Yours sincerely

Sd/-
(A K Singhal)
General Manager (Mktg.)

Bharat Heavy Electricals Limited
(A Govt. of India Undertaking)
Power Sector – Marketing
BHEL House, Siri Fort, New Delhi – 110 049

Tel. : 66337814
Fax : 26493561
e-mail : alok@bhel.in

Ref. No. MS-1-06-0051 Dated- 27.05.2020

Chief Finance Officer,
ONGC Tripura Power Company Limited
6th Floor, IFCI Tower,
61, Nehru Place,
New Delhi – 110019

Ref :- (i) NOA no. OTPC/EPC/GEN/2008 dated 23.06.2008
(ii) Supply Contract no. OTPC/EPC/GEN/001 dated 11.08.2008
(iii) Services Contract no. OTPC/EPC/GEN/002 dated 11.08.2008
(iv) MOM of Joint Committee held on 18.12.2019 regarding closing of subject Contract
(v) OTPC letter dated 03.03.2020 regarding settlement of LD & other dues
(vi) OTPC letter dated 12.03.2020 regarding settlement of LD & other dues

Sub: 726 MW ONGC Tripura CCPP at Palatana, Tripura by OTPC

Dear Sir,

Further to above letters, we thankfully acknowledge the receipt of full and final payment of Rs. 63.74 Crs on 24.03.2020 after adjustment of Rs. 19.26 Crs on account of GST on LD of Rs. 107 Crs recovered by OTPC for the delay in the Commissioning Completion of the subject project on account of rectification of various teething problems attributable to EPC Contractor (BHEL) as per terms of EPC contract.

Thanking you.

Yours sincerely

27/5/20

(A K Singhal)
General Manager (PS-Mktg)

INDEPENDENT AUDITOR'S REPORT

To the Members of **ONGC Tripura Power Company Limited**

Report on the Audit of the Standalone Financial Statements

Opinion

We have audited the accompanying standalone financial statements of **ONGC Tripura Power Company Limited** ("the Company"), which comprise the standalone balance sheet as at 31st March 2020, the standalone statement of Profit and Loss (including Other Comprehensive Income), the standalone statement of changes in equity and the standalone statement of cash flows for the year then ended, and notes to the financial statements, including a summary of significant accounting policies and other explanatory information(hereinafter referred to as "the standalone financial statements").

In our opinion and to the best of our information and according to the explanations given to us, the aforesaid standalone financial statements give the information required by the Companies Act, 2013 ("the Act") in the manner so required and give a true and fair view in conformity with the Indian Accounting Standards prescribed under section 133 of the Act read with the Companies (Indian Accounting Standards) Rules, 2015, as amended, ("Ind AS") and other accounting principles generally accepted in India, of the state of affairs of the Company as at March 31, 2020, the profit and total comprehensive income, changes in equity and its cash flows for the year ended on that date.

Basis for Opinion

We conducted our audit of the standalone financial statements in accordance with the Standards on Auditing specified under section 143(10) of the Act (SAs). Our responsibilities under those Standards are further described in the *Auditor's Responsibilities for the Audit of the FinancialStatements* section of our report. We are independent of the Company in accordance with the *Code ofEthics* issued by the Institute of Chartered Accountants of India (ICAI) together with the ethicalrequirements that are relevant to our audit of the standalone financial statements under the provisions of the Act and the Rules thereunder, and we have fulfilled our other ethical responsibilities in accordance with these requirements and the ICAI's Code of Ethics. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion on the standalone financial statements.

Information Other than the Standalone Financial Statements and Auditor's Report Thereon

The Company's Board of Directors is responsible for the other information. The other information comprises the information included in theBoard's Report including annexures to the Board's Report, but does not include the standalone financial statements and our auditor's report thereon. The Above Reportsare expected to be made available to us after the date of this auditor's report.

Our opinion on the standalone financial statements does not cover the other information and we do not express any form of assurance conclusion thereon.

In connection with our audit of the standalone financial statements, our responsibility is to read the other information identified above when it becomes available and, in doing so, consider whether the other information is materially inconsistent with the standalone financial statements or our knowledge obtained in the audit or otherwise appears to be materially misstated.

When we read the above identified reports, if we conclude that there is a material misstatement therein, we are required to communicate the matter to those charged with governance and take appropriate actions necessitated by the circumstances and the applicable laws and regulations.

Responsibility of Management for Standalone Financial Statements

The Company's Board of Directors is responsible for the matters stated in section 134(5) of the Act with respect to the preparation of these standalone financial statements that give a true and fair view of the financial position, financial performance, total comprehensive income,changes in equity and cash flows of the Company in accordance with the Ind AS and other accounting principles generally accepted in India. This responsibility also includes maintenance of adequate accounting records in accordance with the provisions of the Act for safeguarding of the assets of the Company and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statement that give a true and fair view and are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, management is responsible for assessing the Company's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the Company or to cease operations, or has no realistic alternative but to do so.

The Board of Directors is also responsible for overseeing the Company's financial reporting process.

Auditor's Responsibilities for the Audit of the Standalone Financial Statements

Our objectives are to obtain reasonable assurance about whether the standalone financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these standalone financial statements.

As part of an audit in accordance with SAs, we exercise professional judgment and maintain professional skepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the standalone financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.

- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances. Under section 143(3)(i) of the Act, we are also responsible for expressing our opinion on whether the company has adequate internal financial controls system in place and the operating effectiveness of such controls.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by management.
- Conclude on the appropriateness of management's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Company's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the standalone financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the Company to cease to continue as a going concern.
- Evaluate the overall presentation, structure and content of the standalone financial statements, including the disclosures, and whether the standalone financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

Materiality is the magnitude of misstatements in the standalone financial statements that, individually or in aggregate, makes it probable that the economic decisions of a reasonably knowledgeable user of the financial statements may be influenced. We consider quantitative materiality and qualitative factors in

(i) planning the scope of our audit work and in evaluating the results of our work; and
(ii) to evaluate the effect of any identified misstatements in the financial statements.

We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

We also provide those charged with governance with a statement that we have complied with relevant ethical requirements regarding independence, and to communicate with them all relationships and other matters that may reasonably be thought to bear on our independence, and where applicable, related safeguards.

Report on Other Legal and Regulatory Requirements

1. As required by the Companies (Auditor's Report) Order, 2016 ("the Order"), issued by the Central Government of India in terms of sub-section (11) of section 143 of the Companies Act, 2013, we give in the Annexure A, a statement on the matters specified in paragraphs 3 and 4 of the Order, to the extent applicable.

2. As required by Section 143(3) of the Act, we report that:

(a) we have sought and obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our audit;

(b) in our opinion, proper books of account as required by law have been kept by the Company so far as it appears from our examination of those books;

(c) the Balance Sheet, the Statement of Profit and Loss, and the Cash Flow Statement and the statement of changes in equity dealt with by this Report are in agreement with the books of account;

(d) in our opinion, the aforesaid standalone financial statements comply with the Accounting Standards specified under Section 133 of the Act, read with relevant rule issued there under;

(e) on the basis of the written representations received from the directors as on 31st March, 2020 taken on record by the Board of Directors, none of the directors is disqualified as on 31st March, 2020 from being appointed as a director in terms of Section 164 (2) of the Act;

(f) with respect to the adequacy of the internal financial controls over financial reporting of the Company and the operating effectiveness of such controls, refer to our separate Report in "Annexure B". Our report expresses an unmodified opinion on the adequacy and operating effectiveness of the Company's internal financial controls over financial reporting;

(g) With respect to the other matters to be included in the Auditor's Report in accordance with the requirements of section 197(16) of the Act, as amended:
In our opinion and to the best of our information and according to the explanations given to us, the remuneration paid by the Company to its directors during the year is in accordance with the provisions of section 197 of the Act; and

(h) with respect to the other matters to be included in the Auditor's Report in accordance with Rule 11 of the Companies (Audit and Auditors) Rules, 2014, in our opinion and to the best of our information and according to the explanations given to us:

i. The Company has disclosed the impact of pending litigations on its financial position in its standalone financial statements – Refer Note 42 to the standalone financial statements
ii. The Company did not have any on long-term contracts including derivative contracts for which there were any material foreseeable losses.
iii. There were no amount which were required to be transferred to the Investor Education and Protection Fund by the Company

For K KSoni& Co.
Chartered Accountants
FRN: 000947N

K K SONI & CO. DELHI Chartered Accountants

Abhinav Aggarwal
Partner
Membership number: 517358

Place: New Delhi
Dated: 10 JUN 2020

Annexure - A to the Auditors' Report

The Annexure referred to in Independent Auditors' Report to the members of the Company on the standalone financial statements for the year ended 31 March 2020, we report that:

(i) (a) The Company has maintained proper records showing full particulars, including quantitative details and situation of fixed assets.

(b) Fixed Assets have been physically verified by the management at reasonable intervals. In accordance with the physical verification of the assets conducted during the year, no material discrepancies were noticed.

(c) According to the information and explanations given to us and on the basis of our examination of the records of the Company, the title deeds of immovable properties are held in the name of the Company.

(ii) Physical Verification of Inventory has been conducted by the management at reasonable intervals& the company is maintaining proper records of inventory & no material discrepancies were noticed on physical verification of inventories.

(iii) The Company has not granted any loans to companies, firms or other parties covered in the register maintained under section 189 of the Companies Act, 2013 ('the Act'). Thus, paragraphs 3(iii)(a), 3(iii)(b) and 3(iii)(c) of the order are not applicable.

(iv) In our opinion and according to the information and explanations given to us, the Company has complied with the provisions of section 185 and 186 of the Act, with respect to the loans and investments made.

(v) The Company has not accepted any deposits from the public during the year and does not have any unclaimed deposit as at 31 March 2020 and therefore provisions of the clause 3(v) of the Order are not applicable to the company.

(vi) According to the information and explanations given to us, the cost records as prescribed by the Central Government under section 148(1) of the Act, have been made and maintained by the company.

(vii) (a) According to the information and explanations given to us and on the basis of our examination of the records of the Company, amounts deducted/ accrued in the books of account in respect of undisputed statutory dues including provident fund, income tax, sales tax, duty of customs, service tax, cess and other material statutory dues have been regularly deposited during the year by the Company with the appropriate authorities. As explained to us, the Company did not have any dues on account of employees' state insurance and duty of excise.

According to the information and explanations given to us, no undisputed amounts payable in respect of provident fund, income tax, sales tax, value added tax, duty of customs, service tax, cess and other material statutory dues were in arrears as at 31 March 2020 for a period of more than six months from the date they became payable.

(b) According to the information and explanations given to us, there are no dues of provident fund, sales tax, service tax which have not been deposited with the appropriate authorities on account of any dispute. However, according to information and explanations given to us, the following dues of income tax have not been deposited by the Company on account of disputes:

Name of Statute	Nature of Dues	Amount (in Lakhs)	Period to which the amount pertains	Forum where dispute is pending
Income Tax Act, 1961	Income Tax and Interest	262.75	FY 2012-13	Income Tax Appellate Tribunal
Income Tax Act, 1961	Income Tax and Interest	3.59	FY 2014-15	Joint Commissioner of Income Tax
Income Tax Act, 1961	Income Tax and Interest	114.93	FY 2016-17	Commissionerof Income Tax (Appeals)
Income Tax Act, 1961	Income Tax and Interest	441.91	FY 2015-16	Commissioner of Income Tax (Appeals)

(viii) According to the information and explanations given to us and on the basis of our examination of the records of the company, the Company has not defaulted in repayment of dues to a financial institution or Bank. The company does not have any debenture holders during the year.

(ix) The Company did not raise any money by way of initial public offer or further public offer (including debt instruments) during the year. Money raised by way of Term Loans was applied for the purposes for which those were raised.

(x) To the best of our knowledge and according to the information and explanations given to us, no material fraud by the Company or on the Company by its officers or employees has been noticed or reported during the course of our audit.

(xi) According to the information and explanations give to us and based on our examination of the records of the Company, the Company has paid/provided for managerial remuneration in accordance with the requisite approvals mandated by the provisions of section 197 read with Schedule V to the Act.

(xii) In our opinion and according to the information and explanations given to us, the Company is not a Nidhi company. Accordingly, paragraph 3(xii) of the Order is not applicable.

(xiii) According to the information and explanations given to us and based on our examination of the records of the Company, transactions with the related parties are in compliance with sections 177 and 188 of the Act where applicable and details of such transactions have been disclosed in the standalone financial statements as required by the applicable accounting standards.

(xiv) According to the information and explanations give to us and based on our examination of the records of the Company, the Company has not made any preferential allotment or private placement of shares or fully or partly convertible debentures during the year.

(xv) According to the information and explanations given to us and based on our examination of the records of the Company, the Company has not entered into non-cash transactions with directors or persons connected with him. Accordingly, paragraph 3(xv) of the Order is not applicable.

(xvi) The Company is not required to be registered under section 45-IA of the Reserve Bank of India Act 1934.

For K KSoni& Co.
Chartered Accountants
FRN: 000947N

Abhinav Aggarwal
Partner
Membership number: 517358

Place: New Delhi
Dated: 10 JUN 2020

Annexure - B to the Auditors' Report

Report on the Internal Financial Controls under Clause (i) of Sub-section 3 of Section 143 of the Companies Act, 2013 ("the Act")

We have audited the internal financial controls over financial reporting in financial statements of ONGC Tripura Power Company Limited ("the Company") as of 31 March 2020 in conjunction with our audit of the standalone financial statements of the Company for the year ended on that date.

Management's Responsibility for Internal Financial Controls

The Company's management is responsible for establishing and maintaining internal financial controls over financial reporting in financial statements based on the internal control over financial reporting in financial statements criteria established by the Company considering the essential components of internal control stated in the Guidance Note on Audit of Internal Financial Controls over Financial Reporting issued by the Institute of Chartered Accountants of India ('ICAI'). These responsibilities include the design, implementation and maintenance of adequate internal financial controls over financial reporting in financial statements that were operating effectively for ensuring the orderly and efficient conduct of its business, including adherence to company's policies, the safeguarding of its assets, the prevention and detection of frauds and errors, the accuracy and completeness of the accounting records, and the timely preparation of reliable financial information, as required under the Companies Act, 2013.

Auditors' Responsibility

Our responsibility is to express an opinion on the Company's internal financial controls over financial reporting in financial statements based on our audit. We conducted our audit in accordance with the Guidance Note on Audit of Internal Financial Controls over Financial Reporting (the "Guidance Note") issued by the Institute of Chartered Accountants of India and the Standards on Auditing as specified under section 143(10) of the Companies Act, 2013, to the extent applicable to an audit of internal financial controls over financial reporting in financial statements. Those Standards and the Guidance Note require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether adequate internal financial controls over financial reporting in financial statements were established and maintained and if such controls operated effectively in all material respects.

Our audit involves performing procedures to obtain audit evidence about the adequacy of the internal financial controls system over financial reporting in financial statements and their operating effectiveness.

Our audit of internal financial controls over financial reporting in financial statements included obtaining an understanding of internal financial controls over financial reporting in financial statements, assessing the risk that a material weakness exists, and testing and evaluating the design and operating effectiveness of internal control based on the assessed risk. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the standalone financial statements, whether due to fraud or error.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion on the Company's internal financial controls system over financial reporting in financial statements.

Meaning of Internal Financial Controls over Financial Reporting

A company's internal financial control over financial reporting in financial statements is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal financial control over financial reporting in financial statements includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorisations of management and directors of the company; and (3) provide reasonable assurance regarding prevention or timely detection of unauthorised acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

Inherent Limitations of Internal Financial Controls over Financial Reporting

Because of the inherent limitations of internal financial controls over financial reporting in financial statements, including the possibility of collusion or improper management override of controls, material misstatements due to error or fraud may occur and not be detected. Also, projections of any evaluation of the internal financial controls over financial reporting in financial statements to future periods are subject to the risk that the internal financial control over financial reporting in financial statements may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

Opinion

In our opinion, to the best of our information and according to the explanations given to us, the Company has, in all material respects, an adequate internal financial controls over financial reporting in financial statements and such internal financial controls over financial reporting in financial statements were operating effectively as at 31 March 2020, based on the internal control over financial reporting in financial statements criteria established by the Company considering the essential components of internal control stated in the Guidance Note on Audit of Internal Financial Controls Over Financial Reporting issued by the Institute of Chartered Accountants of India.

For KKSoni& Co.
Chartered Accountants
FRN: 000947N

Abhinav Aggarwal
Partner
Membership number: 517358

Place: New Delhi
Dated: 10 JUN 2020

ONGC TRIPURA POWER COMPANY LIMITED

Standalone Balance Sheet as at March 31, 2020

(All amounts are ₹ in Lakhs unless otherwise stated)

	Particulars	Note No.	As at March 31, 2020	As at March 31, 2019
I	**ASSETS**			
(1)	**Non-current assets**			
	(a) Property, plant and equipment	5	2,74,791.57	2,91,583.28
	(b) Capital work in progress	6	14.51	7,336.15
	(c) Other intangible assets	7	783.01	958.11
	(d) Financial assets			
	(i) Investments	8	10,696.40	10,696.40
	Investments in joint venture			
	(ii) Loans	9	33.88	126.30
	(e) Non-current tax asset (Net)	11	20.89	20.89
	(f) Other non-current assets	12	113.74	923.87
	Total non-current assets		**2,86,454.00**	**3,11,645.00**
(2)	**Current assets**			
	(a) Inventories	13	2,817.08	3,160.82
	(b) Financial assets			
	(i) Investments	14	12,181.70	17,323.87
	(ii) Trade receivables	15	16,891.86	12,674.06
	(iii) Loans	9	129.00	-
	(iv) Cash and cash equivalents	16	457.82	17.22
	(v) Bank balance other than (iv) above	17	0.51	0.52
	(vi) Other financial assets	10	7,568.47	13,713.31
	(c) Current tax asset (Net)	11	951.21	-
	(d) Other current assets	12	2,907.08	3,079.25
	Total current assets		**43,904.73**	**49,969.05**
(3)	**Regulatory deferral account debit balance**	27	**8,914.85**	**7,331.77**
	Total assets		**3,39,273.58**	**3,68,945.82**
II	**EQUITY AND LIABILITIES**			
(1)	**EQUITY**			
	(a) Equity share capital	18	1,12,000.00	1,12,000.00
	(b) Other equity	19	14,366.65	19,467.15
	Total equity		**1,26,366.65**	**1,31,467.15**
(2)	**Non-current liabilities**			
	(a) Financial liabilities			
	(i) Borrowings	20	1,63,725.39	1,80,229.39
	(ii) Finance lease obligations	21	3.30	-
	(iii) Other financial liabilities	21	3,210.74	3,475.06
	(b) Provisions	22	170.00	119.15
	(c) Deferred tax liabilities (Net)	23	10,306.18	8,476.04
	(d) Other non-current liabilities	24	309.92	2,180.05
	Total non-current liabilities		**1,77,725.53**	**1,94,479.69**
(3)	**Current liabilities**			
	(a) Financial liabilities			
	(i) Borrowings	20	-	235.49
	(ii) Trade payables	25		
	(a) Micro & Small enterprises payable		0.06	0.13
	(b) Other trade payables		2,096.02	3,537.14
	(iii) Finance lease obligations	21	9.37	-
	(iv) Other financial liabilities	21	29,668.30	37,278.30
	(b) Other current liabilities	24	3,355.86	1,184.81
	(c) Current tax liabilities (net)	26	(0.00)	740.56
	(d) Provisions	22	51.79	22.55
	Total current liabilities		**35,181.40**	**42,998.98**
	Total liabilities		**2,12,906.93**	**2,37,478.67**
	Total equity and liabilities		**3,39,273.58**	**3,68,945.82**

See accompanying notes to the standalone financial statements (Notes 1 - 48)

This is the Statement of Financial Statements referred to in our report of even date.

For K K Soni & Co.
Chartered Accountants
FRN : 000947N

Abhinav Aggarwal
Partner
Membership Number : 517358
Place : New Delhi
Date : 10 JUN 2020

For and on behalf of the Board of Directors
CIN : U40101TR2004PLC007544

(Subhash Kumar)
Director
DIN : 07005656

(Avijundra Gupta)
Chief Financial Officer
Place : New Delhi
Date : 10 JUN 2020

(Sanil C. Namboodiripad)
Managing Director
DIN : 07963665

(N.K. Aggarwal)
Company Secretary

ONGC TRIPURA POWER COMPANY LIMITED

Standalone Statement of Profit and Loss for the year ended March 31, 2020

(All amounts are ₹ in Lakhs unless otherwise stated)

	Particulars	Note No.	Year ended March 31, 2020	Year ended March 31, 2019
I	Revenue from Operations	28	1,24,833.32	1,40,997.42
II	Other Income	29	4,104.85	5,120.83
III	**Total Income (I+II)**		**1,28,938.17**	**1,46,118.25**
IV	**EXPENSES**			
	Cost of gas consumed	-	60,450.30	65,779.30
	Employee benefit expenses	30	2,091.20	2,163.43
	Finance costs	31	15,952.42	17,331.48
	Generation, operation & maintenance expenses	32	18,549.64	11,001.49
	Depreciation and amortization expenses	33	19,673.45	19,492.19
	Other expenses	34	3,293.88	2,052.89
	Total expenses (IV)		**1,20,010.89**	**1,17,820.78**
V	**Profit/(loss) before tax and rate regulated activities (III-IV)**		**8,927.28**	**28,297.47**
VI	**Tax expense:**	35		
	(a) Current Tax relating to:			
	Current tax		1,344.00	5,988.18
	(b) Deferred tax		1,830.15	(2,049.53)
	Total tax expenses		**3,174.15**	**3,938.64**
VII	**Profit for the year before rate regulated activities (V-VI)**		**5,753.13**	**24,358.83**
VIII	Net Movement in regulatory deferral account balance (Net of tax)	27	1,306.48	(3,937.61)
IX	**Profit for the year (VII+VIII)**		**7,059.61**	**20,421.23**
X	**Other Comprehensive Income**			
	-Items that will not be reclassified to profit or loss			
	(a) Remeasurement of the defined benefit plans		(9.88)	4.18
	-Income tax relating to above items		1.73	(0.89)
	Total other comprehensive income		**(8.15)**	**3.29**
XI	**Total Comprehensive Income for the year (IX+X)**		**7,051.46**	**20,424.51**
XII	Earnings per equity share (including regulatory income/expense)	36		
	(1) Basic (in Rs.)		0.63	1.82
	(2) Diluted (in Rs.)		0.63	1.82
	Earnings per equity share (excluding regulatory income/expense)			
	(1) Basic		0.51	2.17
	(2) Diluted		0.51	2.17

See accompanying notes to the standalone financial statements (Notes 1 - 48)
This is the Statement of Financial Statements referred to in our report of even date.

For K K Soni & Co.
Chartered Accountants
FRN : 000947N

Abhinav Aggarwal
Partner
Membership Number : 517358

Place : New Delhi
Date : 10 JUN 2020

For and on behalf of the Board of Directors
CIN : U40101TR2004PLC007544

(Subhash Kumar)
Director
DIN : 07905656

(Sanil C. Namboodiripad)
Managing Director
DIN : 07963665

(Avinder Gupta)
Chief Financial Officer

(N.K. Aggarwal)
Company Secretary

Place : New Delhi
Date : 10 JUN 2020

ONGC TRIPURA POWER COMPANY LIMITED

Standalone statement of changes in equity for the year ended March 31, 2020

(All amounts are ₹ in Lakhs unless otherwise stated)

a) Equity share capital	
Balance at March 31 , 2018	**1,12,000**
Changes in equity share capital during the year	-
Balance at March 31 , 2019	**1,12,000**
Changes in equity share capital during the year	-
Balance at March 31 , 2020	**1,12,000**

b) Other equity

Particulars	Reserves and surplus			
	General Reserves	Retained Earnings	Accumulated OCI	Total
Balance at March 31 , 2018	-	**15,257.38**	**(12.11)**	**15,245.27**
i) Profit for the year	-	20,421.23	-	20,421.23
ii) Remeasurement of defined benefit obligation, net of income tax	-	-	3.29	3.29
iii) Payment of dividend (including corporate dividend tax)	-	(16,202.63)	-	(16,202.63)
Balance at March 31 , 2019	-	**19,475.98**	**(8.82)**	**19,467.16**
i) Profit for the year	-	7,059.61	-	7,059.61
ii) Remeasurement of defined benefit obligation, net of income tax	-	-	(8.15)	(8.15)
iii) Payment of dividend (including corporate dividend tax)	-	(12,151.97)	-	(12,151.97)
Balance at March 31 , 2020	-	**14,383.61**	**(16.97)**	**14,366.65**

This is the Statement of Financial Statements referred to in our report of even date.

For K K Soni & Co.
Chartered Accountants
FRN : 000947N

Abhinav Aggarwal
Partner
Membership Number : 517358

Place : New Delhi
Date : 10 JUN 2020

For and on behalf of the Board of Directors
CIN : U40101TR2004PLC007544

(Subhash Kumar)
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DIN : 07963665

(Avininder Gupta)
Chief Financial Officer

(N.K. Aggarwal)
Company Secretary

Place : New Delhi
Date : 10 JUN 2020

ONGC TRIPURA POWER COMPANY LIMITED

Standalone Cash flow statement for the year ended March 31, 2020

(All amounts are ₹ in Lakhs unless otherwise stated)

Particulars	Year Ended March 31,2020		Year Ended March 31,2019	
A CASH FROM OPERATING ACTIVITES :				
Profit for the year		**5,753.13**		**24,358.83**
Net Movement in regulatory deferral account balance		1,583.08		(3,193.80)
Profit for the year		**7,336.21**		**21,165.04**
Adjustments for:				
Depreciation & amortisation expenses	19,673.45		19,492.19	
Income tax expense	3,174.15		3,938.64	
Interest income	(203.89)		(587.55)	
Dividend income	(1,283.57)		(534.82)	
Other non operating income	(844.41)		(1,275.46)	
Rent expenses	3.86		5.12	
Re measurement of the defined benefit plans	(9.88)		4.18	
Capital work in progress written off	-		59.77	
Foreign exchange difference loss/(gain)	61.02		(6.01)	
Provisions for employee benefits	80.10		8.15	
Finance cost	15,841.62	36,492.45	17,253.47	38,357.69
Operating profit before working capital changes		**43,828.66**		**59,522.73**
Movements in working capital :				
Decrease / (Increase) in other trade receivables	(4,217.80)		(1,239.73)	
Decrease / (Increase) in inventories	343.74		(930.39)	
Decrease / (Increase) in other assets	172.17		(505.42)	
Decrease / (Increase) in financial assets	6,108.26		(3,604.33)	
Increase / (Decrease) in other financial liabilities	(15,150.18)		83.10	
Increase / (Decrease) in other liabilities	2,171.05		(434.78)	
Increase / (Decrease) in trade payables	(1,502.21)		907.26	
Increase / (Decrease) in non current liabilities	(1,870.13)	(13,945.11)	(219.95)	(5,944.23)
Net cash from operating activities		**29,883.56**		**53,578.50**
Direct taxes paid (net of refunds)		(3,310.64)		(5,808.54)
Net cash provided/(used) from operating activities (A)		**26,572.92**		**47,769.96**
B. Cash flows from investing activities				
Disposal/(Purchase) of property plant & equipment	4,615.00		(2,900.00)	
Capital advances given	810.13		213.56	
Balance in escrow account & other bank balance	0.01		(0.40)	
Interest received	203.89		587.55	
Dividends received during the year	1,283.57		534.82	
Other non operating income	123.95		78.19	
Short term gains on sale of investments	720.45		1,197.26	
Change in regulatory deferral account balance	(1,583.08)		3,193.80	
Net Redemption/(Investment) in mutual funds	(2,857.83)		10,916.60	
Net Encashment/(Investment) of term deposits	8,000.00		(8,000.00)	
Net cash provided/(used) in investing activities (B)		**11,316.09**		**5,821.38**
C. Cash flows from financing activities				
Accepted/(Repayment) of Lease liability (Net)	12.68		-	
Loan accepted/(Repaid) during the year -Long Term	(9,232.00)		(24,002.66)	
Loan accepted/(Repaid) during the year -Short Term	(235.49)		235.49	
Payment of interest on borrowings	(15,840.17)		(17,253.47)	
Payment of interest on Lease liability	(1.46)		-	
Payment of interim/final dividend	(10,080.00)		(13,440.00)	
Payment of dividend distribution tax	(2,071.97)		(2,762.63)	
Net cash provided/(used) from financing activities (C)		**(37,448.41)**		**(57,223.27)**
Net increase in cash and cash equivalents (A + B + C)		**440.60**		**(3,631.93)**
Cash and cash equivalents at the beginning of the year		17.22		3,649.15
Cash and cash equivalents at the end of the year		**457.82**		**17.22**

Notes :

1. Cash and cash equivalents consist of balance with bank and deposits with original maturity of upto three months
2. Reconciliation of cash and cash equivalents
   Cash and cash equivalents as per Note -16
3. Reconciliation of liabilities from financing activities :

Particulars	Year Ended March 31 ,2020	Year Ended March 31 ,2019
Opening Balance at the beginning of the year	1,95,496.88	2,19,264.04
Withdrawn/(Repayment) during the year - short term loan	(235.49)	235.49
Withdrawn/(Repayment) during the year - long term loan	(9,232.00)	(24,002.66)
Closing Balance at the end of year	1,86,029.39	1,95,496.88
Long term loan pending for withdrawn from bank	**9,100.00**	**14,900.00**

This is the Statement of Financial Statements referred to in our report of even date

For K K Soni & Co.
Chartered Accountants
FRN : 000947N

Abhinav Aggarwal
Partner
Membership Number : 517358

Place : New Delhi
Date : 10 JUN 2020

For and on behalf of the Board of Directors
CIN : U40101TR2004PLC007544

(Subhash Kumar)
Director
DIN : 07905656

(Avinindo Gupta)
Chief Financial Officer

Place : New Delhi
Date : 10 JUN 2020

(Sanil C. Namboodiripad)
Managing Director
DIN : 07963665

(N.K. Aggarwal)
Company Secretary

1. Corporate information

ONGC Tripura Power Company Limited ('OTPC' or 'the Company') is a public limited company domiciled and incorporated in India having its registered office at Udaipur - Kakraban Road, Palatana P.O District Gomati, Tripura -799105 and its corporate office at 6th Floor, IFCI tower, Nehru place, Delhi-110019. The Company is engaged in the business of generating power and has a Combined Cycle Gas based Power Plant of 726 Mega Watt in Tripura.

2. Application of new Indian Accounting Standards

2.1. Application of new and revised Ind AS

All the Indian Accounting Standards issued and notified by the Ministry of Corporate Affairs under the Companies (Indian Accounting Standards) Rules, 2015 (as amended) till the financial statements are authorized have been considered in preparing these financial statements.

Standards/ Amendments issued but not yet effective

3. Significant accounting policies

3.1. Statement of compliance

In accordance with the notification ***dated 16th February, 2015***, issued by the Ministry of Corporate Affairs, the Company has adopted Indian Accounting Standards (referred to as "Ind AS") notified under the Companies (Indian Accounting Standards) Rules, 2015 (as amended) with effect from April 1, 2016.

The financial statements have been prepared in accordance with Ind AS notified under the Companies (Indian Accounting Standards) Rules, 2015 (as amended).

3.2. Basis of preparation

The financial statements have been prepared on the historical cost basis except for certain financial instruments that are measured at fair values at the end of each reporting period, as explained in the accounting policies below.

Historical cost is generally based on the fair value of the consideration given in exchange for goods and services.

All assets and liabilities have been classified as current or non-current as per the Company's normal operating cycle and other criteria's set out in Ind AS 1 'Presentation of Financial Statements' and Schedule III to the Companies Act, 2013.

The financial statements are presented in Indian Rupee (₹) and all values are rounded to the nearest two decimal Lakhs except otherwise stated.

Fair value measurement

Fair value is the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date under current market conditions.

The Company categorizes assets and liabilities measured at fair value into one of three levels depending on the ability to observe inputs employed in their measurement, which are described as follows:

(a) Level 1 inputs are quoted prices (unadjusted) in active markets for identical assets or liabilities.
(b) Level 2 inputs are inputs that are observable, either directly or indirectly, other than quoted prices included within level 1 for the asset or liability.
(c) Level 3 inputs are unobservable inputs for the asset or liability reflecting significant modifications to observable related market data or Company's assumptions about pricing by market participants.

3.3. Investments in joint venture

The Company records the investments in joint venture at cost less impairment loss, if any.

After initial recognition, the Company determines whether there is any objective evidence of impairment as a result of one or more events that occurred after the initial recognition of investment in joint venture and that event (or events) has an impact on the estimated future cash flows of the joint venture that can be reliably estimated. If there exists such an objective evidence of impairment, then impairment loss is recognized with respect to the Company's investment in joint venture.

When necessary, the cost of the investment is tested for impairment in accordance with Ind AS 36 'Impairment of Assets' as a single asset by comparing its recoverable amount (higher of value in use and fair value less costs of disposal) with its carrying amount, any impairment loss recognized forms part of the cost of the investment. Any reversal of that impairment loss is recognized in accordance with Ind AS 36 'Impairment of Assets' to the extent that the recoverable amount of the investment subsequently increases.

On disposal of investment in joint venture, the difference between net disposal proceeds and the carrying amounts are recognized in the statement of profit and loss.

3.4. Revenue recognition

Effective April 01, 2018, the company has adopted Ind AS 115 Revenue from Contracts with customers under the cumulative effect method and therefore the comparatives have not been retrospectively adjusted. The Standard is applied to contracts that remain in force as at April 01, 2018. The application of the standard does not have any significant Impact on the retained earnings as at April 01, 2018 or on these financial statements.

Revenues are recognized when the company transfers control over a product or service to a customer
Revenue is measured at the transaction price of the consideration received or receivable and represents amounts receivable for goods and services provided in the normal course of business, net of rebate, Trade allowances, Duty , GST and VAT etc. Any retrospective revision in prices is accounted for in the year of such revision.

(i) Revenue from Operation :

a) Sale of Power

The CERC determines the tariff for the Company's Power Plants based on the norms prescribed in the tariff regulations as applicable from time to time.

Sale of energy is accounted for based on tariff rates approved by the Central Electricity Regulatory Commission ('CERC') (except items indicated as provisional) as modified by the orders of Appellate Tribunal for Electricity to the extent applicable. Revenue is reduced for estimated tariff adjustments if any, rebates and other similar allowances.
Customers are billed on a periodic and regular basis. At each reporting date, revenue from sale of power includes an accrual for sale of energy delivered to customers but not yet billed.

In case of power stations where the tariff rates are yet to be approved, provisional rates as per CERC tariff regulations are adopted.

Part of the revenue from sale of energy is recognized based on the rates and terms and conditions mutually agreed with the beneficiaries and trading of power through power exchanges.

The interest/surcharge on late payment/overdue sundry debtors in respect of sale of energy, is recognized when no significant uncertainty as to measurability or collectability exists.

The incentive/disincentives are accounted for based on the norms notified/approved by the CERC as per principles enunciated in Ind AS 115 'Revenue'.

b) Revenue from EPC business

Revenue is recognized in proportion to the stage of completion of the work performed at the reporting date, which is determined based on input method.

c) Other income

Dividend income from investments is recognised when the shareholder's right to receive payment is established.

Interest income from financial assets is recognised at the effective interest rate applicable on initial recognition.

Revenue from sale of scrap is recognized when risk and rewards are passed to customers.

In the comparative period, Revenue was measured at the fair value of the consideration received or receivable.

Insurance claims are accounted for based on claims admitted to the extent that the amount recoverable can be measured reliably and its ultimate collection is virtually certain.

3.5. Leases

Effective 1 April 2019, the Company adopted Ind AS 116 'Leases' and applied to all lease contracts existing on 1 April 2019 using the modified retrospective transition method. Consequently, the lease liability is measured at the present value of remaining lease payments which are discounted using the interest rate implicit in the lease or, if not readily determinable, using the incremental borrowing rate applicable at the date of initial application and the right-of-use asset has been recognized at an amount equal to lease liability. Comparatives as at and for the year ended 31 March 2019 have not been adjusted and therefore will continue to be reported as per Ind AS 17. The details of accounting policies as per Ind AS 17 are disclosed separately if they are different from those under Ind AS 116.

As lessee

The Company assesses whether a contract contains a lease, at inception of a contract. A contract is, or contains, a lease if the contract conveys the right to control the use of an identified asset for a period of time in exchange for consideration. To assess whether a contract conveys the right to control the use of an identified asset, the Company assesses whether: (1) the contact involves the use of an identified asset (2) the Company has substantially all of the economic benefits from use of the asset through the period of the lease and (3) the Company has the right to direct the use of the asset.

The Company recognizes a right-of-use asset and a corresponding lease liability for all lease arrangements in which it is a lessee, except for leases with a term of twelve months or less (short-term

leases) and leases for low value underlying assets. For these short-term and leases for low value underlying assets, the Company recognizes the lease payments as an operating expense on a straight-line basis over the term of the lease.

Certain lease arrangements include the options to extend or terminate the lease before the end of the lease term. Right-of use assets and lease liabilities include these options when it is reasonably certain that the option to extend the lease will be exercised/option to terminate the lease will not be exercised.

The right-of-use assets are initially recognized at cost, which comprises the initial amount of the lease liability adjusted for any lease payments made at or prior to the commencement date of the lease plus any initial direct costs less any lease incentives. They are subsequently measured at cost less accumulated depreciation/amortization and impairment losses.

Right-of-use assets are depreciated/amortized from the commencement date to the end of the useful life of the underlying asset, if the lease transfers ownership of the underlying asset by the end of lease term or if the cost of right-of-use assets reflects that the purchase option will be exercised. Otherwise, Right-of-use assets are depreciated /amortized from the commencement date on a straight-line basis over the shorter of the lease term and useful life of the underlying asset.

Right-of-use assets are evaluated for recoverability whenever events or changes in circumstances indicate that their carrying amounts may not be recoverable. For the purpose of impairment testing, the recoverable amount (i.e. the higher of the fair value less cost to sell and the value-in-use) is determined on an individual asset basis unless the asset does not generate cash flows that are largely independent of those from other assets. In such cases, the recoverable amount is determined for the Cash Generating Unit (CGU) to which the asset belongs.

The lease liability is initially measured at amortized cost at the present value of the future lease payments. The lease payments are discounted using the interest rate implicit in the lease or, if not readily determinable, using the incremental borrowing rate. Lease liabilities are re-measured with a corresponding adjustment to the related right-of-use asset if the Company changes its assessment whether it will exercise an extension or a termination option.

In the comparative period, as lessee the leases were accounted as per Ind AS 17 and classified as finance lease and operating lease, and accounted as follows:

Accounting for finance leases

In the comparative period, leases of property, plant and equipment where the Company, as lessee has substantially all risks and rewards of ownership were classified as finance lease. On initial recognition, assets held under finance leases were recorded as property, plant and equipment and the related liability was recognized under borrowings. At inception of the lease, finance leases were recorded at amounts equal to the fair value of the leased asset or if lower the present value of the minimum lease payments. Minimum lease payments amounts under finance leases were apportioned between the finance cost and the reduction of the outstanding liability.

The finance cost was allocated to each period during the lease term so as to produce a constant periodic rate of interest on the remaining balance of the liability.

Accounting for operating leases

In the comparative period, leases in which a significant portion of the risks and rewards of ownership were not transferred to the Company as lessee are classified as operating lease. Payments made under operating leases were recognized as an expense on a straight-line basis over the lease term unless the payments were structured to increase in line with expected general inflation to compensate for the lessor's expected inflationary cost increases. Lease incentives received were recognized as an integral part of the total lease expense, over the term of the lease.

As a lessor

Leases are classified as finance lease whenever the terms of the lease transfer substantially all the risks and

rewards incidental to ownership to the lessee. All other leases are classified as operating lease. The Company recognises lease payments received under operating leases as income on a straight-line basis over the lease term as part of other income.

3.6. Foreign Exchange Transactions

The functional currency of the Company is Indian Rupee which represents the currency of the primary economic environment in which it operates.

Transactions in currencies other than the Company's functional currency (foreign currencies) are recognised at the rates of exchange prevailing at the dates of the transactions. At the end of each reporting period, monetary items denominated in foreign currencies are translated using exchange rate prevailing on the last day of the reporting period.

Exchange differences on monetary items are recognised in statement of profit and loss in the period in which they arise.

Exchange difference arising in respect of long-term foreign currency monetary items is recognised in the statement of profit and loss except for the exchange difference related to long-term foreign currency monetary items those were recognized as at March 31, 2016, in so far as, they relate to the acquisition of depreciable assets, are adjusted against the cost of such assets and depreciate the said adjustment, over the balance life of asset.

3.7. Borrowing costs

Borrowing costs specifically identified to the acquisition or construction of qualifying assets is capitalized as part of such assets. A qualifying asset is one that necessarily takes substantial period of time to get ready for intended use. All other borrowing costs are recognised in profit or loss in the period in which they are incurred.

3.8. Employee Benefits

Employee benefits include provident fund, gratuity and compensated absences.

Defined contribution plan

Employee benefit under defined contribution plan comprising of provident fund is recognized based on the amount of obligation of the Company to contribute to the plan. The contribution is paid to Provident Fund authorities which is expensed during the year.

Defined benefit plans

The Company's gratuity plan is a defined benefit plan. The present value of the obligation under such defined benefit plan is determined based on actuarial valuation using the projected unit credit method, which recognises each period of service as giving rise to additional unit of employee benefit entitlement and measures each unit separately to build up the final obligation. The obligation is measured at the present value of the estimated future cash flows. The discount rate used for determining the present value of the obligation under defined benefit plans, is based on the prevailing market yields on government securities as at the balance sheet date.

Remeasurement, comprising actuarial gains and losses, the effect of the changes to the asset ceiling (if applicable) and the return on plan assets (excluding net interest), is reflected immediately in the balance sheet with a charge or credit recognised in other comprehensive income in the period in which they occur. Remeasurement recognised in other comprehensive income is reflected immediately in retained earnings and is not reclassified to profit or loss. Past service cost is recognised in profit or loss in the period of a plan amendment. Net interest is calculated by applying the discount rate at the beginning of the period to the net defined benefit liability or asset. Defined benefit costs are categorized as follows:

- Service cost (including current service cost, past service cost, as well as gains and losses on curtailments and settlements);
- Net interest expense or income; and
- Remeasurement

The Company presents the first two components of defined benefit costs in profit or loss in the line item 'Employee benefits expense'. Curtailment gains and losses are accounted for as past service costs.

The Company has taken the group policy with Life Insurance Corporation of India (LIC) to meet its obligation towards gratuity. The Company contributes all ascertained liabilities to a gratuity fund administered through a separate trust which is governed by board of trustees. The board of trustee comprises of the officers of the Company.Liability with respect to the gratuity plan is determined based on an actuarial valuation done by an independent actuary.

The gratuity benefit obligation recognised in the standalone balance sheet represents the actual deficit or surplus in the Company's defined benefit plans. Any surplus resulting from this calculation is limited to the present value of any economic benefits available in the form of refunds from the plans or reductions in future contributions to the plans.

Short-term employee benefits

The undiscounted amount of short-term employee benefits expected to be paid in exchange for the services rendered by employees are recognised during the year when the employees render the service. These benefits include performance incentive and compensated absences which are expected to occur within twelve months after the end of the period in which the employee renders the related service.

The cost of short-term compensated absences is accounted as under:

(a) In case of accumulated compensated absences, when employees render the services that increase their entitlement of future compensated absences; and

(b) In case of non-accumulating compensated absences, when the absences occur.

Long-term employee benefits

Compensated absences which are not expected to occur within twelve months after the end of the period in which the employee renders the related service are recognised as a liability at the present value of the obligation as at the balance sheet date.

3.9. Taxation

Income tax expense represents the sum of the tax currently payable and deferred tax.

(i) Current tax

The tax currently payable is based on taxable profit for the year. Taxable profit differs from 'profit before tax' as reported in the Statement of Profit and Loss because of items of income or expense that are taxable or deductible in other years and items that are never taxable or deductible. The Company's current tax is calculated using tax rates that have been enacted or substantively enacted by the end of the reporting period.

(ii) Deferred tax

Deferred tax is recognised on temporary differences between the carrying amounts of assets and liabilities in the financial statements and the corresponding tax bases used in the computation of taxable profit. Deferred tax liabilities are generally recognised for all taxable temporary differences. Deferred tax assets are generally recognised for all deductible temporary differences to the extent that it is probable that taxable profits will be available against which those deductible temporary differences can be utilised.

Deferred taxes are recognised in respect of temporary differences which originate during the tax holiday period but reverse after the tax holiday period. For this purpose, reversal of temporary difference is determined using first in first out method.

The carrying amount of deferred tax assets is reviewed at the end of each reporting period and reduced to the extent that it is no longer probable that sufficient taxable profits will be available to allow all or part of the asset to be recovered.

Deferred tax liabilities and assets are measured at the tax rates that are expected to apply in the period in which the liability is settled or the asset realised, based on tax rates (and tax laws) that have been enacted or substantively enacted by the end of the reporting period.

Deferred tax assets include Minimum Alternate Tax ('MAT') paid in accordance with the tax laws in India, which is likely to give future economic benefits in the form of availability of set off against future income tax liability. Accordingly, MAT is recognised as deferred tax asset in the balance sheet when the asset can be measured reliably and it is probable that the future economic benefit associated with asset will be realised.

The measurement of deferred tax liabilities and assets reflects the tax consequences that would follow from the manner in which the Company expects, at the end of the reporting period, to recover or settle the carrying amount of its assets and liabilities.

(iii) Current and deferred tax for the year

Current and deferred tax expense is recognised in Statement of Profit and Loss, except when they relate to items that are recognised in other comprehensive income or directly in equity, in which case, the current and deferred tax are also recognised in other comprehensive income or directly in equity respectively.

3.10. Property, Plant and Equipment ('PPE')

Items of property, plant and equipment are measured at cost less accumulated depreciation and accumulated impairment losses, if any. Cost includes expenditure that is directly attributable to bringing the asset to the location and condition necessary for it to be capable of operating in the manner intended by the management.

Expenditure on major inspection and overhauls of generating unit is capitalized when it meets the asset recognition criteria.

Items of spare parts, stand-by equipment and servicing equipment which meet the definition of property, plant and equipment are capitalized. Other spare parts are carried as inventory and recognized in the statement of profit and loss on consumption

The costs of day to day servicing of property, plant and equipment are recognized in profit or loss as incurred.

Capital Work-in-Progress

Properties in the course of construction for production, supply or administrative purposes are carried at cost, less any recognised impairment loss. Cost includes direct cost, related incidental expenses and, for qualifying assets, borrowing costs capitalised in accordance with the Company's accounting policy. Such properties are classified to the appropriate categories of property, plant and equipment when completed and ready for intended use.

Depreciation

Depreciation on assets relating to generation of electricity is charged on straight line method following the rates and methodology provided under CERC Tariff Regulations 2014 as notified by the Central Electricity Regulatory Commission except for IT equipment (including software) on which depreciation is charged at the rate of 30%.

Depreciation on PPE commences when the assets are ready for their intended use.

As per the policy continuously followed by the Company, the depreciation charged during the construction period for assets directly related to such construction is charged under the head Capital work-in-progress.

Depreciation on leasehold improvements has been provided on a straight line basis for the lease period or estimated useful life, whichever is less.

Depreciation on additions/deletions to PPE during the year is provided for on a pro-rata basis with reference to the date of additions/deletions except low value items not exceeding ₹ 5,000 which are fully depreciated at the time of addition leaving a written down value of 10% of the purchase/acquisition value till disposal/retirement.

Freehold land is not depreciated.

Useful lives of the assets

Useful life of the assets relating to generation of electricity is determined as per CERC Tariff Regulations in accordance with Schedule II of the Companies Act, 2013.

Derecognition of PPE

An item of property, plant and equipment is derecognised upon disposal or when no future economic benefits are expected to arise from the continued use of the asset. Any gain or loss arising on the disposal or retirement of an item of property, plant and equipment is determined as the difference between the sales proceeds and the carrying amount of the asset and is recognised in profit or loss.

3.11. Intangible assets

(i) Intangible assets acquired separately

Intangible assets with finite useful lives that are acquired separately are carried at cost less accumulated amortisation and accumulated impairment losses. Computer software is amortised on a straight-line method over a period of 3 years. The estimated useful life and amortization period is reviewed at the end of each reporting period, with the effect of any changes in estimate being accounted for on prospective basis.

Amount paid by the Company to take possession of the Forest Land has been accounted as 'Right to use Land' by the Company and the said amount is amortised from the year of commencement of commercial operation of the Company over the period of 25 years being estimated operating life of the Project.

(ii) Derecognition of Intangible assets

An intangible asset is derecognised on disposal, or when no future economic benefits are expected from use or disposal. Gains or losses arising from derecognition of an intangible asset, are determined as the difference between the net disposal proceeds and the carrying amount of the asset and recognised in statement of profit and loss when the asset is derecognised.

3.12. Impairment of PPE and intangible assets

The Company reviews the carrying amounts of its PPE (including capital work-in-progress) and intangible assets of a cash generating unit to determine whether there is any indication that those assets have suffered an impairment loss. If any such indication exists, the recoverable amount of the asset is estimated in order to determine the extent of the impairment loss (if any). When it is not possible to estimate the recoverable amount of an individual asset, the Company estimates the recoverable amount of the cash generating unit to which the asset belongs.

Recoverable amount is the higher of fair value less costs of disposal and value in use. In assessing value in use, the estimated future cash flows are discounted to their present value using a pre-tax discount rate that reflects current market assessments of the time value of money and the risks specific to the asset for which the estimates of future cash flows have not been adjusted.

If the recoverable amount of an asset (or cash-generating unit) is estimated to be less than its carrying amount, the carrying amount of the asset (or cash-generating unit) is reduced to its recoverable amount. An impairment loss is recognised immediately in statement of profit and loss.

An assessment is made at the end of each reporting period to see if there are any indications that impairment losses recognized earlier may no longer exist or may have come down. The impairment loss is reversed, if there has been a change in the estimates used to determine the asset's recoverable amount since the previous impairment loss was recognized. If it is so, the carrying amount of the asset is increased to the lower of its recoverable amount and the carrying amount that have been determined, net of depreciation, had no impairment loss been recoznised for the asset in prior years. After a reversal the depreciation charge is adjusted in future periods to allocate the asset's revised carrying amount, less any residual value, on a systematic basis over its remaining useful life. Reversals of Impairment loss are recognized in the statement of profit and loss.

3.13. Inventories

Inventories of stores and spares are valued at weighted average cost or net realisable value, whichever is lower. Provisions are made for obsolete, unserviceable and surplus stores and spares.

3.14. Provisions, Contingent Liabilities and Contingent Assets

Provisions are recognised when the Company has a present obligation (legal or constructive) as a result of a past event, it is probable that the Company will be required to settle the obligation, and a reliable estimate can be made of the amount of the obligation.

The amount recognised as a provision is the best estimate of the consideration required to settle the present obligation at the end of the reporting period, taking into account the risks and uncertainties surrounding the obligation. When a provision is measured using the cash flows estimated to settle the present obligation, its carrying amount is the present value of those cash flows (when the effect of the time value of money is material).

Contingent assets are disclosed in the financial statements by way of notes to accounts when an inflow of economic benefits is probable.

Contingent liabilities are disclosed in the financial statements by way of notes to accounts, unless possibility of an outflow of resources embodying economic benefit is remote.

3.15. Financial Instruments

Financial assets and financial liabilities are recognised when Company becomes a party to the contractual provisions of the instruments.

Financial assets and financial liabilities are initially measured at fair value. Transaction costs that are directly attributable to the acquisition or issue of financial assets and financial liabilities (other than

financial assets and financial liabilities at fair value through profit or loss) are added to or deducted from the fair value of the financial assets or financial liabilities, as appropriate, on initial recognition. Transaction costs directly attributable to the acquisition of financial assets or financial liabilities at fair value through profit or loss are recognised immediately in the Statement of Profit and Loss.

3.16. Equity instruments

An equity instrument is any contract that evidences a residual interest in the assets of an entity after deducting all of its liabilities. Equity instruments issued by the Company are recognised at the proceeds received. Incremental costs directly attributable to the issuance of new ordinary equity shares are recognized as a deduction from equity, net of tax effects.

3.17. Financial assets

(i) Cash and cash equivalents

The Company considers all highly liquid financial instruments, which are readily convertible into known amounts of cash that are subject to an insignificant risk of change in value and having original maturities of three months or less from the date of purchase, to be cash equivalents. Cash and cash equivalents consist of balances with banks which are unrestricted for withdrawal and usage.

(ii) Financial assets at amortised cost

Financial assets are subsequently measured at amortised cost using the effective interest method if these financial assets are held within a business whose objective is to hold these assets in order to collect contractual cash flows and the contractual terms of the financial asset give rise on specified dates to cash flows that are solely payments of principal and interest on the principal amount outstanding.

(iii) Financial assets at fair value through other comprehensive income

Financial assets are measured at fair value through other comprehensive income if these financial assets are held within a business whose objective is achieved by both selling financial assets and collecting contractual cash flows, the contractual terms of the financial asset give rise on specified dates to cash flows that are solely payments of principal and interest on the principal amount outstanding.

(iv) Financial assets at fair value through profit or loss ('FVTPL')

Financial assets are measured at fair value through profit or loss unless it is measured at amortised cost or at fair value through other comprehensive income on initial recognition.

(v) Impairment of financial assets

The Company assesses at each balance sheet date whether a financial asset or a group of financial assets is impaired. Ind AS 109 'Financial Instruments ' requires expected credit losses to be measured through a loss allowance. The Company recognises lifetime expected losses for trade receivables that do not constitute a financing transaction. For all other financial assets, expected credit losses are measured at an amount equal to 12 month expected credit losses or at an amount equal to lifetime expected losses, if the credit risk on the financial asset has increased significantly since initial recognition.

(vi) Derecognition of financial assets

The Company derecognises a financial asset when the contractual rights to the cash flows from the asset expire, or when it transfers the financial asset and substantially all the risks and rewards of ownership of the asset to another party.

On derecognition of a financial asset in its entirety, the difference between the asset's carrying amount and the sum of the consideration received and receivable is recognised in the statement of profit and loss.

3.18. Financial liabilities

a) **Financial liabilities**

Financial liabilities are measured at amortised cost using the effective interest method.

b) **Derecognition of financial liabilities**

The Company derecognises financial liabilities when, and only when, the Company's obligations are discharged, cancelled or have expired. The difference between the carrying amount of the financial liability derecognised and the consideration paid and payable is recognised in the statement of profit and loss.

3.19. Earnings per share

Basic earnings per share are computed by dividing the profit after tax by the weighted average number of equity shares outstanding during the period. Diluted earnings per share is computed by dividing the profit after tax as adjusted for dividend, interest and other charges to expense or income (net of any attributable taxes) relating to the dilutive potential equity shares by the weighted average number of equity shares considered for deriving basic earnings per share and also the weighted average number of equity shares that could have been issued upon conversion of all dilutive potential equity shares.

3.20. Cash Flow Statement

Cash flows are reported using the indirect method, whereby profit for the year is adjusted for the effects of transactions of a non-cash nature, any deferrals or accruals of past or future operating cash receipts or payments and item of income or expenses associated with investing or financing cash flows. The cash flows are segregated into operating, investing and financing activities.

3.21. Segment reporting

Operating segments are identified and reported taking into account the different risks and returns, the organization structure and the internal reporting systems.

3.22. Regulatory Deferral Account

Expenses/income recognized in the Statement of Profit & Loss to the extent recoverable from or payable to the beneficiaries in subsequent period as per CERC tariff Regulations are recognized as "Regulatory Deferral Account Balances"

Regulatory deferral account balances are adjusted from the year in which the same become recoverable from or payable to the beneficiaries.

Regulatory deferral account balances are evaluated at each balance sheet date to ensure that the underlying activities meet the recognition criteria and it is probable that future economic benefits associated with such balances will flow to the entity. If these criteria are not met, the regulatory deferral account balances are derecognised.

A separate line item is presented in the profit or loss section of the Statement of Profit and Loss for the net movement in all Regulatory Deferral Account Balances for the reporting period.

4. Critical Accounting Judgments and Key Sources of Estimation Uncertainty-

Inherent in the application of many of the accounting policies used in preparing the standalone financial statements is the need for management to make judgments, estimates and assumptions that affect the reported amounts of assets and liabilities, the disclosure of contingent assets and liabilities, and the reported amounts of revenues and expenses. Actual outcomes could differ from the estimates and assumptions used.

Estimates and underlying assumptions are reviewed on an ongoing basis. Revisions to accounting estimates are recognised in the period in which the estimates are revised and future periods are affected.

Key source of judgement and estimation of uncertainty in the preparation of the standalone financial statements which may cause a material adjustment to the carrying amounts of assets and liabilities within the next financial year, are in respect of revenue and recognition of deferred tax assets.

4.1. Critical judgements in applying accounting policies

(i) Revenue

The Company records revenue from sale of energy based on tariff rates approved by the CERC (except items indicated as provisional) as modified by the orders of Appellate Tribunal for Electricity as per principles enunciated under Ind AS 115 ' Revenue'. However, in cases where tariff rates are yet to be approved, provisional rates are adopted considering the applicable CERC Tariff Regulations.

(ii) Recognition of deferred tax asset

The extent to which deferred tax assets can be recognized is based on an assessment of the probability of the Company's future taxable income against which the deferred tax assets can be utilized. In addition, significant judgement has been used in assessing the impact of any legal or economic limits or uncertainties.

Deferred tax has been recognised in respect of temporary differences which originate during the tax holiday period but reverse after the tax holiday period. For this purpose, reversal of temporary difference has been determined using first in first out method.

Notes to the Standalone financial statement for the year ended March 31, 2020
(All amounts are ₹ in Lakhs unless otherwise stated)

Note 5: Property, Plant and Equipment

Carrying amounts	As at March 31, 2020	As at March 31, 2019
Freehold Land	969.21	961.85
Buildings	53,447.05	45,976.59
Computers	11.20	131.22
Vehicles	9.51	12.84
Plant & Equipment	2,17,922.06	2,41,891.53
Office Equipments	219.63	231.34
Furniture & Fixtures	2,183.06	2,356.86
Leasehold Improvements	17.68	21.05
Right of use Assets	12.17	-
Total	**2,74,791.57**	**2,91,583.28**

Cost	Freehold Land	Buildings	Computers	Vehicles	Plant & Equipments	Office Equipments	Furniture & Fixtures	Leasehold improvements	Right of use Assets	Total
Balance at March 31, 2018	**961.85**	**54,842.88**	**1,078.63**	**35.00**	**3,20,637.13**	**223.25**	**2,694.62**	**141.38**	**-**	**3,80,614.74**
Additions during the year	-	33.88	0.92	-	72.19	77.85	3.09	-	-	187.93
Disposal/ Adjustments during the year	-	-	-	-	(0.24)	(1.75)	-	-	-	(1.99)
Balance at March 31, 2019	**961.85**	**54,876.76**	**1,079.55**	**35.00**	**3,20,709.08**	**299.35**	**2,697.71**	**141.38**	**-**	**3,80,800.68**
Additions during the year	7.36	10,891.59	3.75	-	2,596.79	8.15	(3.54)	-	21.30	13,525.40
Disposal/ Adjustments during the year	-	(1,551.26)	-	-	(9,280.95)	(0.23)	-	-	-	(10,832.44)
Balance at March 31, 2020	**969.21**	**64,217.09**	**1,083.30**	**35.00**	**3,14,024.92**	**307.27**	**2,694.17**	**141.38**	**21.30**	**3,83,493.64**

Accumulated Depreciation	Freehold Land	Buildings	Computers	Vehicles	Plant & Equipments	Office Equipments	Furniture & Fixtures	Leasehold improvements	Right of use Assets	Total
Balance at March 31, 2018	**-**	**7,067.62**	**636.77**	**18.84**	**61,876.20**	**48.97**	**170.46**	**107.01**	**-**	**69,925.87**
Additions during the year	-	1,832.56	311.57	3.32	16,941.36	19.54	170.39	13.31		19,292.04
Disposal/ Adjustments during the year	-	-	-	-	(0.01)	(0.48)	-	-		(0.49)
Balance at March 31, 2019	**-**	**8,900.18**	**948.34**	**22.16**	**78,817.55**	**68.03**	**340.85**	**120.32**	**-**	**89,217.42**
Additions during the year	-	1,869.86	123.77	3.33	17,285.30	19.76	170.26	3.38	9.13	19,484.78
Disposal/ Adjustments during the year	-	-	-	-	-	(0.12)	-	-	-	(0.12)
Balance at March 31, 2020	**-**	**10,770.04**	**1,072.11**	**25.49**	**96,102.85**	**87.66**	**511.11**	**123.70**	**9.13**	**1,08,702.08**

5.1. Additions/ (adjustments) to plant and equipment includes ₹ 198 Lakhs (For the year ended March 31, 2019 ₹ 131 Lakhs) in relation to foreign exchange differences.

5.2. Rupee term loan and cash credit are secured against PPE (Refer note 20.3 and 20.4).

5.3 Right of use assets of ₹ 21.30 Lakhs has been recognised on transition to Ind As 116 as on April 1,2019. (refer note 38)

5.4 The adjustment of ₹ 10,832.44 Lakhs in cost herein above includes adjustment of Liquidated Damages (LD) claim of ₹ 10,700 Lakhs settled with EPC Contractor. The depreciation on the said adjusted cost has been taken prospectively as per Ind AS 16.

Notes to the Standalone financial statement for the year ended March 31, 2020
(All amounts are ₹ in Lakhs unless otherwise stated)

Note 6 : Capital work in progress

Cost	Land	Buildings	Computers	Plant & Equipments	Furniture & Fixtures	Others	Total
Balance at March 31, 2018	-	**4,297.18**	-	**261.86**	**43.81**	**79.71**	**4,682.56**
Additions during the year	-	2,522.94	-	192.30	29.62	66.70	2,811.57
Transferred to Property, plant and equipment	-	-	-	(3.59)	-	(56.18)	(59.77)
Transferred to Profit and loss accounts	-	-	-	-	(51.68)	(46.53)	(98.21)
Balance at March 31, 2019	-	**6,820.13**	-	**450.57**	**21.75**	**43.70**	**7,336.15**
Additions during the year	-	4,052.74	-	(126.33)	(25.12)	44.17	3,945.46
Transferred to Property, plant and equipment	-	(10,872.87)	-	(315.26)	4.45	(83.43)	(11,267.11)
Balance at March 31, 2020	-	**0.00**	-	**8.98**	**1.08**	**4.44**	**14.51**

6.1 Rupee term loan and cash credit are secured against Capital work-in-progress (Refer note 20.3 and 20.4).

Notes to the Standalone financial statement for the year ended March 31, 2020
(All amounts are ₹ in Lakhs unless otherwise stated)

Note 7: Other intangible assets

Carrying amount	As at March 31, 2020	As at March 31, 2019
Right to use land	767.97	808.92
Software	15.04	149.19
Total	**783.01**	**958.11**

Cost	Right to use land	Software	Total
Balance at March 31, 2018	**1,023.77**	**645.62**	**1,669.39**
Additions during the year	-	0.22	0.22
Disposal/ Adjustments during the year	-	-	-
Balance at March 31, 2019	**1,023.77**	**645.84**	**1,669.61**
Additions during the year	-	13.57	13.57
Disposal/ Adjustments during the year	-	-	-
Balance at March 31, 2020	**1,023.77**	**659.41**	**1,683.18**

Accumulated amortisation	Right to use land	Software	Total
Balance at March 31, 2018	**173.90**	**337.44**	**511.34**
Additions during the year	40.95	159.21	200.16
Disposal/ Adjustments during the year	-	-	-
Balance at March 31, 2019	**214.85**	**496.64**	**711.50**
Additions during the year	40.95	147.72	188.67
Disposal/ Adjustments during the year	-	-	-
Balance at March 31, 2020	**255.80**	**644.37**	**900.17**

7.1. **Rupee term loan and cash credit are secured against Intangible assets (Refer note 20.3 and 20.4).**

Notes to the Standalone financial statement for the year ended March 31, 2020
(All amounts are ₹ in Lakhs unless otherwise stated)

Note -8 : Investments-non current

Particulars	As at March 31, 2020		As at March 31, 2019	
Non-Trade Investment	**Qty (in Lakhs)**	**Amount**	**Qty (in Lakhs)**	**Amount**
Investment in Equity Instruments : Unquoted at Cost				
a) Investment in Joint Venture				
i) North East Transmission Company Limited (unquoted 10,69,64,000 Equity shares of INR 10/- each fully paid up)	1,069.64	10,696.40	1,069.64	10,696.40
Aggregate carrying value of unquoted investments		**10,696.40**		**10,696.40**
Aggregate amount of impairment in value of unquoted investments		-		-

8.1 Details of joint venture

Name of joint venture	Principal activity	Place of Incorporation and principal place of business	As at March 31, 2020	As at March 31, 2019
North East Transmission Company Limited	Transmission of Electricity	India	26%	26%

8.2 Refer Note 3.3 for method followed for accounting of investments in joint venture.

Note - 9 : Loans

9.1 Loans-Non current

Particulars	As at March 31, 2020	As at March 31, 2019
Secured, Considered good	-	-
Unsecured, Considered good		
Security deposits	33.88	126.30
Significant increase in Credit risk	-	-
Credit impaired	-	-
Total	**33.88**	**126.30**

9.2 Loans-Current

Particulars	As at March 31, 2020	As at March 31, 2019
Secured, Considered good	-	-
Unsecured, Considered good		
Security deposits	129.00	-
Significant increase in Credit risk	-	-
Credit impaired	-	-
Total	**129.00**	**-**

Note - 10 : Other financial assets

10.1 Current

Particulars	As at March 31, 2020	As at March 31, 2019
Advance to Employees	6.07	11.89
Other receivables	7,561.93	13,579.12
Interest accrued on deposits	0.13	119.32
Others	0.34	2.98
Total	**7,568.47**	**13,713.31**

Notes to the Standalone financial statement for the year ended March 31, 2020
(All amounts are ₹ in Lakhs unless otherwise stated)

Note - 11 : Tax asset (Net)

11.1 Non-current

Particulars	As at March 31, 2020	As at March 31, 2019
Advance payment of income tax and tax deducted at source	20.89	20.89
Total	**20.89**	**20.89**

11.2 Current

Particulars	As at March 31, 2020	As at March 31, 2019
Advance payment of income tax and tax deducted at source	951.21	-
Total	**951.21**	**-**

Note - 12 : Other assets

12.1 Non current

Particulars	As at March 31, 2020	As at March 31, 2019
Capital advances	113.74	923.87
Total	**113.74**	**923.87**

12.2 Current

Particulars	As at March 31, 2020	As at March 31, 2019
Prepaid expenses	249.00	140.06
Deposits with Customs Authorities (refer note no.42.1)	1,914.66	1,914.41
Others	743.42	1,024.78
Total	**2,907.08**	**3,079.25**

Note - 13 : Inventories

Particulars	As at March 31, 2020	As at March 31, 2019
Stores and spares	2,817.08	3,160.82
Total	**2,817.08**	**3,160.82**

13.1 The mode of valuation of inventories has been stated in note 3.13.
13.2 Rupee term loan and cash credit are secured against inventories (Refer note 20.3 and 20.4).

Note - 14 : Investments - Current

Particulars	As at March 31, 2020	As at March 31, 2019
Deposits with financial institutions(refer note 14.1)	-	8,000.00
Measurement at fair value through profit or loss account		
Unquoted Investments (refer note 14.2)		
Investments in mutual funds	12,181.70	9,323.87
Aggregate amount of unquoted investment	**12,181.70**	**17,323.87**

14.1 Investment - Financial Institutions

Particulars	As at March 31, 2020	As at March 31, 2019
Deposits with financial institutions		
a) Bajaj Finance Limited	-	4,500.00
b) Kotak Mahindra Investments Ltd.	-	3,500.00
Total	**-**	**8,000.00**

Notes to the Standalone financial statement for the year ended March 31, 2020
(All amounts are ₹ in Lakhs unless otherwise stated)

14.2 Investment - unquoted

Particulars	As at March 31, 2020		As at March 31, 2019	
Investment in Mutual funds	Qty (in Lakhs)	Amount	Qty (in Lakhs)	Amount
a) SBI Liquid Fund Direct Growth	0.22	697.48	0.43	1,258.57
b) SBI Debt Fund Series - C15 (91 Days) Direct Growth	-	-	94.22	1,006.88
c) ICICI Liquid Fund Direct Growth	-	-	7.63	2,108.61
d) UTI Liquid Cash Plan Direct Growth	0.74	2,409.16	1.42	4,337.85
e) UTI Money Market Fund Direct Growth	0.09	200.00	-	-
f) AXIS Liquid Cash Plan Direct Growth	-	-	0.30	611.96
g) SBI Overnight Fund - Direct Plan (G)	0.38	1,250.54	-	-
h) Axis Liquid Fund -D-G	0.12	264.91	-	-
i) UTI Overnight Fund -D- G	1.14	3,106.85	-	-
j) KOTAK Overnight Fund -D- G	3.57	3,805.35	-	-
k) ICICI Overnight Fund -D- G	0.91	97.79	-	-
l) ABSP Overnight Fund -D- G	0.32	349.62	-	-
Aggregate amount of unquoted investment		**12,181.70**		**9,323.87**

Note 15 : Trade receivables

15.1 Current

Particulars	As at March 31, 2020	As at March 31, 2019
-Secured, considered good(refer note 15.2) Trade receivables	6,346.94	1,284.50
-Unsecured, considered good Trade receivables	10,544.92	11,389.56
-Significant increase in Credit risk Trade receivables	-	-
-Credit impaired Trade receivables	-	-
Total	**16,891.86**	**12,674.06**

15.2 Trade receivables are secured by letter of credits.

15.3 The average credit period on sales of energy is 45 Days (60 days for year ended March 31, 2019). No interest is charged on trade receivables for the first 45 days from the date of the invoice. Thereafter, interest is charged at 15% per annum (18 % per annum for year ended March 31, 2019) on the outstanding balance, as per CERC Regulation.

Of the trade receivables balance as at March 31, 2020 of ₹ 16,510.13 lakhs (as at March 31, 2019 ₹ 11,568.56 lakhs) are due from customers mentioned below. There are no other customers who represented more than 5% of the total balance of trade receivables other than mentioned below:

Particulars	As at March 31, 2020	As at March 31, 2019
Customer 1	4,756.87	1,377.30
Customer 2	1,588.74	10,191.26
Customer 3	10,164.52	-
Total	**16,510.13**	**11,568.56**

15.4 Age to Trade receivables

Particulars	As at March 31, 2020	As at March 31, 2019
Within the credit period	5,531.36	5,078.02
1-30 Days past due	1,910.65	1,332.45
31-60 Days past due	1,738.96	1,424.97
More than 60 days past due	7,710.89	4,838.60
Total	**16,891.86**	**12,674.04**

Note 16 : Cash and cash equivalents

Particulars	As at March 31, 2020	As at March 31, 2019
Balances with Banks -Current account	72.61	17.22
Bank deposits : upto 3 months maturity -Bank deposit with original maturity utpo 3 months (Refer note 16.1)	385.21	-
Total	**457.82**	**17.22**

16.1 The deposits maintained by the Company with banks comprise time deposit, which can be withdrawn by the Company at any point without prior notice or penalty on the principal.

Note 17 : Other bank balances

Particulars	As at March 31, 2020	As at March 31, 2019
Banks Balances in Escrow Account	0.51	0.52
Total	**0.51**	**0.52**

Note 18 : Equity Share Capital

Particulars	As at March 31, 2020	As at March 31, 2019
Equity Share Capital	**1,12,000.00**	**1,12,000.00**
Total	**1,12,000.00**	**1,12,000.00**
Authorised share capital :		
12,000 lakhs equity shares of ₹ 10 each (as at March 31, 2019 , 12,000 lakhs, equity shares of ₹ 10 each)	1,20,000.00	1,20,000.00
3,000 lakhs preference shares of ₹ 10 each (as at March 31, 2019, 3,000 lakhs preference shares of ₹ 10 each)	30,000.00	30,000.00
Issued , Subscribed & fully Paid up equity share capital:		
11,200 lakhs fully paid up equity shares of ₹ 10/- each (as at March 31, 2019 , 11,200 lakhs fully paid up equity shares of ₹ 10 each)	1,12,000.00	1,12,000.00
Total	**1,12,000.00**	**1,12,000.00**

18.1 Reconciliation of equity shares outstanding at the beginning and at the end of the reporting period:

Particulars	Number of Shares (in Lakhs)	Number of Shares (in Lakhs)
Balance at March 31, 2018	11,200.00	11,200.00
Shares issued during the year	-	-
Balance at March 31, 2019	11,200.00	11,200.00
Shares issued during the period	-	-
Balance at March 31, 2020	**11,200.00**	**11,200.00**

18.2 Terms/rights attached to equity shares

The Company has only one class of equity shares having a par value of ₹ 10 per share. Each holder of equity shares is entitled to one vote per share.

In the event of liquidation of the Company, the holders of equity shares will be entitled to receive remaining assets of the Company, after distribution of all preferential amounts. The distribution will be in proportion to the number of equity shares held by the shareholders.

18.3 Details of shareholders holding more than 5% shares in the Company are as under:-

Name of the equity share holder	As at March 31, 2020		As at March 31, 2019	
	Number (in lakhs)	% Holding	Number (in lakhs)	% Holding
Fully paid up share capital				
Oil and Natural Gas Corporation Limited	5,600.00	50.00%	5,600.00	50.00%
IL&FS Energy Development Company Limited	1,347.34	12.03%	1,347.34	12.03%
IL&FS Financial Services Limited (IFIN)	1,564.66	13.97%	1,564.66	13.97%
India Infrastructure Fund II	2,632.00	23.50%	2,632.00	23.50%

Note 19 : Other Equity

Particulars	As at March 31, 2020	As at March 31, 2019
Retained earning (refer Note 19.1)	14,383.61	19,475.98
Accumulated OCI	(16.97)	(8.82)
General reserves	-	-
Total	**14,366.64**	**19,467.16**

Notes to the Standalone financial statement for the year ended March 31, 2020
(All amounts are ₹ in Lakhs unless otherwise stated)

19.1 Retained Earnings & Accumulated Other Comprehensive Income

Particulars	As at March 31, 2020	As at March 31, 2019
Balance at beginning of the year	**19,467.15**	**15,245.27**
Profit for the year	7,059.61	20,421.23
OCI income arising from remeasurement of defined benefit obligation (net of income tax)	(8.15)	3.29
Payment of Dividends (including Corporate Distribution Tax)		
-Final dividend FY 2017-2018	-	5,400.88
-Interim dividend FY 2018-2019	-	10,801.75
-Final dividend FY 2018-2019	8,101.32	-
-Interim dividend FY 2019-2020	4,050.65	-
Balance as at end of the year	14,366.64	19,467.15

19.2. In respect of the year ended March 31, 2019, the Board of Directors in the meeting held on February 21, 2019 had approved Interim dividend of ₹ 0.80 per share be paid on fully paid equity shares. The total equity dividend be paid was ₹ 8,960.00 Lakhs and the dividend distribution tax thereon amounts to ₹ 1,841.75 Lakhs was paid in FY 2018-19.

19.3. In respect of the year ended March 31, 2019, the Board of Directors in the meeting held on May 09, 2019 has proposed final dividend of ₹ 0.60 per share to be paid on fully paid equity shares. This equity dividend has approved by shareholders at Annual General Meeting and hence paid to shareholders during year ended March 31, 2020. The total equity dividend be paid was ₹ 6,720.00 Lakhs and the dividend distribution tax thereon amounts to ₹ 1,381.32 Lakhs.

19.4. In respect of the year ended March 31, 2020, the Board of Directors in the meeting held on January 29, 2020 had approved Interim dividend of ₹ 0.30 per share be paid on fully paid equity shares. The total equity dividend be paid was ₹ 3,360.00 Lakhs and the dividend distribution tax thereon amounts to ₹ 690.65 Lakhs was paid in FY 2019-2020.

19.5. In respect of the year ended March 31, 2020, the Board of Directors in the meeting held on June 10, 2020 has proposed final dividend of ₹ 0.20 per share to be paid on fully paid equity shares.The equity dividend is subject to approval by shareholders at Annual General Meeting and has not been included as liability in these standalone financial statements.The proposed dividend is payable to all holders of fully paid equity shares. The total estimated equity dividend to be paid is ₹2,240.00 Lakhs.

Note -20 : Borrowings

20.1 Non-current borrowings

Particulars	As at March 31, 2020	As at March 31, 2019
Secured - at amortised cost		
Rupee Term Loan (RTL) from Banks		
Rupee Term Loan (RTL) from Banks (refer Note 20.3)	1,63,725.39	1,80,229.39
Cash credit (refer note 20.4)	-	-
Total	1,63,725.39	1,80,229.39

20.2 Current borrowings

Particulars	As at March 31, 2020	As at March 31, 2019
Secured - at amortised cost		
Cash credit (refer note 20.4)	-	235.49
Short term loan (STL) from Others (refer Note 20.4)	-	-
Total	-	235.49

20.3 Rupee Term Loan (RTL) from bank

RTL carries effective interest rate of 8.55 % per annum as at March 31, 2020 (as at March 31, 2019 8.37 % per annum).

RTL is secured by:
i) first rank pari-passu charge on all immovable properties, present and future, relating to the Company
ii) first charge by way of hypothecation on all movable properties and intangible assets, present and future, relating to the Company
iii) first charge on all receivables, letter of credit and Escrow Account. (Also refer note 20.4)

₹ 22,304 Lakhs (As at March 31, 2019 ₹ 15,032 Lakhs) is repayable within one year and the same has been shown as "Current maturities of long term borrowings". (Refer Note 21.2)

Repayment schedule of RTL :-

Year of repayment	As at March 31, 2020	As at March 31, 2019
2019-20	-	15,032.00
2020-21	22,304.00	22,304.00
2021-22	22,304.00	22,304.00
2022-23	22,304.00	22,304.00
2023-24	22,304.00	22,304.00
2024-25	22,304.00	22,304.00
2025-26	22,304.00	22,304.00
2026-27	22,304.00	22,304.00
2027-28	22,303.00	22,303.00
2028-29	7,598.39	1,798.39
Total	1,86,029.39	1,95,261.39

20.4 Cash Credit
Cash credit carries variable rate of interest and is repayable on demand.

Cash credit is secured by:
i) First priority hypothecation charge on all current assets of the Company, both present and future.

ii) First hypothecation charge on all the movable property, plant and equipment of the Company and intangible assets, both present and future.

iii)First charge on all the bank accounts of the Company, including but not limited to the accounts/ escrow accounts opened with banks.

iv) First equitable mortgage charge on the private land together with all super-structures, construction thereof, easements, right to way and appurtenances thereon, both present and future. (Also refer note 20.5)

20.5 Cash Credit
All the securities mentioned herein above shall be shared amongst the RTL Lender and consortium member for cash credit facilities, on pari-passu basis.

Note - 21 : Other financial liabilities

21.1 Non- current

Particulars	As at March 31, 2020	As at March 31, 2019
Unsecured		
Retention money payable	67.37	827.30
Tariff Adjustment Account(Liability)	3,143.37	2,647.76
Total	3,210.74	3,475.06

Particulars	As at March 31, 2020	As at March 31, 2019
Leasehold liability (Refer Note 38)	3.30	-
Total	3.30	-

21.2 Current

Particulars	As at March 31, 2020	As at March 31, 2019
Current maturities of long term borrowings	22,304.00	15,032.00
Liability for capital goods and services	1,823.71	6,728.64
Retention money payable	1,376.68	13,317.59
Other liabilities	4,163.91	2,200.07
Total	29,668.30	37,278.30

Particulars	As at March 31, 2020	As at March 31, 2019
Leasehold liability (Refer Note 38)	9.37	-
Total	9.37	-

Note - 22 : Provisions

22.1 Non-current

Particulars	As at March 31, 2020	As at March 31, 2019
Provision for Employee benefits		
Leave Encashment	152.11	108.22
Sick Leave	17.89	10.93
Total	170.00	119.15

22.2 Current

Particulars	As at March 31, 2020	As at March 31, 2019
Provision for Employee benefits		
Leave Encashment	4.44	3.41
Sick Leave	1.97	1.77
Gratuity (refer Note 41)	45.38	17.37
Total	**51.79**	**22.55**

Note - 23 : Deferred Tax liabilities (Net)

Particulars	As at March 31, 2020	As at March 31, 2019
Deferred Tax assets	(9,252.33)	(7,617.65)
Deferred Tax liabilities	19,558.51	16,093.68
Total	**10,306.18**	**8,476.03**

23.1 For the year ended March 31, 2020

Particulars	Opening Balance	Recognised in profit and loss	Recognised in OCI	Closing Balance
Tax effect of items constituting deferred tax liabilities				
Property , plant and equipment and intangibles assets	16,023.81	3,474.87	-	19,498.68
Others	69.87	(10.04)	-	59.83
	16,093.68	**3,464.83**	-	**19,558.51**
Tax effect of items constituting deferred tax assets				
Unabsorbed depreciation, Carry Forward, Bought Forward business losses and MAT credit	7,617.59	1,634.56	-	9,252.15
Others	0.05	0.12	-	0.18
	7,617.65	**1,634.68**	-	**9,252.33**
Deferred tax liabilities/(assets), net	**8,476.03**	**1,830.15**	-	**10,306.18**

23.2 For the year ended March 31, 2019

Particulars	Opening Balance	Recognised in profit and loss	Recognised in OCI	Closing Balance
Tax effect of items constituting deferred tax liabilities				
Property , plant and equipment and intangibles assets	15,177.26	846.55	-	16,023.81
Others	81.64	(11.77)	-	69.87
	15,258.90	**834.78**	-	**16,093.68**
Tax effect of items constituting deferred tax assets				
Unabsorbed depreciation, Carry Forward, Bought Forward business losses and MAT credit	4,732.82	2,884.77	-	7,617.59
Others	0.51	(0.46)	-	0.05
	4,733.33	**2,884.31**	-	**7,617.65**
Deferred tax liabilities/(assets), net	**10,525.57**	**(2,049.53)**	-	**8,476.04**

Note - 24 : Other liabilities

24.1 Other non current liabilities

Particulars	As at March 31, 2020	As at March 31, 2019
Other Non current liabilities	309.92	2,180.05
Total	**309.92**	**2,180.05**

The Company had received an advance of ₹ 2,400 Lakhs during FY 2017-2018 against EPC contract awarded to the Company for setting up of 400KV Line Bay at Palatana. During year ended March 31, 2020 ₹ 1,870.13 Lakhs (₹ 219.95 Lakhs during March 31, 2019) has been booked as revenue from EPC contract for 400 KVA Bay installation. Advance outstanding as at March 31, 2020 is ₹ 309.92 Lakhs (as at March 31, 2019 ₹ 2,180.05 Lakhs).

24.2 Other current liabilities

Particulars	As at March 31, 2020	As at March 31, 2019
Statutory liabilities	2,657.86	268.92
Advance from customers	698.00	915.89
Total	**3,355.86**	**1,184.81**

Notes to the Standalone financial statement for the year ended March 31, 2020
(All amounts are ₹ in Lakhs unless otherwise stated)

Note - 25 : Trade Payable-Current

Particulars	As at March 31, 2020	As at March 31, 2019
Trade payables		
Outstanding dues to micro and small enterprises	0.06	0.13
Outstanding dues to other than micro and small enterprises	2,096.02	3,537.14
Total	**2,096.08**	**3,537.27**

25.1 Trade payable -Total outstanding dues of Micro and small enterprises as defined under Micro, Small and Medium Enterprises Development Act,2006.

-The balance due is ₹ 0.06 Lakhs (as at March 31, 2019 ₹ 0.13 Lakhs) and interest is ₹ Nil during the year is payable under the terms of the MSMED Act, 2006 or otherwise.

-Total amount paid is ₹ Nil along with interest thereon of ₹ Nil During FY 2019-20 (₹ Nil during FY 2018-19) beyond the appointed day during the financial year as per Section 16 of the Micro, Small and Medium Enterprises Development Act 2006.

-Total amount of interest is ₹ Nil due and payable as at March 31, 2020 (₹ Nil as at 31 March, 2019) for the delay in payments other than interest payable as per MSME Development Act 2006.

-The amount of interest accrued and unpaid is ₹ Nil as at March 31, 2020 (₹ Nil as at March 31, 2019)

25.2 The average credit period for gas supply is 7 days thereafter, interest is charged at 10.20% (15.45% during FY 2018-19) per annum on the outstanding balance. The Company has financial risk Management policies in place to ensure that all payables are paid within the pre-agreed credit terms.

Note - 26 : Current tax liabilities (net)

Particulars	As at March 31, 2020	As at March 31, 2019
Provision for Income Tax (net)	0.00	740.56
Total	**0.00**	**740.56**

Note - 27 : Regulatory Deferral Account Balance

27.1 : Reconciliation of Regulatory Asset / (Liability) as per rate regulated activities

Particulars	As at March 31, 2020	As at March 31, 2019
Opening Balance	7,331.78	10,525.57
Addition/(Adjustment) during the year		
a) Deferred assets against Deferred Tax liability	1,583.08	(3,193.79)
b) On others	-	-
Closing Balance	**8,914.86**	**7,331.78**

27.2: As per Ind AS 114 'Regulatory Deferral Account', the business of electricity generation is a Rate Regulated activity wherein Central Electricity Regulation Commission (CERC), the regulator determines Tariff to be charged from the consumers based on prevailing regulation in place. CERC Multi Year Tariff Regulation 2019-2024 (MYT Regulations), is applicable for the period beginning from 1st April 2019 to 31st March 2020.These regulation requires CERC to determine tariff in a manner wherein the Company can recover its fixed and variable cost including assured rate of return on approved equity base, from the consumers. The Company determines the Revenue, Regulatory Assets and Liabilities as per the terms and conditions specified in MYT Regulations.

27.2 : Regulatory income / (expense) during the year

Particulars	As at March 31, 2020	Year ended March 31, 2019
Regulatory income / (Expenses) during the year		
a) Deferred assets against Deferred Tax liability	1,583.08	(3,193.79)
b) On others	-	-
Total	**1,583.08**	**(3,193.79)**

27.3 : Net Movement in regulatory deferral account balance recognised in statement of profit and loss account

Particulars	As at March 31, 2020	Year ended March 31, 2019
Net movement in regulatory deferral account balances	1,583.08	(3,193.79)
Tax on net movements in regulatory deferral account balances	(276.60)	(743.81)
Total amount recognised in statement of profit and loss account	**1,306.48**	**(3,937.60)**

27.4. Refer Note 3.22 for Regulatory Deferral Account.

27.5. Risk/Uncertainty associated with future recovery of Regulatory Deferral Account Balances

*** Demand risk** : Recovery of regulatory deferral balances are subjected to billing to its beneficiaries and accordingly associated with related normal risks, such as, attitude of the customers towards settlement of their dues, availability of alternate source of supply, etc.

*** Regulatory risk** : Changes, if any, in tariff Regulations on allow ability of such cost through tariff.

Notes to the Standalone financial statement for the year ended March 31, 2020

(All amounts are ₹ in Lakhs unless otherwise stated)

Note - 28 : Revenue From Operations

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Revenue from sale of power (refer note no.28.1)	1,24,069.91	1,42,273.41
Less: Rebate to Customers	(1,106.73)	(1,495.94)
Revenue from EPC contract (refer note no.28.2)	1,870.13	219.95
Total	**1,24,833.31**	**1,40,997.42**

28.1 CERC vide its order dated March 30, 2017 has approved Multi Year Tariff for FY 2014-2019 which was subject to truing up . The petition for truing up has been filed with CERC. The final outcome /order for truing up of MYT 2014-2019 is yet to be received.

The Company has recognized revenue for the financial year ended March 31, 2020 on the basis of expected trued figures for FY 2019-2020 considering approved capital cost by CERC. As such revenue from sale of power shown above is net off tariff adjustments of ₹ 495.66 Lakhs (i.e. difference between the billing done till March 31, 2020 and expected truing up figures for FY 2019-2020).

28.2 Revenue from EPC contract for installation of 400 KVA bay on turnkey basis has been recognised by ₹ 1,870.13 Lakhs for year ended March 31, 2020 (₹ 219.95 Lakhs during year ended March 31,2019).

Note - 29 : Other Income

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Interest Income on financial assets measured at amortised cost		
On Bank Deposit	203.89	587.55
On Others	1,574.54	1,483.26
	1,778.43	**2,070.81**
Dividend received on Mutual Fund Investments	-	-
Dividend from equity investment in joint venture	1,283.57	534.82
	1,283.57	**534.82**
Miscellaneous income		
Miscellaneous income (including deviation charges received)	322.39	1,311.92
Exchange rate fluctuation (gain)/loss	-	6.01
Gain/(loss) on disposal of investments in mutual funds	705.79	1,108.94
Net gain/(loss) arising on financial assets mandatorily measured at FVTPL	14.67	88.32
	1,042.85	**2,515.20**
Total	**4,104.85**	**5,120.83**

Note-30 : Employee benefit expenses

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Salaries, Bonus and other allowances	1,823.47	1,904.59
Contribution to Provident and Other Funds	220.81	187.58
Staff Welfare Expenses	46.92	71.26
Total	**2,091.20**	**2,163.43**

Note - 31 : Finance costs

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Interest expenses	15,840.17	17,253.47
Interest on Right of use assets (refer note 38)	1.46	-
Other financial charges	110.79	78.01
Total	**15,952.42**	**17,331.48**

Notes to the Standalone financial statement for the year ended March 31, 2020

(All amounts are ₹ in Lakhs unless otherwise stated)

Note -32 : Generation, Operation & Maintenance Expenses

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Operation & Maintenance Expenses	8,408.03	8,273.22
Purchase of Power	5,696.22	818.28
Repair & Maintenance -Plant	1,730.86	257.54
Rates & Taxes	283.42	9.58
Deviation Charges to NERLDC	67.26	-
Insurance Charges	992.32	500.51
Consumption of Spare and Store	794.95	757.46
Other Generation and Operation Expenses	576.58	384.90
Total	**18,549.64**	**11,001.49**

During FY 2019-2020 Govt. of Tripura (GOT) levied Electricity Duty (ED) on interstate sale transaction & auxiliary power consumed by the Company. As per legal advice received by the company, the levying of ED on interstate transactions is out of the purview of State Governments, as such the company has deposited ED amounting to ₹ 1,921.06 Lakhs on Interstate sales during FY 2019-2020 under protest with GOT. Out of said deposited amount company has billed beneficiaries ₹ 1,768.65 Lakhs as per terms of PPA and ₹ 275.35 Lakhs has been expensed in accounts.

Note-33 : Depreciation and amortization

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Depreciation property , plant and equipment	19,484.78	19,292.06
Amortisation of intangibles assets	188.67	200.16
Total	**19,673.45**	**19,492.22**

Note - 34 : Other expenses

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Power, Fuel and water charges	2.13	1.25
Fees & Subscription	34.95	35.64
Office Repair & Maintenance	98.31	98.09
Rent	216.12	217.87
Communication Expenses	17.82	20.36
Travel & Conveyance	84.86	93.51
Vehicle Hire Charges	87.22	86.88
Legal & Professional Expenses	104.75	66.91
Consultancy Fees	43.18	76.36
HR consultancy expense	1.52	0.25
Security Expenses	760.40	665.21
Training & Recruitment Expenses	72.33	48.24
Director Sitting Fees	18.29	18.88
Audit Fees	7.67	7.67
Capital work in progress written off	-	59.77
CSR Activities	112.17	145.35
Exchange rate fluctuation (gain)/loss	61.02	-
EPC Contract expenses	1,294.59	155.81
Miscellaneous Expenses	276.55	254.84
Total	**3,293.88**	**2,052.89**

Notes to the Standalone financial statement for the year ended March 31, 2020
(All amounts are ₹ in Lakhs unless otherwise stated)

34.1 As per requirements of the Companies Act during FY 2019-2020 the company was required to spend ₹ 478.08 Lakhs on CSR. Out of said amount during FY 2019-2020 the company has incurred an expenditure of ₹ 112.17 Lakhs (year ended March 31, 2019 ₹ 145.35 lakhs) towards Corporate Social responsibility. Balance of ₹ 365.91 Lakhs has been carried forward to next financial year.

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
i) Construction/acquisition of any assets	-	82.77
ii) On purpose other than (i) above	112.17	62.58
Total	**112.17**	**145.35**

Of above Nil (previous year ₹ 58.71 lakhs) yet to be paid.

34.2 Statutory auditors remuneration and other fees paid/payable to auditors (including taxes) is as under:

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Audit Fees		
Limited Review fees	4.25	4.25
Statutory audit fees	2.83	2.83
Tax audit fees	0.59	0.59
	7.67	**7.67**
Other Certification and Professional Fees	1.48	2.66
Total	**9.15**	**10.33**

Note- 35 : Income Taxes

35.1 Income tax recognised in profit and loss

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Current Tax	1,344.00	5,988.18
Deferred Tax	1,830.15	(2,049.53)
Total Tax Expense	**3,174.15**	**3,938.65**
Income tax expense on regulatory deferral account balance	**276.60**	**743.81**
Income tax expense recognised in other comprehensive income	**(1.73)**	**0.89**

35.2 The income tax expense for the year can be reconciled to the accounting profit as follows:

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Current Tax Expense		
Provision for tax (A)	1,618.87	6,732.88
Income tax expense recognised in other comprehensive income (B)	(1.73)	0.89
Pertaining to regulatory deferral account balances(C)	276.60	743.81
Total Current Tax Expense (D=A-B-C)	**1,344.00**	**5,988.18**
Deferred tax expense		
Origination and reversal of temporary differences	1,830.15	(2,049.53)
Total Deferred Tax Expense (C)	**1,830.15**	**(2,049.53)**
Income Tax expense(F=D+E)	**3,174.15**	**3,938.65**
Income tax expenses recognised in profit or Loss (relating to continuing operations)	**3,174.15**	**3,938.65**

Note- 36 : Earning per share

36.1 Earnings per equity share (including regulatory income / expense)

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Profit for the year attributable to equity shareholders (₹ in Lakhs)	7,059.61	20,421.23
Weighted average number of equity shares (Number in Lakhs)	11,200.00	11,200.00
Basic and diluted earnings per equity shares (in ₹)	0.63	1.82
Face Value per equity share (₹)	10.00	10.00

36.2 Earnings per equity share (excluding regulatory income / expense)

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Profit for the year attributable to equity shareholders (₹ in Lakhs)	5,753.13	24,358.83
Weighted average number of equity shares (Number in Lakhs)	11,200.00	11,200.00
Basic and diluted earnings per equity shares (in ₹)	0.51	2.17
Face Value per equity share (in ₹)	10.00	10.00

36.3 The Company does not have any potential dilutive equity shares.

Note- 37 : Segment Reporting

The Company has "electricity generation" as single reportable segment.

Information about major customers

The Company has entered into long term power purchase agreement for the sale of electricity to 7 north eastern states of India which amounts to 86.5% of the Company's total revenue. The total sales to such customers amounted to ₹ 99,516.00 lakhs for the year ended March 31, 2020 and ₹ 1,19,572.70 lakhs for the year ended March 31, 2019.

The Company has entered into short term power sale agreement for the sale of electricity which amounts to 13.5% of the Company's total revenue. The total sales to such customers amounted to ₹ 22,213.64 lakhs for the year ended March 31, 2020 and ₹ 20,390.40 lakhs for the year ended March 31, 2019.

Information about geographical areas

a) The Company is domiciled in India. The amount of its revenue from external customers broken down by location of customers is tabulated below:

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
India	1,24,833.32	1,40,997.42
Outside India	-	-
Total	**1,24,833.32**	**1,40,997.42**

b) The Company's non-current assets (excluding financial assets) broken down by location of customers is tabulated below:

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
India	2,75,702.82	3,00,801.40
Outside India	-	-
Total	**2,75,702.82**	**3,00,801.40**

38. Leasing arrangements

38.1 Transition to Ind AS 116

Ind AS 116 "Leases" (Ind AS 116) was notified in March 2019 and it replaces Ind AS 17 Leases. Ind AS 116 is effective for annual periods beginning on or after 1 April, 2019. The Company has applied Ind AS 116 Lease with a date of initial application of 1 April, 2019 using modified retrospective approach, under which the cumulative effect of initial application is recognised as at 1 April, 2019.

Lessor accounting under Ind AS 116 is substantially unchanged from Ind AS 17. As a lessee, the Company previously classified leases as operating or finance lease based on its assessment of whether the lease transferred significantly all of the risk and rewards incidental to the ownership of the underlying asset of the Company. Under Ind AS 116, the Company recognises the right-of-use assets (refer note no. 5) and lease liabilities (refer note no. 21).

When measuring lease liabilities, the Company discounted lease payments using the incremental rate of borrowing as at 1 April, 2019. Further, the comparative information has not been restated and continues to be reported under Ind AS 17 "Leases".

There is no impact on retained earnings as at 1 April, 2019.

The Company has applied Ind AS 116 only to the contracts that were previously identified as leases. As a practical expedient, contracts previously identified as lease under Ind AS 17 has not reassessed as to whether a contract is, or contains, a lease under Ind AS 116.

The Company has used the following practical expedients when applying Ind AS 116 to leases:

- Applied a single discount rate to a portfolio of leases with similar characteristics.
- Relied on its assessment of whether leases are onerous immediately before the date of initial application.
- Applied the exemption not to recognise right-of-use asset and liabilities for leases with remaining lease term of 12 months or less.
- Applied the exemption not to recognise right-of-use asset for the lease of low value asset.
- Excluded initial direct costs from measuring the right-of-use asset at the date of application.
- Used hindsight when determining the lease term if the contract contains options to extend or terminate the lease.

The lease liabilities as at 1st April, 2019 can be reconciled to the operating lease commitments as of 31st March, 2019 as follows:

Particulars	Amount
a) Operating lease commitments as at 31st March, 2019	52.75
Less: Commitments relating to short-term leases/Low value Leases	29.23
Net operating lease commitments	23.52
Weighted average incremental borrowing rate as at 1 April, 2019	8.37%
Discounted operating lease commitments as at 1 April, 2019	**21.30**
b) Discounting impact of minimum expected payments referred in (a) above	2.22
Lease liabilities as at 1st April , 2019 (a-b)	**21.30**

The Company is not required to make any adjustments on transition to Ind AS 116 for leases where it acts as a lessor.

38.2 Disclosure as per Ind AS 116

Particulars	Year ended March 31, 2020
Nature of asset :	
The Company has lease contracts for car used in its operations. Leases of car has been considered for a lease term of 2 years and four months as at 1 April, 2019	
(a) Right-of-use assets	
Cost	
Balance as on 1 April, 2019 due to adoption of Ind AS 116	21.30
Add: Additions during the year	-
Less : Amortisation/Impaired during the period	-
Balance as at 31st March, 2020 (refer note 5)	**21.30**
Accumulated depreciation and impairment	
Balance as on 1 April, 2019 due to adoption of Ind AS 116	-
Depreciation for the year (refer note (i) below)	9.13
Balance as at 31 March, 2020 (refer note 5)	**9.13**
Net carrying amount	
As at 31 March, 2020 (refer note 5)	**12.17**
(b) Lease liabilities {refer note (iii) below}	
Balance as on 1 April, 2019 due to adoption of Ind AS 116	21.30
Add: Interest expense accrued on lease liabilities (refer note (c) (ii) below and note 31)	1.46
Less: Lease liabilities paid	10.08
Closing balance as at 31 March, 2020 (including current maturities of ₹ 9.37 lakhs)	**12.68**
(c) Amount recognised in Statement of Profit or Loss	
(i) Depreciation of Right-of-use assets (classified under Depreciation and amortisation expense)	9.13
(ii) Interest on lease liabilities (classified under Finance costs)	1.46
(iii) Expenses related to short term leases (classified under Other expenses)	318.11
(iv) Expenses related to leases of low value assets, excluding short term leases of low value assets (classified under Other expenses)	8.63
(d) Amount recognised in Statement of Cash Flows	
Total cash inflow/(outflow) of leases (Net)	11.22

(i) The total amortisation expense on right-of-use asset for the year ended 31 March, 2020 is ₹ 9.13 lakhs.

(ii) The incremental rate of borrowing as at 1 April, 2019 has been considered at 8.37%.

(iii) Refer note 40.10 for maturity analysis of lease liabilities.

38.3 Payments recognized as an expense as per Ind AS 17

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Lease payments	-	210.98
Total	**-**	**210.98**

38.4 Operating Lease commitments as per Ind As 17

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
90 Day's notice period lease amount	-	52.75
Total	**-**	**52.75**

Notes to the Standalone financial statement for the year ended March 31, 2020
(All amounts are ₹ in Lakhs unless otherwise stated)

Note -39 : Related Party Disclosures

39.1. Name of related parties and description of relationship:

A. Enterprises having significant influence over the Company
Oil and Natural Gas Corporation Limited
IL&FS Energy Development Company Limited
IL&FS Financial Services Ltd (IFIN)
India Infrastructure Fund II (IIF)

B. Joint Venture
North East Transmission Company Limited

C. Key Management Personnel

Executive director
Mr. Satyajit Ganguly (Managing Director) ceased to be Managing Director w.e.f. 27.05.2020
Mr. Sanil C. Namboodiripad (Managing Director) joined as Managing Director w.e.f. 27.05.2020
Non-Executive Directors
Mr. Shashi Shanker
Mr. Subhash Kumar
Mr. N. C. Pandey ceased as Director w.e.f. 27.04.2020
Mr. Om Prakash Singh appointed as Director w.e.f. 12.05.2020
Ms. A. Vizayasree appointed as Director w.e.f. 09.05.2019
Mr. Keshav Prasad appointed as Director w.e.f. 30.10.2019
Mr. M.M. Joshi
Dr. M.S. Kele
Other Non-Executive Directors(Independent directors)
Dr. V.K. Garg
Mr. A.K.Purwar

Chief Financial Officer
Mr. Avininder Gupta

Company Secretary
Mr. Neeraj Kumar Aggarwal

39.2. Details of Transactions:

39.2.1. Transactions with Enterprises having significant influence over the Company

Name of related party	Nature of Transaction	As at 31 March, 2020	As at 31 March, 2019
Purchase of product:			
Oil and Natural Gas Corporation Limited	Fuel purchase	60,450.30	65,779.30
Dividend Paid :			
Oil and Natural Gas Corporation Limited	Final Dividend paid for the FY 2018-2019 (FY 2017-2018) and Interim Dividend for the FY 2019-2020 (2018-2019)	5,040.00	6,720.00
IL&FS Energy Development Company Limited	Final Dividend paid for the FY 2018-2019 (FY 2017-2018) and Interim Dividend for the FY 2019-2020 (2018-2019)	1,212.61	1,616.81
IL&FS Financial Services Ltd	Final Dividend paid for the FY 2018-2019 (FY 2017-2018) and Interim Dividend for the FY 2019-2020 (2018-2019)	1,408.19	1,877.59
India Infrastructure Fund II	Final Dividend paid for the FY 2018-2019 (FY 2017-2018) and Interim Dividend for the FY 2019-2020 (2018-2019)	2,368.80	3,158.40
Security Deposit Received :			
Oil and Natural Gas Corporation Limited	Security deposit received towards nomination of Directors	-	1.00
IL&FS Energy Development Company Limited	Security deposit received towards nomination of Directors	-	1.00
Refund of security deposit received towards nomination of Directors:			
Oil and Natural Gas Corporation Limited	Refund of security deposit Received towards nomination of Directors	-	1.00
IL&FS Energy Development Company Limited	Refund of security deposit Received towards nomination of Directors	-	1.00
Charges for Training :			
Oil and Natural Gas Corporation Limited	Training Expenses	-	1.75
Reimbursement of professional charges:			
IL&FS Energy Development Company Limited	Reimbursement of Professional charges	4.50	4.50

39.2.2. Outstanding balances with Enterprises having significant influence over the Company

Name of related party	Nature of transaction	As at 31 March, 2020	As at 31 March, 2019
Amount payable:			
Oil and Natural Gas Corporation Limited	Fuel purchase	2,087.15	3,480.86
Amount Receivable:			
Oil and Natural Gas Corporation Limited	Training Charges	-	1.75

39.2.3. Transactions with joint ventures

Name of related party	Nature of transaction	As at 31 March, 2020	As at 31 March, 2019
Dividend income:			
North East Transmission Company Limited	Dividend income	1,283.57	534.82
Charges for Training :			
North East Transmission Company Limited	Training Charges received	0.83	2.12

39.2.4. Outstanding balances with joint venture is ₹ Nil (as at March 31, 2019 ₹ Nil)

39.2.5. Transactions with Key Management Personnel

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Short term employee benefits	272.45	269.44
Post-employment benefits (gratuity)	26.11	19.42
Long-term benefit (Compensated absences)	35.06	26.48
Contribution to provident fund	10.99	10.42
Total	**344.61**	**325.76**

Note - 40: Financial instruments

40.1. Capital Management :

The Company's objective when managing capital is to:
-Safeguard its ability to continue as going concern so that the Company is able to provide return to stakeholders and benefits for other stakeholders; and maintain an optimal capital structure of debt and equity balance.

The Company maintains its financial framework to support the pursuit of value growth for shareholders, while ensuring a secure financial base. In order to maintain or adjust the capital structure, the Company may adjust the amount of dividends paid to shareholders, return capital to shareholders, issue new shares or sell assets to reduce debt.

The capital structure of the Company consists of net debt (borrowings as detailed in note no. 20 offset by cash and bank balances) and total equity of the Company.

The Company's management reviews the capital structure of the Company on regular basis. As part of this review, the management considers the cost of capital and the risks associated with each class of capital.

40.2. Gearing Ratio :

The gearing ratio at end of the reporting period was as follows.

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
(i) Debt	1,86,029.39	1,95,261.39
(ii) Cash and bank balances	458.32	17.74
(iii) **Net debt [(i) - (ii)]**	**1,85,571.06**	**1,95,243.65**
(iv) Equity share capital	1,12,000.00	1,12,000.00
(v) Other equity	14,366.64	19,467.16
(vi) **Total equity [(iv) + (v)]**	**1,26,366.64**	**1,31,467.16**
(vii) Net debt to equity ratio (without considering other equity)	1.66	1.74
(viii) Net debt to equity ratio (considering other equity)	1.47	1.49

Debt is defined as long-term and short-term borrowings as described in note no. 20.

40.3. Categories of financial instruments :

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
Financial assets		
Measured at FVTPL		
Mandatory measured:		
(a) Investment in mutual fund	12,181.70	9,323.87
Measured at amortised cost		
(a) Trade receivables	16,891.86	12,674.06
(b) Cash and cash equivalents	457.82	17.22
(c) Other bank balances	0.51	0.52
(d) Loans	162.88	126.30
(e) Other financial assets	7,568.47	13,713.31
(f) Deposits with financial institutions	-	8,000.00
Financial liabilities		
Measured at amortised cost		
(a) Borrowings (including current maturities of long-term borrowings)	1,86,029.39	1,95,261.39
(b) Borrowings - Short term	-	235.49
(c) Trade payables	2,096.08	3,537.27
(d) Other financial liabilities	10,587.71	25,721.36

*Investment in joint venture is a financial asset, however the same has not been included in the above table, since it is measured at cost.

40.4. Financial risk management objectives :
While ensuring liquidity is sufficient to meet Company's operational requirements, the Company's management monitors and manages key financial risks relating to the operations of the Company by analysing exposures by degree and magnitude of risks. These risks include market risk (including currency risk and price risk), credit risk and liquidity risk.

40.5. Market Risk :
The risk that the fair value or future cash flows of a financial instrument will fluctuate because of changes in market prices. Market risk comprises three types of risk: currency risk, interest rate risk and price risk.

40.6. Foreign currency risk management :
The Company undertakes transactions denominated in foreign currency and consequently, expose to exchange rate fluctuations arise.

The carrying amounts of the Company's foreign currency denominated monetary liabilities at the end of the reporting period are as follows.

Particulars	Liabilities	
	Year ended March 31, 2020	Year ended March 31, 2019
Total EURO	-	4,220.67
Euro having impact on profit and loss account	-	734.49

Particulars	Liabilities	
	Year ended March 31, 2020	Year ended March 31, 2019
Total USD	2,727.83	-
USD having impact on profit and loss account	2,727.83	-

40.6.1. Foreign currency sensitivity analysis :

As per management's assessment of reasonable possible changes in the exchange rate of +/- 5% between EURO -INR currency pair, sensitivity of profit or (loss) only on outstanding foreign currency denominated monetary items at the period end is presented below:

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
EURO sensitivity at year end		
Payable		
EURO depreciation by 5%	-	36.72
EURO appreciation by 5%	-	(36.72)

As per management's assessment of reasonable possible changes in the exchange rate of +/- 5% between USD -INR currency pair, sensitivity of profit or (loss) only on outstanding foreign currency denominated monetary items at the period end is presented below:

Particulars	Year ended March 31, 2020	Year ended March 31, 2019
USD sensitivity at year end		
Payable		
USD depreciation by 5%	136.39	-
USD appreciation by 5%	(136.39)	-

Sensitivity analysis at year end is unrepresentative of the inherent foreign exchange risk because the exposure at the end of the reporting period does not reflect the exposure during the year.

40.6.2. Forward foreign exchange contracts :
The Company has not entered into any forward foreign exchange contracts during the reporting period.

40.7 Interest rate risk management :
The Company is exposed to interest rate risk because the Company has borrowed funds at floating interest rates.

For floating rate liabilities, the analysis is prepared assuming the amount of the liability outstanding at the end of the reporting period was outstanding for the whole year. A 50 basis point increase or decrease is used when reporting interest rate risk internally to the management and represents management's assessment of the reasonably possible change in interest rates.

If interest rates had been 50 basis points higher/lower and all other variables were held constant, the Company's:

Profit before tax for the year ended March 31, 2020 would decrease/increase by ₹ 925.41 Lakhs (For the year ended March 31, 2019: decrease/increase by ₹ 1,031.47 Lakhs). This is mainly attributable to the Company's exposure to interest rates on its variable rate borrowings.

40.8. Price risks :
The company is exposed to price risk arising from investments in mutual funds measured at FVTPL.

40.8.1. Price sensitivity analysis :
The sensitivity of profit or loss in respect of investments in mutual funds at the end of the reporting period for +/-5% change in net asset value is presented below:

Profit before tax for the year ended March 31, 2020 would increase/decrease by ₹ 609.09 Lakhs (For the year ended March 31, 2019 would increase/decrease by ₹ 466.19 Lakhs) as a result of the changes in net asset value of investment in mutual funds.

40.9. Credit risk management :

Credit risk refers to the risk that a counterparty will default on its contractual obligations resulting in financial loss to the Company. Credit risk arises from bank balances, deposits with banks and trade receivables. Credit risk management considers available reasonable and supportive forward-looking information including indicators like external credit rating (as far as available), macro-economic information (such as regulatory changes, government directives, market interest rate).

The Company makes sales to its customers which have high credit rating / govt entities.

Only high rated banks are considered for placement of deposits. Bank balances are held with reputed and creditworthy banking institutions.

40.10. Liquidity risk management :

The Company manages liquidity risk by maintaining sufficient cash and cash equivalents including bank deposits and availability of funding through an adequate amount of committed credit facilities to meet obligations when due. Management monitors rolling forecasts of liquidity position and cash and cash equivalents on the basis of expected cash flows. In addition, liquidity management also involves projecting cash flows considering level of liquid assets necessary to meet obligations by matching the maturity profiles of financial assets and liabilities and monitoring balance sheet liquidity ratios.

The following tables detail the Company's remaining contractual maturity for its non-derivative financial liabilities with agreed repayment periods. The information included in the tables have been drawn up based on the undiscounted cash flows of financial liabilities based on the earliest date on which the Company can be required to pay. The tables include both interest and principal cash flows. The contractual maturity is based on the earliest date on which the Company may be required to pay.

Notes to the Standalone financial statement for the year ended March 31, 2020
(All amounts are ₹ in Lakhs unless otherwise stated)

Particulars	Weighted average effective interest rate	Less 1 month	1 month -1 year	1 year – 3 years	More than 3 years	Total	Carrying amount
As at March 31, 2020							
-Borrowings (including current maturities of long-term borrowings) (variable rate)	8.55%	-	22,304.00	66,912.00	96,813.39	1,86,029.39	1,86,029.39
- Borrowings - Short term		-	-	-	-	-	-
-Trade Payable		2,096.08	-	-	-	2,096.08	2,096.08
-Finance Lease Obligations		-	9.37	3.30	-	12.67	12.67
-Other financial liabilities (Excluding current maturities of long-term borrowings)		4,759.22	5,757.82	70.67	-	10,587.71	10,587.71
Total		6,855.31	28,071.19	66,985.97	96,813.39	1,98,725.86	1,98,725.85

Particulars	Weighted average effective interest rate	Less 1 month	1 month -1 year	1 year – 3 years	More than 3 years	Total	Carrying amount
As at March 31, 2019							
-Borrowings (including current maturities of long-term borrowings) (variable rate)	8.37%	-	15,032.00	66,912.00	1,13,317.39	1,95,261.39	1,95,261.39
- Borrowings - Short term		235.49	-	-	-	235.49	235.49
-Trade Payable		3,537.27	-	-	-	3,537.27	3,537.27
-Finance Lease Obligations		-	-	-	-	-	-
-Other financial liabilities (Excluding current maturities of long-term borrowings)		3,284.89	21,609.16	827.31	-	25,721.36	25,721.36
Total		7,057.66	36,641.16	67,739.31	1,13,317.39	2,24,755.52	2,24,755.51

The following table details the Company's expected maturity for its non-derivative financial assets. The information included in the table has been drawn up based on the undiscounted contractual maturities of the financial assets including interest that will be earned on those assets. The inclusion of information on non-derivative financial assets is necessary in order to understand the Company's liquidity risk management as the liquidity is managed on a net asset and liability basis.

Particulars	Weighted average effective interest rate	Less 1 month	1 month -1 year	1 year – 3 years	More than 3 years	Total	Carrying amount
As at March 31, 2020							
-Loans	-	-	129.00	33.88	-	162.88	162.88
-Investments	-	12,181.70	-	-	-	12,181.70	12,181.70
-Trade receivables	-	16,891.86	-	-	-	16,891.86	16,891.86
-Cash and cash equivalents	-	457.82	-	-	-	457.82	457.82
-Other bank balance	-	0.51	-	-	-	0.51	0.51
-Other financial assets	-	-	7,568.47	-	-	7,568.47	7,568.47
Total	-	29,531.89	7,697.47	33.88	-	37,263.25	37,263.25

Particulars	Weighted average effective interest rate	Less 1 month	1 month -1 year	1 year – 3 years	More than 3 years	Total	Carrying amount
As at March 31, 2019							
-Loans	-	-	-	126.30	-	126.30	126.30
-Investments		9,323.87	8,000.00	-	-	17,323.87	17,323.87
-Trade receivables	-	7,596.02	4,887.04	-	-	12,483.06	12,483.06
-Cash and cash equivalents	-	17.22	-	-	-	17.22	17.22
-Other bank balance	-	0.52	-	-	-	0.52	0.52
-Other financial assets	-	-	13,713.31	-	-	13,713.31	13,713.31
Total	-	16,937.64	26,600.35	126.30	-	43,664.30	43,664.30

The Company has access to committed credit facilities as described below, of which ₹ 20,000.00 Lakhs were unused at the end of the reporting period (as at March 31, 2019 ₹ 19,787.34 Lakhs). The Company expects to meet its other obligations from operating cash flows and proceeds of maturing financial assets.

Particulars	As at 31 March, 2020	As at 31 March, 2019
Secured cash credit facility, reviewed annually and payable at call:		
-amount used *	-	212.66
-amount unused	20,000.00	19,787.34

* Cheque issued but not cleared amount to Nil (as at March 31, 2019 ₹ 22.83 Lakhs).

40.11. Fair value measurement

The management considers the carrying amounts of financial assets and financials liabilities recognised in the financial statements approximate their fair values.

Note -41 : Employee benefit plans

41.1. Defined benefit plans

Brief Description: A general description of the type of employee benefits plan is as follows:

41.1.1. Gratuity
15 days salary for each completed year of service. Vesting period is 5 years and the payment is restricted to ₹ 20 Lakhs.

The Company has taken the group policy with Life Insurance Corporation of India (LIC) to meet its obligation towards gratuity.

41.1.2. These plans typically expose the Group to actuarial risks such as: investment risk, interest rate risk, longevity risk and salary risk.

Investment risk

The present value of the defined benefit plan liability (denominated in Indian Rupee) is calculated using a discount rate which is determined by reference to market yields at the end of the reporting period on government bonds; if the return on plan asset is below this rate, it will create a plan deficit. Currently it has a relatively balanced mix of investments in government securities, insurance investment and other debt instruments.

Interest risk

A decrease in the bond interest rate will increase the plan liability; however, this will be partially offset by an increase in the return on the plan's debt investments.

Longevity risk

The present value of the defined benefit plan liability is calculated by reference to the best estimate of the mortality of plan participants both during and after their employment. An increase in the life expectancy of the plan participants will increase the plan's liability.

Salary Risk

The present value of the defined benefit plan liability is calculated by reference to the future salaries of plan participants. As such, an increase in the salary of the plan participants will increase the plan's liability. Employment. An increase in the life expectancy of the plan participants will increase the plan's liability.

In respect of gratuity, the actuarial valuation was carried out as at March 31, 2020 by member firm of the Institute of Actuaries of India. The present value of the defined benefit obligation, and the related current service cost and past service cost, were measured using the projected unit credit method.

41.2. The principal assumptions used for the purposes of the actuarial valuations were as follows.

Particulars	As at 31 March, 2020	As at 31 March, 2019
Gratuity		
Discount rate	6.80%	7.66%
Annual increase in salary	8.00%	8.00%

The discount rate is based upon the market yield available on Government bonds at the accounting date with a term that matches. The salary growth takes account inflation, seniority, promotion and other relevant factor on long term basis.

41.3. Amounts recognised in statement of profit and loss in respect of these defined benefit plans are as follows:

Gratuity : Particulars	As at 31 March, 2020	As at 31 March, 2019
Service Cost :		
Current service cost	30.53	27.58
Net interest expense	1.32	2.37
Components of defined benefit costs recognised in the statement of profit and loss	**31.85**	**29.95**

41.4. Movements in the present value of the defined benefit obligation are as follows:

Gratuity : Particulars	As at 31 March, 2020	As at 31 March, 2019
Opening defined benefit obligation	152.69	117.84
Current service cost	30.53	27.58
Interest cost	11.70	9.03
Benefits paid	-	-
Remeasurement (gains)/losses:	-	-
Actuarial (gains)/ losses arising from changes in financial assumptions	-	-
Actuarial (gains)/ losses arising from changes in experience assumptions	10.58	(1.76)
Closing defined benefit obligation	**205.49**	**152.69**
Current obligation	3.23	2.51
Non-current obligation	202.26	150.17

41.5. The amount included in the Balance sheet arising from the entity's obligation in respect of its defined benefit plan is as follows :

Gratuity : Particulars	As at 31 March, 2020	As at 31 March, 2019
Present value of funded defined benefit obligation	205.49	152.69
Fair value of plan assets	160.11	135.32
Unfunded status	45.38	17.37
Net liability arising from defined benefit obligation	**45.38**	**17.37**

41.6. Movements in the fair value of the plan assets are as follows :

Gratuity : Particulars	As at 31 March, 2020	As at 31 March, 2019
Opening fair value of plan assets	135.32	87.35
Difference in opening	0.14	(0.45)
Actuarial gain/ (loss) on plan assets	11.08	9.07
Contributions paid to the fund	15.11	40.83
Fund management charges	(1.53)	(1.48)
Benefits paid	-	-
Closing fair value of plan assets	**160.11**	**135.32**

Expected contribution in respect of Gratuity for next year will be ₹ 15.11 Lakhs (For the year ended March 31, 2019 ₹ 40.83 Lakhs).

41.7. The fair value of the plan assets at the end of the reporting period for each category, are as follows.

Gratuity :		
Particulars	As at 31 March, 2020	As at 31 March, 2019
Fair value of plan assets of gratuity		
- Managed by Life Insurance Corporation of India	160.11	135.32
	160.11	**135.32**

The actual return on plan assets was ₹ 11.08 Lakhs (For the year ended March 31, 2019 ₹ 9.07 Lakhs)

41.8. Significant actuarial assumptions for the determination of the defined obligation are discount rate and expected salary increase. The sensitivity analyses below have been determined based on reasonably possible changes of the respective assumptions occurring at the end of the reporting period, while holding all other assumptions constant.

41.8.1. Sensitivity Analysis as on March 31, 2020

Significant actuarial assumptions	Gratuity
Discount Rate	
- Impact due to increase of 50 basis points	(12.37)
- Impact due to decrease of 50 basis points	13.53
Salary increase	
- Impact due to increase of 50 basis points	10.96
- Impact due to decrease of 50 basis points	(10.58)

41.8.2. Sensitivity Analysis as on March 31, 2019

Significant actuarial assumptions	Gratuity
Discount Rate	
- Impact due to increase of 50 basis points	(9.28)
- Impact due to decrease of 50 basis points	10.14
Salary increase	
- Impact due to increase of 50 basis points	8.51
- Impact due to decrease of 50 basis points	(7.85)

The sensitivity analysis presented above may not be representative of the actual change in the defined benefit obligation as it is unlikely that the change in assumptions would occur in isolation of one another as some of the assumptions may be correlated.

Furthermore, in presenting the above sensitivity analysis, the present value of the defined benefit obligation has been calculated using the projected unit credit method at the end of the reporting period, which is the same as that applied in calculating the defined benefit obligation liability recognised in the balance sheet.

There was no change in the methods and assumptions used in preparing the sensitivity analysis from prior years.

The planned asset of the company are managed by the Life Insurance Corporation of India in terms of an Insurance Policy taken to fund obligations of the company with respect to its gratuity plan. Information on categories of plan assets is not available with the company.

There has been no change in the process used by the Company to manage its risks from prior periods.

42. Contingent liabilities, commitments and others

42.1. Claims against the Company not acknowledged as debt:-

Particulars	As at 31 March, 2020	As at 31 March, 2019
I. Income Tax : FY 2011-12(AY 2012-13) – matter under appeal	-	0.99
II. Income Tax : FY 2012-13 (AY 2013-14) -matter under appeal	262.75	262.75
III. Income Tax : FY 2014-2015 (AY 2015-2016)- matter under rectification	3.59	3.59
IV. Income Tax : FY 2015-16(AY 2016-17) – matter under appeal	441.91	441.91
V. Income Tax : FY 2016-17(AY 2017-18) – matter under appeal	114.93	-
VI. Custom Duty : matter under appeal	1,914.41	1,914.41
Total	2,737.59	2,623.65

Notes to the Standalone financial statement for the year ended March 31, 2020
(All amounts are ₹ in Lakhs unless otherwise stated)

43. Capital Commitments:

The estimated amount of contracts remaining to be executed on capital account and not provided for as at March 31, 2020 ₹ 81.58 Lakhs (as at March 31, 2019 ₹ 4,799.37 Lakhs)

44. The company had entered into long term service agreement (LTSA) with GE Inc. & GE spares USA for maintenance & supply of parts for Gas Turbines. As per LTSA, payment of fee is linked with Factored Fired Hours (FFH) run by respective gas turbines. Till June-2016, the company was paying the fee to GE considering FFH equivalent to running hours on the basis of explanation dated 26.03.2014 from GE. However, w.e.f. July-2016, on the basis of technical advice, the company started calculating FFH on the basis of base load parameters. The Company is in advanced discussion with GE for revision in billing from the start of agreement besides downward revision in variable rate per FFH in view of high escalation rate factor mentioned in LTSA coupled with sharp increase in USD conversion rate and present LTSA pricing offered by GE in Indian market. The effect of these negotiations will be recognized in the accounts on its final determination & settlement.

45.1. During the FY 2019-2020, unit I of the company remained shut down for six months due to rotor damage owing to which company profitability also got impacted as a result of less generation. The unit was synchronized on March 31, 2020, and trial run was completed in Ist week of April 2020. The company has property damage & business interruption insurance policy to cover such losses. The company has filed insurance claim which is yet to be approved and admitted by the insurance company.

45.2. The Open access recovery amounting to ₹ 1,015.19 Lakhs as on 31st March 2020 has been included in trade receivable mentioned in note no. 15 and is subject to reconciliation with the beneficiary.

46. Effect of uncertainties relating to the global health pandemic from COVID-19:

The Company has considered the possible effects, that may result from the pandemic relating to COVID-19, on the carrying amounts of receivables, unbilled revenues, tangible assets etc. In assessing the recoverability of trade receivables, unbilled revenue and investments, the company has considered internal and external information up to the date of approval of these financial statements including credit reports and economic forecasts.

As the company's revenue is mainly based on regulated tariff mechanism and falls under essential services and based on the current indicators of future economic conditions, the company expects to recover the carrying amount of these assets.

47. Figures in parenthesis as given in these Notes to Financial Statements relate to previous years. Previous year figures have been regrouped / reclassified where ever necessary to confirm the current year classification.

48. Approval of financial statements

The Financial Statements were approved for issue by the board of directors on 10 JUN 2020

For K K Soni & Co.
Chartered Accountants
FRN : 000947N

Abhinav Aggarwal
Partner
Membership Number : 517358

Place : New Delhi
Date : 10 JUN 2020

For and on behalf of the Board of Directors
CIN : U40101TR2004PLC007544

(Subhash Kumar)
Director
DIN : 07905656

(Sanil C. Namboodiripad)
Managing Director
DIN : 07963665

(Avinder Gupta)
Chief Financial Officer

(N.K. Aggarwal)
Company Secretary

Place : New Delhi
Date : 10 JUN 2020

Date : 6 Nov 2024
Account Number : 00000033627474136
Description : BR-T L C&I=3Y>NOV99
Name : ONGC TRIPURA POWER COMPANY LIMITED
Currency : INR
Corporate Address 10th Floor, Core 4 and Central, SCOPE Minar, Laxmi Nagar

NEW DELHI
DELHI-110092

Branch : CAG-II NEW DELHI(17313)
Rate of Interest (% p.a.) : 8.7%
Drawing Power : 10123456147.00
Limit : 3.035E10
Outstanding Amount : 8600128113.00
C.Y.YTD Interest : 4.58263905E8
P.Y.YTD Interest : 9.05474269E8
Balance as on 1 Apr 2022 : -11,90,53,59,157.00

Account Statement from 1 Apr 2022 to 31 Mar 2023

Txn Date	Value Date	Description	Ref No./Cheque No.	Branch Code	Debit	Credit	Balance
31/03/2023	31/03/2023	PART PERIOD INTER--	- /	99999	8,43,69,063.00		-11,98,97,28,220.00
31/03/2023	31/03/2023	DEPOSIT TRANSFER-INB Installment CIAAGDPFI8 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		500.00	-11,90,53,59,157.00
31/03/2023	31/03/2023	DEPOSIT TRANSFER-INB Int Mar 23 CIAAGDOFF5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		8,43,69,064.00	-11,90,53,59,657.00
31/03/2023	31/03/2023	DEPOSIT TRANSFER-INB Installment Mar 23 CIAAGDOFI8 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		13,16,00,000.00	-11,98,97,28,721.00
01/03/2023	01/03/2023	DEPOSIT TRANSFER-INB Interest feb 23 CIAAGAGZL5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,62,48,139.00	-12,12,13,28,721.00
28/02/2023	28/02/2023	PART PERIOD INTER--	- /	99999	7,62,48,139.00		-12,19,75,76,860.00
01/02/2023	01/02/2023	DEPOSIT TRANSFER-INB Int Jan 23 CIAAFXIVK5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		8,29,06,568.00	-12,12,13,28,721.00
31/01/2023	31/01/2023	PART PERIOD INTER--	- /	99999	8,28,89,963.00		-12,20,42,35,289.00
31/01/2023	31/01/2023	INTEREST--	- /	99999	16,605.00		-12,12,13,45,326.00
31/12/2022	31/12/2022	PART PERIOD INTER--	- /	99999	7,81,90,037.00		-12,12,13,28,721.00
30/12/2022	30/12/2022	DEPOSIT TRANSFER-INB Int - Dec 2022 CIAAFTUEQ4 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,81,90,037.00	-12,04,31,38,684.00

Txn Date	Value Date	Description	Ref No./Cheque No.	Branch Code	Debit	Credit	Balance
07/12/2022	07/12/2022	DEPOSIT TRANSFER-INB Term Loan Installment Mar 2022 CIAAFRPHY5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-12,12,13,28,721.00
07/12/2022	07/12/2022	DEPOSIT TRANSFER-INB Term Loan Installment Mar2022 CIAAFRPGP0 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-12,32,13,28,721.00
01/12/2022	01/12/2022	DEPOSIT TRANSFER-INB TERM LOAN INTEREST NOV 2022 CIAAFQZXK8 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,87,11,266.00	-12,52,13,28,721.00
30/11/2022	30/11/2022	PART PERIOD INTER--	- /	99999	7,87,11,266.00		-12,60,00,39,987.00
29/11/2022	29/11/2022	NPB REPAYMENT FRO- DGM 29/11/2022 REVERSAL OF EXCESS INT 31/10-	- /	17313		1,25,165.00	-12,52,13,28,721.00
29/11/2022	29/11/2022	DEPOSIT TRANSFER-INB TERL LOAM REPAYMENT CIAAFQTNJ5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		13,16,00,000.00	-12,52,14,53,886.00
07/11/2022	07/11/2022	CORRECT REPAYMENT-FROM GEN O00000097867173137 INR 00000004602000000+-	- /	17313	46,02,000.00		-12,65,30,53,886.00
07/11/2022	07/11/2022	NPB REPAYMENT FRO- DGM 03/11/2022 REFUND OF COMMITMENT CHARGES-	- /	17313		46,02,000.00	-12,64,84,51,886.00
04/11/2022	04/11/2022	DEPOSIT TRANSFER-INB TRF TO TERM LOAN ACC CIAAFOOMZ2 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-12,65,30,53,886.00
04/11/2022	04/11/2022	DEPOSIT TRANSFER-INB TRF TO TERM LOAN CIAAFOOMH1 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-12,85,30,53,886.00
01/11/2022	01/11/2022	DEPOSIT TRANSFER-INB TERM LOAN INTEREST OCT 2022 CIAAFOFRD3 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		8,29,48,680.00	-13,05,30,53,886.00
31/10/2022	31/10/2022	PART PERIOD INTER--	- /	99999	8,30,73,845.00		-13,13,60,02,566.00
30/09/2022	30/09/2022	PART PERIOD INTER--	- /	99999	7,77,65,704.00		-13,05,29,28,721.00
30/09/2022	30/09/2022	DEPOSIT TRANSFER-INB TL Interest Sep 2022 CIAAFLKSZ2 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,77,65,704.00	-12,97,51,63,017.00
27/09/2022	27/09/2022	SINGLE SIDED REPA-TRASNFER-	- /	17313		18,117.00	-13,05,29,28,721.00
13/09/2022	13/09/2022	INTEREST--	- /	17313	3,89,80,033.04		-13,05,29,46,838.00
13/09/2022	13/09/2022	CREDIT INTEREST A--	- /	17313		3,89,80,033.04	-13,01,39,66,804.96
13/09/2022	13/09/2022	INTEREST--	- /	17313	3,89,80,033.04		-13,05,29,46,838.00
13/09/2022	13/09/2022	CREDIT INTEREST A--	- /	17313		3,89,80,033.04	-13,01,39,66,804.96
08/09/2022	01/09/2022	CREDIT REPAYMENT-REFUND OF EXCESS INTEREST WITH DGM APPROVAL-	- /	17313		9,83,900.00	-13,05,29,46,838.00
01/09/2022	01/09/2022	DEPOSIT TRANSFER-INB Term Loan Interst Aug 2022 CIAAFIZIN6 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		8,03,73,856.00	-13,05,39,30,738.00
31/08/2022	31/08/2022	PART PERIOD INTER--	- /	99999	8,13,57,756.00		-13,13,43,04,594.00
31/08/2022	31/08/2022	INTEREST--	- /	99999	18,117.00		-13,05,29,46,838.00
26/08/2022	26/08/2022	ADVANCE:LOAN TO G-RECOVERY ISHORT INTT.JULY 22 - I-	- /	17313	35,08,084.00		-13,05,29,28,721.00

Txn Date	Value Date	Description	Ref No./Cheque No.	Branch Code	Debit	Credit	Balance
01/08/2022	01/08/2022	DEPOSIT TRANSFER-INB TERM LOAN INTEREST JUL 2022 CIAAFGNYM2 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		8,14,30,004.00	-13,04,94,20,637.00
31/07/2022	31/07/2022	PART PERIOD INTER--	- /	99999	7,79,21,920.00		-13,13,08,50,641.00
22/07/2022	22/07/2022	DEPOSIT TRANSFER-INB TERM LOAN INSTALLMENT CIAAFFSGU1 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		13,16,00,000.00	-13,05,29,28,721.00
21/07/2022	21/07/2022	DEPOSIT TRANSFER-INB TERM LOAN INSTALLMENT CIAAFFQAN4 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-13,18,45,28,721.00

**This is a computer generated statement and does not require a signature.

Date : 6 Nov 2024
Account Number : 00000033627474136
Description : BR-T L C&I=3Y>NOV99
Name : ONGC TRIPURA POWER COMPANY LIMITED
Currency : INR
Corporate Address 10th Floor, Core 4 and Central, SCOPE Minar, Laxmi Nagar

NEW DELHI
DELHI-110092

Branch : CAG-II NEW DELHI(17313)
Rate of Interest (% p.a.) : 8.7%
Drawing Power : 10123456147.00
Limit : 3.035E10
Outstanding Amount : 8600128113.00
C.Y.YTD Interest : 4.58263905E8
P.Y.YTD Interest : 9.05474269E8
Balance as on 1 Apr 2023 : -9,79,30,25,417.00

Account Statement from 1 Apr 2023 to 31 Mar 2024

Txn Date	Value Date	Description	Ref No./Cheque No.	Branch Code	Debit	Credit	Balance
31/03/2024	31/03/2024	PART PERIOD INTER--	- /	99999	7,03,02,698.00		-9,86,33,28,115.00
28/03/2024	28/03/2024	DEPOSIT TRANSFER-INB CIAAHXBHV9 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,03,02,700.00	-9,79,30,25,417.00
01/03/2024	01/03/2024	DEPOSIT TRANSFER-INB Interest Feb 2024 CIAAHSPYP1 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		6,65,58,037.00	-9,86,33,28,117.00
29/02/2024	29/02/2024	PART PERIOD INTER--	- /	99999	6,65,58,036.00		-9,92,98,86,154.00
16/02/2024	16/02/2024	DEPOSIT TRANSFER-INB Installment CIAAHQPDC2 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		13,16,00,000.00	-9,86,33,28,118.00
07/02/2024	07/02/2024	DEPOSIT TRANSFER-INB Installment CIAAHPIBH3 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-9,99,49,28,118.00
01/02/2024	01/02/2024	DEPOSIT TRANSFER-INB Interest Jan 2024 CIAAHOLMU5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,37,38,111.00	-10,19,49,28,118.00
31/01/2024	31/01/2024	PART PERIOD INTER--	- /	99999	7,37,38,111.00		-10,26,86,66,229.00
25/01/2024	25/01/2024	DEPOSIT TRANSFER-INB Installment CIAAHNNGG5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-10,19,49,28,118.00
31/12/2023	31/12/2023	PART PERIOD INTER--	- /	99999	7,36,67,993.00		-10,39,49,28,118.00

Txn Date	Value Date	Description	Ref No./Cheque No.	Branch Code	Debit	Credit	Balance
29/12/2023	29/12/2023	DEPOSIT TRANSFER-INB Interest December 2023 CIAAHJNZY3 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,36,67,993.00	-10,32,12,60,125.00
01/12/2023	01/12/2023	DEPOSIT TRANSFER-INB Interest November 2023 CIAAHFYEB0 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,18,22,226.00	-10,39,49,28,118.00
30/11/2023	30/11/2023	PART PERIOD INTER--	- /	99999	7,18,22,226.00		-10,46,67,50,344.00
17/11/2023	17/11/2023	DEPOSIT TRANSFER-INB Loan Prepayment CIAAHEDQS1 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		13,16,00,000.00	-10,39,49,28,118.00
01/11/2023	01/11/2023	DEPOSIT TRANSFER-INB Term Loan Int Oct 23 CIAAHCDDT4 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,59,19,658.00	-10,52,65,28,118.00
31/10/2023	31/10/2023	PART PERIOD INTER--	- /	99999	7,59,19,658.00		-10,60,24,47,776.00
16/10/2023	16/10/2023	DEPOSIT TRANSFER-INB Loan Prepayment CIAAHAENM5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-10,52,65,28,118.00
16/10/2023	16/10/2023	DEPOSIT TRANSFER-INB Loan prepayment CIAAHAEME5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-10,72,65,28,118.00
30/09/2023	30/09/2023	PART PERIOD INTER--	- /	99999	7,46,25,639.00		-10,92,65,28,118.00
29/09/2023	29/09/2023	DEPOSIT TRANSFER-INB Interest Sept 23 CIAAGYAMI3 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,46,25,640.00	-10,85,19,02,479.00
05/09/2023	05/09/2023	DEPOSIT TRANSFER-INB Loan payment- CIAAGVFFD7 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		13,16,00,000.00	-10,92,65,28,119.00
01/09/2023	01/09/2023	DEPOSIT TRANSFER-INB Int Aug 23 CIAAGUXBZ5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,96,34,969.00	-11,05,81,28,119.00
31/08/2023	31/08/2023	PART PERIOD INTER--	- /	99999	7,96,34,969.00		-11,13,77,63,088.00
22/08/2023	22/08/2023	DEPOSIT TRANSFER-INB Loan prepayment CIAAGTRCH0 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-11,05,81,28,119.00
17/08/2023	17/08/2023	DEPOSIT TRANSFER-INB Loan prepayment CIAAGTDRA4 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-11,25,81,28,119.00
01/08/2023	01/08/2023	DEPOSIT TRANSFER-INB Interest July 2023 CIAAGRBCU9 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		8,07,71,956.00	-11,45,81,28,119.00
31/07/2023	31/07/2023	PART PERIOD INTER--	- /	99999	8,07,71,955.00		-11,53,89,00,075.00
30/06/2023	30/06/2023	PART PERIOD INTER--	- /	99999	7,81,48,637.00		-11,45,81,28,120.00
30/06/2023	30/06/2023	DEPOSIT TRANSFER-INB Int June 23 CIAAGNNUM0 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,81,48,637.00	-11,37,99,79,483.00
01/06/2023	01/06/2023	DEPOSIT TRANSFER-INB Interest May 2023 CIAAGKIYM7 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		8,07,71,955.00	-11,45,81,28,120.00

Txn Date	Value Date	Description	Ref No./Cheque No.	Branch Code	Debit	Credit	Balance
01/06/2023	01/06/2023	CORR DEPOSIT TRAN- TRANSFER FROM TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922	34,08,593.00		-11,53,89,00,075.00
01/06/2023	01/06/2023	DEPOSIT TRANSFER-INB Interest May 23 CIAAGKHQD7 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		34,08,593.00	-11,53,54,91,482.00
31/05/2023	31/05/2023	PART PERIOD INTER--	- /	99999	8,07,71,955.00		-11,53,89,00,075.00
30/04/2023	30/04/2023	PART PERIOD INTER--	- /	99999	7,95,12,392.00		-11,45,81,28,120.00
28/04/2023	28/04/2023	DEPOSIT TRANSFER-INB Interest April 23 CIAAGGOBO0 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,95,12,492.00	-11,37,86,15,728.00
19/04/2023	19/04/2023	DEPOSIT TRANSFER-INB Installment CIAAGFOAA9 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		13,16,00,000.00	-11,45,81,28,220.00
13/04/2023	13/04/2023	DEPOSIT TRANSFER-INB Term Loan Installment CIAAGEZIM3 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-11,58,97,28,220.00
13/04/2023	13/04/2023	DEPOSIT TRANSFER-INB Term Loan Repayment CIAAGEZHD2 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		20,00,00,000.00	-11,78,97,28,220.00

**This is a computer generated statement and does not require a signature.

Date : 6 Nov 2024
Account Number : 00000040504191970
Description : MC-TL-SPL FOR CAG-3M MCLR
Name : ONGC TRIPURA POWER COMPANY LIMITED
Currency : INR
Corporate Address 10th Floor, Core 4 and Central, SCOPE Minar, Laxmi Nagar

NEW DELHI
DELHI-110092

Branch : CAG-II NEW DELHI(17313)
Rate of Interest (% p.a.) : 8.7%
Drawing Power : 356127680.00
Limit : 6.75E8
Outstanding Amount : 353535392.00
C.Y.YTD Interest : 1.8834227E7
P.Y.YTD Interest : 3.8257444E7
Balance as on 1 Apr 2022 : -50,95,35,500.00

Account Statement from 1 Apr 2022 to 31 Mar 2023

Txn Date	Value Date	Description	Ref No./Cheque No.	Branch Code	Debit	Credit	Balance
31/03/2023	31/03/2023	COMMITMENT INTERE--	- /	99999	3,535.00		-50,95,39,035.00
31/03/2023	31/03/2023	PART PERIOD INTER--	- /	99999	37,23,001.00		-50,95,35,500.00
31/03/2023	31/03/2023	DEPOSIT TRANSFER-INB Installment CIAAGDPFY0 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		500.00	-50,58,12,499.00
31/03/2023	31/03/2023	DEPOSIT TRANSFER-INB Int Mar 23 CIAAGDOFG6 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		37,23,001.00	-50,58,12,999.00
31/03/2023	31/03/2023	DEPOSIT TRANSFER-INB Installment Mar 23 CIAAGDOFZ2 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		2,60,00,000.00	-50,95,36,000.00
01/03/2023	01/03/2023	DEPOSIT TRANSFER-INB Interest Feb 23 CIAAGAGZN8 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		33,68,742.00	-53,55,36,000.00
28/02/2023	28/02/2023	PART PERIOD INTER--	- /	99999	33,68,742.00		-53,89,04,742.00
01/02/2023	01/02/2023	DEPOSIT TRANSFER-INB Int Jan 23 CIAAFXIUY0 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		36,34,309.00	-53,55,36,000.00
31/01/2023	31/01/2023	PART PERIOD INTER--	- /	99999	36,34,309.00		-53,91,70,309.00
02/01/2023	01/01/2023	O.S. DEPOSIT TRAN-SERVICING INTEREST TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	17313		1.00	-53,55,36,000.00
31/12/2022	31/12/2022	PART PERIOD INTER--	- /	99999	34,32,613.00		-53,55,36,001.00

Txn Date	Value Date	Description	Ref No./Cheque No.	Branch Code	Debit	Credit	Balance
30/12/2022	30/12/2022	DEPOSIT TRANSFER-INB Int - Dec 2022 CIAAFTUFJ8 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		34,32,612.00	-53,21,03,388.00
01/12/2022	01/12/2022	DEPOSIT TRANSFER-INB TERM LOAN INTEREST NOV 2022 CIAAFQZYV0 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		34,73,844.00	-53,55,36,000.00
30/11/2022	30/11/2022	PART PERIOD INTER--	- /	99999	34,73,844.00		-53,90,09,844.00
29/11/2022	29/11/2022	DEPOSIT TRANSFER-INB TERL LOAN REPAYMENT CIAAFQTMF6 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		2,60,00,000.00	-53,55,36,000.00
01/11/2022	01/11/2022	DEPOSIT TRANSFER-INB TERM LOAN INTEREST OCT 2022 CIAAFOFPZ6 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		35,54,600.00	-56,15,36,000.00
31/10/2022	31/10/2022	PART PERIOD INTER--	- /	99999	35,54,600.00		-56,50,90,600.00
30/09/2022	30/09/2022	PART PERIOD INTER--	- /	99999	31,66,197.00		-56,15,36,000.00
30/09/2022	30/09/2022	DEPOSIT TRANSFER-INB TERL LOAN INSTALLMENT CIAAFLKXJ9 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		2,52,50,000.00	-55,83,69,803.00
30/09/2022	30/09/2022	DEPOSIT TRANSFER-INB TL INTEREST SEP 2022 CIAAFLKSY7 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		31,66,197.00	-58,36,19,803.00
26/09/2022	26/09/2022	DEBIT TRANSFER- TRANSFER TO 33566054516 ONGC TRIPURA POWER CO-	- /	17313	6,54,00,000.00		-58,67,86,000.00
01/09/2022	01/09/2022	DEPOSIT TRANSFER-funds transfer 00000000 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	17313		1,00,000.00	-52,13,86,000.00
01/09/2022	01/09/2022	DEPOSIT TRANSFER-INB Term Loan Interest CIAAFIZIO7 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		31,12,240.00	-52,14,86,000.00
31/08/2022	31/08/2022	PART PERIOD INTER--	- /	99999	32,12,240.00		-52,45,98,240.00
13/08/2022	13/08/2022	DEPOSIT TRANSFER-INB TRF CIAAFHLSJ2 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		7,50,000.00	-52,13,86,000.00
01/08/2022	01/08/2022	DEPOSIT TRANSFER-INB Term Loan Interest Jul 2022 CIAAFGNYM7 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		31,12,584.00	-52,21,36,000.00
31/07/2022	31/07/2022	PART PERIOD INTER--	- /	99999	31,12,584.00		-52,52,48,584.00
07/07/2022	07/07/2022	DEBIT TRANSFER- TRANSFER TO 33566054516 ONGC TRIPURA POWER CO-	- /	17313	4,02,00,000.00		-52,21,36,000.00
01/07/2022	01/07/2022	DEPOSIT TRANSFER-INB Interest June 22 CIAAFDZRK5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		27,13,366.00	-48,19,36,000.00
30/06/2022	30/06/2022	PART PERIOD INTER--	- /	99999	27,13,366.00		-48,46,49,366.00
01/06/2022	01/06/2022	DEPOSIT TRANSFER-INB Term Loan Interest CIAAFBAFB5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		15,780.00	-48,19,36,000.00
01/06/2022	01/06/2022	DEPOSIT TRANSFER-INB Term Loan Interest May 2022 CIAAFAZVS6 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		27,88,031.00	-48,19,51,780.00
31/05/2022	31/05/2022	PART PERIOD INTER--	- /	99999	28,03,811.00		-48,47,39,811.00

Txn Date	Value Date	Description	Ref No./Cheque No.	Branch Code	Debit	Credit	Balance
30/04/2022	30/04/2022	PART PERIOD INTER--	- /	99999	27,12,348.00		-48,19,36,000.00
29/04/2022	29/04/2022	DEPOSIT TRANSFER-INB TERM LOAN INTEREST APR 2022 CIAAEYMPF7 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		27,12,348.00	-47,92,23,652.00

**This is a computer generated statement and does not require a signature.

Date : 6 Nov 2024
Account Number : 00000040504191970
Description : MC-TL-SPL FOR CAG-3M MCLR
Name : ONGC TRIPURA POWER COMPANY LIMITED
Currency : INR
Corporate Address 10th Floor, Core 4 and Central, SCOPE Minar, Laxmi Nagar

NEW DELHI
DELHI-110092

Branch : CAG-II NEW DELHI(17313)
Rate of Interest (% p.a.) : 8.7%
Drawing Power : 356127680.00
Limit : 6.75E8
Outstanding Amount : 353535392.00
C.Y.YTD Interest : 1.8834227E7
P.Y.YTD Interest : 3.8257444E7
Balance as on 1 Apr 2023 : -40,26,44,866.00

Account Statement from 1 Apr 2023 to 31 Mar 2024

Txn Date	Value Date	Description	Ref No./Cheque No.	Branch Code	Debit	Credit	Balance
31/03/2024	31/03/2024	PART PERIOD INTER--	- /	99999	28,90,529.00		-40,55,35,395.00
28/03/2024	28/03/2024	DEPOSIT TRANSFER-INB CIAAHXBHY4 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		28,90,530.00	-40,26,44,866.00
01/03/2024	01/03/2024	DEPOSIT TRANSFER-INB Interest Feb 2024 CIAAHSPYS2 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		27,96,286.00	-40,55,35,396.00
29/02/2024	29/02/2024	PART PERIOD INTER--	- /	99999	27,96,286.00		-40,83,31,682.00
16/02/2024	16/02/2024	DEPOSIT TRANSFER-INB Installment CIAAHQPDG7 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		2,60,00,000.00	-40,55,35,396.00
01/02/2024	01/02/2024	DEPOSIT TRANSFER-INB Interest Jan 2024 CIAAHOLLX0 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		30,72,769.00	-43,15,35,396.00
31/01/2024	31/01/2024	PART PERIOD INTER--	- /	99999	30,72,769.00		-43,46,08,165.00
31/12/2023	31/12/2023	PART PERIOD INTER--	- /	99999	30,58,256.00		-43,15,35,396.00
29/12/2023	29/12/2023	DEPOSIT TRANSFER-INB Interest December 2023 CIAAHJNZY9 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		30,58,255.00	-42,84,77,140.00
01/12/2023	01/12/2023	DEPOSIT TRANSFER-INB Interest Nov 2023 CIAAHFYEQ2 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		30,56,801.00	-43,15,35,395.00
30/11/2023	30/11/2023	PART PERIOD INTER--	- /	99999	30,56,801.00		-43,45,92,196.00

Txn Date	Value Date	Description	Ref No./Cheque No.	Branch Code	Debit	Credit	Balance
17/11/2023	17/11/2023	DEPOSIT TRANSFER-INB Loan Payment CIAAHEESD9 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		2,60,00,000.00	-43,15,35,395.00
01/11/2023	01/11/2023	DEPOSIT TRANSFER-INB Loan Int Oct 23 CIAAHCDEX5 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		32,38,473.00	-45,75,35,395.00
31/10/2023	31/10/2023	PART PERIOD INTER--	- /	99999	32,38,473.00		-46,07,73,868.00
30/09/2023	30/09/2023	PART PERIOD INTER--	- /	99999	31,43,489.00		-45,75,35,395.00
29/09/2023	29/09/2023	DEPOSIT TRANSFER-INB Interest Sept 23 CIAAGYAMK0 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		31,43,490.00	-45,43,91,906.00
05/09/2023	05/09/2023	DEPOSIT TRANSFER-INB Loan Payment- CIAAGVFFE9 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		2,60,00,000.00	-45,75,35,396.00
01/09/2023	01/09/2023	DEPOSIT TRANSFER-INB Int Aug 23 CIAAGUVMJ7 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		34,08,593.00	-48,35,35,396.00
31/08/2023	31/08/2023	PART PERIOD INTER--	- /	99999	34,08,593.00		-48,69,43,989.00
01/08/2023	01/08/2023	DEPOSIT TRANSFER-INB Interest July 2023 CIAAGRBCW1 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		34,08,593.00	-48,35,35,396.00
31/07/2023	31/07/2023	PART PERIOD INTER--	- /	99999	34,08,593.00		-48,69,43,989.00
30/06/2023	30/06/2023	PART PERIOD INTER--	- /	99999	32,97,889.00		-48,35,35,396.00
30/06/2023	30/06/2023	DEPOSIT TRANSFER-INB Int June 23 CIAAGNNVY9 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		32,97,889.00	-48,02,37,507.00
01/06/2023	01/06/2023	DEPOSIT TRANSFER-INB Interest May 2023 CIAAGKIYO0 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		34,08,593.00	-48,35,35,396.00
01/06/2023	01/06/2023	CORR DEPOSIT TRAN-TRANSFER FROM TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922	8,07,71,955.00		-48,69,43,989.00
01/06/2023	01/06/2023	DEPOSIT TRANSFER-INB Interest May 23 CIAAGKHQB9 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		8,07,71,955.00	-40,61,72,034.00
31/05/2023	31/05/2023	PART PERIOD INTER--	- /	99999	34,08,593.00		-48,69,43,989.00
01/05/2023	01/05/2023	DEPOSIT TRANSFER-INT COMM CHARGES TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	17313		88,363.00	-48,35,35,396.00
30/04/2023	30/04/2023	COMMITMENT INTERE--	- /	99999	88,363.00		-48,36,23,759.00
30/04/2023	30/04/2023	PART PERIOD INTER--	- /	99999	33,88,810.00		-48,35,35,396.00
28/04/2023	28/04/2023	DEPOSIT TRANSFER-INB Interest April 23 CIAAGGOBO8 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		33,88,914.00	-48,01,46,586.00
26/04/2023	26/04/2023	DEPOSIT TRANSFER-TL COMMITMENT CHARGES RECOVERED TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	17313		3,535.00	-48,35,35,500.00
19/04/2023	19/04/2023	DEPOSIT TRANSFER-INB Installment CIAAGFOAD1 TRANSFER FROM 33566054516 ONGC TRIPURA POWER CO-	- /	99922		2,60,00,000.00	-48,35,39,035.00

**This is a computer generated statement and does not require a signature.

सत्यमेव जयते

भारत सरकार / Government of India

विद्युत मंत्रालय / Ministry of Power

केंद्रिय विद्युत प्राधिकरण / Central Electricity Authority

तापीय यांत्रिकी एवं अभियांत्रिकी विकास प्रभाग

Thermal Engineering & Technology Development Division

संख्या: CEA/TETD-TT/2018/N-15/1451 **दिनांक : 10.12.2018**

सेवा में

सचिव,
केंद्रीय विधुत विनियामक आयोग,
तीसरी और चौथी मंजिल,
चंद्रलोक बिल्डिंग, 36, जनपथ,
नई दिल्ली - 110 001

विषय: CERC Terms and Conditions of Tariff for the tariff period starting from 01.04.2019 – CEA Recommendations on Operation Norms for thermal generating stations - के बारे में.

महोदय,

This is with reference to your D.O. letter No. No. 1-1/225/2017– CERC dated 26.03.2018 addressed to Chairperson, CEA requesting for CEA recommendations on the operation norms for hydro and thermal generating stations for the tariff period 2019-24 starting from 01.04.2019. The additional operational norms have also been requested for units/ stations on account of implementation of new environmental norms.

The issue of operation norm for tariff period 2019- 24 has been examined and the Recommendation on Operation Norms for Thermal Generating Stations for the Tariff Period 2019- 24 as approved by Chairperson, CEA is enclosed herewith. The additional operation norm as pertaining to implementation of new environmental norms shall be furnished later.

संलग्नक: यथोपरी.

भवदीय,

सुनीत गुप्ता 10/12/2018

(सुनीत कुमार गुप्ता)
उप - निदेशक

Copy for kind information to: i) अध्यक्ष, के.वि.प्रा.
ii) सदस्य (तापीय), के.वि.प्रा.
iii) मुख्य अभियंता (टी.ई.टी.डी.)

सेवा भवन, नवम तल, आर.के.पुरम, नई दिल्ली- 66, टेलीफैक्स: 011- 26715475 ई-मेल cetetd-cea@gov.in वेबसाइट: www.cea.nic.in
Sewa Bhawan,9th Floor,R K Puram,New Delhi-66,Telefax:011- 26715475, e-mail Website www.cea.nic.in

Recommendations on Operation Norms for Thermal Generating Stations for the Tariff Period 2019- 24

Reference: Regulation 36 under Chapter 8 in CERC (Terms and Conditions of Tariff) Regulations, 2014:

The recommendations of Central Electricity Authority on plant operation norms in respect of thermal generating stations for the tariff period 2019- 2024 are as below:

A. Normative Annual Plant Availability Factor (PAF)

i) a) All coal/ lignite based thermal generating stations, except those covered under clause ii), iii) & iv) below:

Pithead stations	:	83%
Non-pithead stations:		75% (to be reviewed after 2 years)
First FY after COD	:	68.5%

i) b) All gas/ liquid fuel based thermal generating stations, except those covered under clause v) below : 85%

ii) M/s NLCIL's following pulverised lignite fired thermal generating stations:

a) TPS- I : 72%

b) TPS- II Stage- I & Stage- II : 80%

iii) M/s DVC's following coal fired thermal generating stations:

a) Bokaro TPS (210 MW Unit- 3) : 75%

b) Chandrapura TPS (630 MW) : 75%

c) Durgapur TPS (210 MW) : 75%

iv) Lignite fired generating stations using circulatory fluidized bed combustion (CFBC) technology and generating stations based on coal rejects:

a) First Three years from COD : 68.5%

b) For next year after completion of three years of COD : 75%

v) M/s NEEPCO's gas fired thermal generating stations:

a) Assam GBP : 72%

B. Normative secondary fuel oil consumption

i) Coal-based generating stations other than Farakka, Stage- II TPS and those at (ii) & (iii) below: 0.50 ml/kWh

Farakka, Stage- II TPS : 1.0 ml/kWh

In Farakka, Stage- II TPS there is front fired boiler which requires oil support during every mill changeover. The actual oil consumption is more than around 1.07 ml/kWh during last 5 years.

Further, considering fast pace of renewable energy based capacity addition in the country, it is suggested that norm of specific oil consumption may be suitably reviewed in near future as for its adequacy based on actual consumption under increased flexible operation of the coal and lignite based thermal generating stations.

ii) Coal-based generating stations of DVC:

a) Bokaro TPS *210 MW Unit- 3* : 1.5 ml/kWh

b) Chandrapura TPS *(630 MW)* : 0.7 ml/kWh

b) Durgapur TPS *(210 MW)* : 2.4 ml/kWh

c) Mejia TPS *210 MW Unit- 1 to 4* : 1.0 ml/kWh

iii) Lignite-fired generating stations:

a) Pulverised lignite-fired generating stations except TPS- I : 1.0 ml/kWh

b) TPS-I : 1.5 ml/kWh

c) Lignite-fired generating stations based on CFBC technology : 1.0 ml/kWh

iv) Generating stations based on coal rejects : 2.0 ml/kWh

C. Gross station heat rate

1. Existing Thermal Generating Stations (COD achieved before 1.4.2009):

i) The normative gross station heat rate for coal based thermal generating units/ stations other than those relaxed norms covered under clause (ii) and (iii) below shall be as under:

200/210/250 MW sets	**500 MW sets (sub-critical)**
2450 kcal/kWh(no change)	2400 kcal/kWh (increased by 25 kcal/kWh)

Note:

In respect of 500 MW and above units where the boiler feed pumps are electrically operated, the gross station heat rate shall be 40 kcal/kWh lower than the gross station heat rate specified above.

ii) NTPC's coal based thermal generating stations:

Talcher TPS (4x60MW+ 2x110MW)	2830 kcal/kWh
Tanda TPS (4x110MW)	2775 kcal/kWh

ii) DVC's coal based thermal generating stations:

Bokaro TPS *210 MW Unit- 3*	2700 kcal/kWh
Chandrapura TPS *130 MW Unit 3*	3000 kcal/kWh
Durgapur TPS *(210 MW Unit- 4)*	2750 kcal/kWh

iii) Lignite fired thermal generating stations:

The relaxed heat rate norms in respect of NLCIL's TPS- I, TPS- I Expansion, TPS- II Stage- I & Stage- II lignite based thermal generating stations shall be as below:

TPS-I (6x50MW+ 3x100MW)	4000 kcal/kWh
TPS-I (Expansion) (2x210MW)	2720 kcal/kWh
TPS-II Stage I (3x210MW) and TPS-II Stage I (4x210MW)	2890 kcal/kWh

v) Open cycle gas turbine/ combine cycle thermal generating stations:

The operation norm for existing open cycle gas turbine/ combine cycle thermal generating stations of NTPC and NEEPCO is proposed to be retained.

2. Existing Thermal Generating Stations (coal & lignite) having COD achieved on or after 1.4.2009 till 31.03.2014:

The normative gross station heat rate of coal-based and lignite-fired thermal generating stations

= 1.05 X Design Heat Rate (kcal/kWh)

Where the Design Heat Rate of a generating unit means the unit heat rate guaranteed by the supplier at conditions of 100% MCR, zero percent make up, design coal and design cooling water temperature/back pressure.

The design heat rate to be considered for coal based stations shall not exceed the following maximum design unit heat rates depending upon the pressure and temperature ratings of the units:

Pressure Rating (kg/ cm^2)	150	170	170	247	247
SHT / RHT (^{0} C)	535/ 535	537/ 537	537/ 565	537/ 565	565/ 593
Type of BFP	Electrical Driven	Turbine Driven	Turbine Driven	Turbine Driven	Turbine Driven
Maximum Design Unit Heat Rate (kcal/ kWh)					
Sub-Bituminous Indian Coal	2300	2294	2276	2235	2176
Bituminous Imported Coal	2197	2191	2174	2135	2097

Further, the applicability of the condition, "Provided that the heat rate norms computed as per above shall be limited to the heat rate norms approved during FY 2009-10 to FY 2013-14." mentioned at end of the regulation may be deleted.

3. Existing thermal generating stations (coal & lignite) having COD achieved on or after 1.4.2014 till 31.3.2019 and new thermal generating stations (coal & lignite) achieving COD on or after 1.4.2019

The normative gross station heat rate of coal-based and lignite-fired thermal generating stations

= 1.05 X Design Heat Rate (kcal/kWh)

Where the Design Heat Rate of a generating unit means the unit heat rate guaranteed by the supplier at conditions of 100% MCR, zero percent make up, design coal and design cooling water temperature/back pressure.

The design heat rate to be considered for coal based stations shall not exceed the following maximum design unit heat rates depending upon the pressure and temperature ratings of the units:

Pressure Rating (kg/ cm^2)	170	247	247	270	270
SHT / RHT (^{0} C)	537/ 565	537/ 565	565/ 593	593/ 593	600/ 600
Type of BFP	Turbine Driven	Turbine Driven	Turbine Driven	Turbine Driven	Turbine Driven
Maximum Design Unit Heat Rate (kcal/kWh)					
Sub-Bituminous Indian Coal	2250	2235	2176	2093	2081
Bituminous Imported Coal	2174	2135	2078	2022	2011

i) Further, the applicability of the condition that the heat rate norms computed as per above shall be limited to the heat rate norms approved during last tariff period mentioned at end of the regulation may be deleted.

ii) The impact of dry cooling system on design heat rate shall be mentioned as below:

"Provided also that maximum turbine cycle heat rate and maximum design unit heat rate shall be increased by 6% each for units based on dry cooling system."

iii) The impact of change of BFP drive from steam turbine driven to electric motor driven on unit heat rate shall be mentioned as below:

"In respect of generating units where the boiler feed pumps are electrically operated, the maximum design unit heat rate shall be 40 kcal/kWh (60 kcal/kWh for supercritical units) lower than the maximum design unit heat rate specified above with turbine driven BFP."

4. Gas-based/ Liquid-based thermal generating unit(s)/ block(s) having COD on or after 01.04.2009:

The existing operation norms as at CERC Regulation 36(C)(d) are proposed to be retained.

Further, the applicability of the condition, "Provided that the heat rate norms computed as per above shall be limited to the heat rate norms approved during FY 2009-10 to FY 2013-14." mentioned at end of the regulation may be deleted.

D. Auxiliary energy consumption

1. Coal Based Thermal Generating Stations:

i) Coal-based thermal generating stations except at (ii) & (iii) below:

	(auxiliary energy consumption as % of gross generation)	
	Without IDCT	With IDCT
200 to 270 MW unit generating stations	8.5%	9.0%
300 to 800 MW unit generating stations (With steam turbine driven boiler feed pumps)	5.75%	6.25%
300 to 800 MW Sub- critical units (With electric motor driven boiler feed pumps)	8.0%	8.5%
300 to 800 MW Super-critical units (With electric motor driven boiler feed pumps)	9.0%	9.5%

In case of thermal generating stations provided with tube and ball mills, the additional auxiliary energy consumption allowed shall be 0.7%.

In case of thermal generating stations provided with Dry Cooling Systems, the additional auxiliary energy consumption allowed shall be as below:

Type of dry cooling system	(% of gross generation)
Direct cooling air cooled condensers with mechanical draft fans	1.0%
Indirect cooling system employing jet condensers with pressure recovery turbine and natural draft tower	0.5%

ii) NTPC's coal based thermal generating stations:

Talcher Thermal Power Station (460 MW)	10.50%
Tanda Thermal Power Station (440 MW)	11.70%

iii) DVC's coal based thermal generating stations:

Bokaro Thermal Power Station *210 MW Unit- 3*	10.25%
Chandrapur Thermal Power Station *(630 MW)*	9.50%
Durgapur Thermal Power Station *(210 MW Unit- 4)*	10.50%

2. Lignite Based Thermal Generating Stations:

i) For all pulverised lignite fired thermal generating stations with 200 MW sets and above, the auxiliary energy consumption norms shall be 0.5 percentage point more than the auxiliary energy consumption norms of coal-based generating stations except at (ii) below.

ii) M/s NLCIL's pulverised lignite fired generating stations:

TPS-I (600 MW)	12.0 %
TPS-II stage- I (630 MW)	9.85 %
TPS- II stage- II (840 MW)	9.85%

iii) For lignite fired thermal generating stations using CFBC technology, the auxiliary energy consumption norms shall be 1.5 percentage point more than the auxiliary energy consumption norms of coal-based generating stations except at (iv) below.

iv) M/s NLCIL's CFBC technology based lignite fired generating stations:

Barsingsar TPS (250 MW)	12.5 %
TPS-II Expansion (500 MW)	12.5 %

3. Gas Turbine/ Combined Cycle Generating Stations:

i) Gas turbine/ combined cycle generating stations, except those at (ii) below:

a) Combined cycle generating stations : 2.5%

b) Open cycle generating stations : 1.0%

ii) a) NEEPCO's Tripura CCPP (101 MW) : 4.2%

b) NTPC's Kayamkulam CCPP (359.58 MW) : 2.7%

c) ONGC- TPCL's Palatana CCPP (726.6 MW) : 3.5%

E. Annual Plant Load Factor (PLF) for Incentive

The level of Annual Plant Load Factor (PLF) for Incentive is recommended at the same level of Normative Annual Plant Availability Factor (NAPAF) for the station for the year.

F. Impact of Part Load Operation on Performance of Thermal Generating Stations:

1. Coal/ lignite based thermal generating stations:

i) Impact on station heat rate:

The currently applicable factors for unit heat rate degradation at part loading for sub- critical and super- critical units as notified by CERC vide its notification dated 6.4.2016 are proposed to be modified as below:

Sl. No.	Unit loading (%)	Unit HR degradation (%)	
		Sub- critical units	Super- critical units
1.	90 – 100	0	0
2.	80 - 89.99	1.3	0.9
3.	70 - 79.99	2.8	2.1
4.	60 - 69.99	4.8	3.7
5.	50 - 59.99	7.2	5.7
6.	40 - 49.99	10.0	8.0

ii) Impact on auxiliary energy consumption:

The currently admissible additional auxiliary energy consumption values at part loading of coal/ lignite based thermal generating station as notified by CERC vide notification dated 6.4.2016 are proposed to be appropriately modified as below:

Sl. No.	Module/ plant loading as % of installed capacity	Admissible % degradation in auxiliary energy consumption (% point)
1.	90 to 100	Nil

2.	80 to 89.99	0.25
3.	70 to 79.99	0.50
4.	60 to 69.99	0.80
5.	50 to 59.99	1.20
6.	40 to 49.99	1.80

2. Gas/ liquid fuel based thermal generating stations:

i) Impact on station heat rate:

The degradation of module/ plant heat rate for gas/ liquid fuel based thermal generating stations in CCGT mode of operation are proposed to be considered as below:

Sl. No.	Module/ plant loading as % of installed capacity	Increase in module/ plant heat rate (%)
1.	90 to 100	Nil
2.	80 to 89.99	2.5
3.	70 to 79.99	5
4.	60 to 69.99	8
5.	50 to 59.99	12

ii) Impact on auxiliary energy consumption:

The additional auxiliary energy consumption admissible at part loading of gas/ liquid fuel based thermal generating station is proposed to be considered as below:

Sl. No.	Plant/ module loading as % of installed capacity	Admissible % additional auxiliary energy consumption (% point)
1.	90 to 100	Nil
2.	80 to 89.99	0.25
3.	70 to 79.99	0.50
4.	60 to 69.99	0.80
5.	50 to 59.99	1.20

G. Transit losses and GCV loss of coal on storage and handling etc.:

The recommendations of the committee constituted by MoP on 26.2.2018 on the issue of ACQ of thermal power stations including for transit loss and GCV loss of coal on storage & handling etc. is given below:

a. Losses in Washing of Coal

For all power plants using washed coal with 34% ash content, additional RoM coal requirement of 7% for ash content up to 40% ±0.5% and additional RoM coal requirement of 10% for ash content beyond 40% may be considered. Further, additional RoM coal of 1% should also be given as a compensation of 1% loss of washed coal on account of addition of 1% TM (ARB) in washed coal during wet washing process.

b. Transit Loss

CERC Tariff Regulation for FY 14-19 allows transit loss of 0.8% for non-pit head plants and 0.2% for pit head plants. However, as per inputs provided by NTPC & RRVUNL, they have experienced an average transit loss of ~1.2% and ~1.5% respectively.

For the time being, the Committee feels that Transit Loss as specified by CERC in its present Tariff Regulations should be included in the consumption norms so that power plants can get compensated in terms of quantity that is lost in transit. In case above norms get modified by CERC in future tariff regulations, the prevailing norms in that regulation will be considered.

c. Loss of Energy in Storage

CEA has already recommended following recommendations to MoP and CERC related to the issue of loss of energy in storage:

i. CEA is of the view that while taking coal sample from wagon top, GCV measurement will not be representative for the whole lot due to impact of moisture change. GCV measurement of wagon top coal will give comparatively higher GCV value due to settling of moisture at the bottom of the wagon and loss of moisture from wagon top during transportation of coal. On this account, for calculating energy charge, a GCV compensation of around 70-80 kcal/kg may be allowed to the generator.
ii. CEA is of the view that there is a loss of GCV in the coal stock where coal is stored inside the power plant. On this account, for calculating energy charge, a GCV compensation of around 35 kcal/kg (on an average 1% loss for a coal of 3500 kcal/kg GCV) may be allowed to the generator for a storage of 30 days in a non-pit head station and 15 kcal/kg for pit head station.
iii. CEA is of the view that there is minor unavoidable loss of GCV in the coal during handling inside the power plant and for that purpose, a GCV compensation of around 2-3 kcal/kg may be allowed to the generator.

Further, in its inputs to MoP & CERC, CEA has suggested that above mentioned margins would vary from plant to plant, season to season and to varying coal characteristics and accordingly a margin of 85-100 kCal/kg for pit head stations and a margin of 105-120 kCal/kg for non-pit head stations may be allowed to the generators as a loss of GCV measured at Wagon top at unloading point till the point of firing in the boiler.

The committee feels that the above recommended losses in coal storage along with loss due to GCV measurement error because of wagon top sampling at plant receiving end are part of energy that needs to be supplied to the generating stations to meet the target generation and hence a quantity compensation for these losses should be provided to the stations. This quantity may be revised further as appropriate post release of revised norms by CERC.

******

Project Engineering Management

Bharat Heavy Electricals Limited
(A Govt. Of India Undertaking)

Ref: PEY-319-KKV-L026

Date: 23/09/2013

To
Sh. Samarjeet Thakur,
Manager (Contracts)
ONGC Tripura Power Company Ltd,
6th Floor, A-Wing, IFCI Tower-61,
Nehru Place, New Delhi-110019.

Sub: GCV (Gross Calorific Value) based Gross CC Station Heat Rates for 2x363.3 MW OTPC Palatana CCPP

Dear Sir,

With reference to your request for GCV (Gross Calorific Value) based Gross CC Station Heat Rates, please refer the table below:

S.No.	Load Conditions	Gross CC Station Heat Rate (kCal/kWh) GCV Based
1	Base Load, 27 Deg C Ambient, 77% RH, 0% Makeup	1670.7
2	80% CC Load, 27 Deg C Ambient, 77% RH, 0% Makeup	1735.4
3	60% CC Load, 27 Deg C Ambient, 77% RH, 0% Makeup	1872.0

Calculation Methodology:
GCV Based Heat Rate = GCV of Fuel X LCV Based Heat Rate/LCV of Fuel
GCV Of Fuel = 9203.10 kCal/m3 (As per Spec)
LCV Of Fuel = 8294.36 kCal/m3 (As per Spec)

The data given in the above table is for information purpose only.

Regards,
23/9/2013.
Sunil Kumar
Senior Engineer
BHEL

26/0343/09/13

ORIGINAL

Attachment#5 To Amendment No. 8

APPENDIX A-8

GUARANTEED PERFORMANCE AT SITE REFERENCE CONDITIONS (REFER ANNEXURE-I)

Sl. No.	EQUIPMENT	100% (BASE LOAD)		80% (BASE LOAD)		60% (BASE LOAD)	
		FIGURES	WORDS	FIGURES	WORDS	FIGURES	WORDS
I							
1	GT #1 Gross output in kW	232390	Two lac Thirty Two thousand Three hundred ninety	174900	One lac Seventy Four thousand Nine hundred	120600	One lac Twenty thousand Six hundred
2	STG #1 Gross output in kW	130910	One lac Thirty thousand Nine hundred ten	115500	One lac Fifteen thousand Five hundred	97500	Ninty Seven thousand Five hundred
3	Block #1 Gross output in kW	363300*	Three lac Sixty Three thousand Three hundred	290400	Two lac Ninty thousand Four hundred	218100	Two lac Eighteen thousand One hundred
4	Block #1 Gross Heat rate in kcal/ kW hr	1505.7	One thousand Five hundred Five point Seven	1564.0	One thousand Five hundred Sixty Four point Zero	1687.2	One thousand Six hundred Eighty Seven point Two
5	Weighted average Gross Heat Rate in kcal/kWhr	1565.4* (One thousand Five hundred Sixty Five point Four)					
II							
1	GT #2 Gross output in kW	232390	Two lac Thirty Two thousand Three hundred ninety	174900	One lac Seventy Four thousand Nine hundred	120600	One lac Twenty thousand Six hundred
2	STG #2 Gross output in kW	130910	One lac Thirty thousand Nine hundred ten	115500	One lac Fifteen thousand Five hundred	97500	Ninty Seven thousand Five hundred
3	Block #2 Gross output in kW	363300*	Three lac Sixty Three thousand Three hundred	290400	Two lac Ninty thousand Four hundred	218100	Two lac Eighteen thousand One hundred
4	Block #2 Gross Heat rate in kcal/ kW hr	1505.7	One thousand Five hundred Five point Seven	1564.0	One thousand Five hundred Sixty Four point Zero	1687.2	One thousand Six hundred Eighty Seven point Two
5	Weighted average Gross Heat Rate in kcal/kWhr	1565.4* (One thousand Five hundred Sixty Five point Four)					

1057

ONGC-Tripura Power Co. Pvt. Ltd. New Delhi

Bharat Heavy Electricals Ltd. PS-Mktg Delhi

Sl. No.	EQUIPMENT	100% (BASE LOAD)		80% (BASE LOAD)		60% (BASE LOAD)	
		FIGURES	WORDS	FIGURES	WORDS	FIGURES	WORDS
III							
1	Plant auxiliary power consumption for the entire Plant in Kw	24800*	Twenty Four thousand Eight hundred	23100	Twenty Three thousand One hundred	21700	Twenty One thousand Seven hundred
IV							
1	Guaranteed NOx for all blocks	50	Fifty	50	Fifty	50	Fifty

Note: Weighted average gross heat rate = 0.4 x base load (100%) Gross Heat Rate + 0.4 x 80% base load Gross Heat Rate + 0.2 x 60% base load Gross Heat Rate

* Only Guaranteed. Rest Data for information only.

COMPANY SEAL

SIGNATURE OF BIDDER
NAME
DESIGNATION
DATE

T. K. DAS
Sr. Dy. General Manager (Mktg.)
BHEL, Power Sector - Marketing
New Delhi

20.12.07

Bharat Heavy Electricals Ltd. PS-Mktg. Delhi

ONGC-Tripura Power Co. Pvt. Ltd. New Delhi

ONGC TRIPURA POWER COMPANY LIMITED

726.6 MW GAS BASED CCPP AT TRIPURA

CC OUTPUT & HEAT RATE CORRECTION CURVE FOR GT FIRED HOURS

DEGRADATION AT GUARANTEE POINT: 0 HRS

FOR INFORMATION ONLY

THE AGED PERFORMANCE EFFECT REPRESENTED BY THESE CURVES ARE BASED ON FOLLOWING:

1 PERFORMANCE IS RELATIVE TO THE GUARANTEE LEVEL

2 ALL COMBINED CYCLE PLANT EQUIPMENT SHALL BE OPERATED AND MAINTAINED IN ACCORDANCE WITH BHEL/GE'S RECOMMENDED PROCEDURES FOR OPERATION, PREVENTIVE MAINTENANCE, INSPECTION AND BOTH ON-LINE AND OFFLINE CLEANING

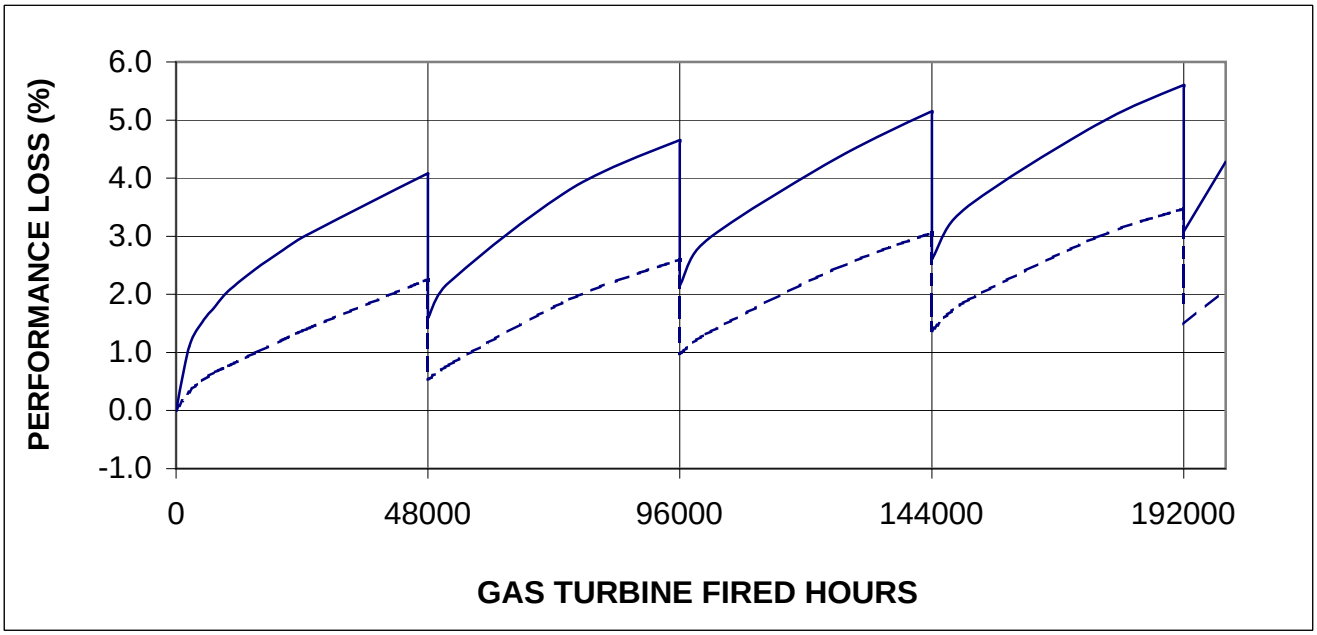
3 ALL OPERATIONS SHALL BE WITHIN THE DESIGN CONDITIONS SPECIFIED IN THE RELEVANT TECHNICAL SPECIFICATION.

4 A DETAILED OPERATIONAL LOG SHALL BE MAINTAINED FOR ALL RELEVANT OPERATIONAL DATA, TO BE AGREED TO AMONGST THE PARTIES PRIOR TO COMMENCEMENT OF CONTRACT.

5 BHEL/GE TECHNICAL PERSONNEL SHALL HAVE ACCESS TO PLANT OPERATIONAL DATA, AND SITE VISITS PRIOR TO CONDUCTING A PERFORMANCE TEST. THE OWNER WILL CLEAN AND MAINTAIN THE EQUIPMENT. THE DEGREE OF CLEANING AND MAINTENANCE WILL BE DETERMINED BASED ON THE OPERATING HISTORY OF EACH UNIT, ATMOSPHERIC CONDITIONS EXPERIENCED DURING THE PERIOD OF OPERATION, THE PREVENTIVE AND SCHEDULED MAINTENANCE PROGRAMS EXECUTED, AND THE RESULTS OF THE GE INSPECTION.

6 THE COMBINED CYCLE PLANT WILL BE SHUT DOWN FOR INSPECTION AND OFF-LINE COMPRESSOR WATER WASH, AS A MINIMUM, IMMEDIATELY PRIOR TO PERFORMANCE TESTING TO DETERMINE PERFORMANCE LOSS. THE COMBINED CYCLE PERFORMANCE TEST SHALL OCCUR WITHIN 100 FIRED HOURS OF THESE ACTIONS.

7 DEMONSTRATION OF GAS TURBINE AND COMBINED CYCLE PLANT PERFORMANCE SHALL BE IN ACCORDANCE WITH TEST PROCEDURES WHICH ARE MUTUALLY AGREED UPON.



Doc No: PE-DC-319-100-D310	PREP: ASHISH KR SINGH	**BHEL PEM**
DEPARTMENT: MSE	CHKD: AK	
Sheet 1 of 1	APPD. AK	

BABBAR SAHIL & ASSOCIATES

Chartered Accountants

TO WHOM SO EVER IT MAY CONCERN

On the basis of the information and explanations given to us by the management and based on the examination of books of accounts and other relevant records of **ONGC TRIPURA POWER COMPANY LIMITED** ("the company") **(PAN: AACCT2591G)** having its Registered Office at **Udaipur-Kakraban Road, Palatana P.O, District Gomati Udaipur, Tripura- 799105** and Delhi/Corporate office at **10TH FLOOR CORE-4 AND CENTRAL, SCOPE MINAR, LAXMI NAGAR, DELHI - 110092**,

we certify the following information related to O&M Expenses:

						Amount in Rs. Lakhs
S. No.	**Particulars**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**
1	**2**	**3**	**4**	**5**	**7**	**8**
1	**O&M expenses under Reg.35(1) (₹ Lakhs Per MW)**	26.34	27.27	28.23	29.22	30.24
1a	Normative (726.6 MW Capacity)#	19,138.64	19,814.38	20,511.92	21,231.25	1,972.38
2	**O&M expenses under Reg.35(6)**					
2a	Water Charges*	3.96	(1.06)	10.04	3.71	5.14
2b	Secutiry expenses*	760.40	741.83	857.10	987.31	1,156.18
2c	Capital Spares*	295.48	1,740.07	571.12	317.80	1,588.63
3	O&M expenses-Ash Transportation*	-	-	-	-	-
4	Additional O&M Expenses*	-	-	-	-	-
	Total O&M Expenses (1a+2a+2b+2c+3+4)	**20,198.48**	**22,295.22**	**21,950.18**	**22,540.07**	**24,722.33**

*Based on the Expenses incurred during the year i.e. the Net Amount debited/(Credited) in the Books of Accounts under the relevant expense head.

#Based on the O&M Expenses under Reg. 35(1) (₹ Lakhs Per MW) for 726.6 MW Capacity.

Notes:

(i) The above information is as per the ledgers and other records provided to us by the management and relied upon by us.

(ii) This certificate has been issued on specific request of the management of the Company for onward submission to CERC for Tariff Petition.

For Babbar Sahil & Associates
Chartered Accountants
FRN- 036253N

Sahil Babbar

Babbar Sahil & Associates * Chartered Accountants * FRN.036253N DELHI

Sahil Babbar
(Partner)
M. No. 546433
UDIN: 24546433BKHLFK8103
Date: 28th November 2024
Place: New Delhi

PROFESSIONAL TECHNICAL REVIEW

REPORT-2017

On

The Plant Operations, Processes and related Reliability, Safety, and Efficiency of OTPC Power Plant

at

Palatana, Gomati Tripura, India.

JOB ENTRUSTED BY

The Dy. General Manager (Mechanical),
Kakraban Road,
P.O: Palatana, P.S: Kakraban,
Gomati District, Gomati Tripura,
PIN:- 799116

JOB CONDUCTED BY

Er. M. K. Deb
Chartered Engineer (India),
Dhaleswar, Road No. 15,
Agartala, West Tripura,
PIN: 799001.
E-mail: mkdebindia@gmail.com, M- (+91) 9436139749

Job No- *MKD/CE/OTPC/11/072017*

PREFACE

A Detailed Professional Technical Review has been conducted on the Plant Operations & Processes in ONGC Tripura Power Company Limited (OTPC) at Palatana Power Plant, Gomati Tripura in reference to the letter No. OTPC/UDP/Palatana/17-18/100(A) dated 15th May, 2017. OTPC (hereinafter read as the Client), has entrusted undersigned (Expert Consultant/Reviewer) for the said job. The purpose of the report is to recommend a suitable measures and review salient proposals as framed to address issues related to salient operations for better reliability, efficiency, and safety of OTPC Palatana Plant.

This report comprises 61 pages covering 15 Nos. of chapters addressing 15 critical issues, and accordingly recommendations are made. The work is a commercial activity to meet the target time of the project for the client, there may be some lacuna found if any is purely unintentional and advance apologized.

It is expected that the client will comply with the recommendations given in this report during the maintenance of the said power plant of OTPC. Any deviation without written confirmation from the consultant, if conducted at the implementation stages, the responsibilities of the consultant will cease to exist.

27/06/2017

Er. Malay Kumar Deb
Chartered Engineer (India),
014403/AM093054-5
Dhaleswar, Road No. 15,
Agartala, West Tripura, 799001.

27/06/2017

Er. M. K. Deb
Chartered Engineer (India)
014403 / AM093054-5
Issued by :-
The Institution of Engineers (India)

Table of Contents

CHAPTER-1 *(Vibration Monitoring System)*

PROBLEM AREA:- Unit 1 and 2 Cooling Tower Fans

EQUIPMENT/SYSTEM:- Vibration Monitoring System for Unit 1 and 2 CT Fan

1. Introduction

The cooling tower fans of Unit 1 and Unit 2 at OTPC have been experiencing recurring bearing failures. These failures have been linked to high levels of vibrations, which negatively impact the overall performance and reliability of the fans. Ensuring the efficient and continuous operation of these cooling tower fans is critical, as any failure can lead to system downtime and cause potential disruptions in power generation. This chapter aims to review the existing situation, analyze the cause of failures, and propose the necessary measures to mitigate this risk.

2. Scope of Works

This review covers:

- A review of the historical incidents of bearing failures in the cooling tower fans of Unit 1 and Unit 2.
- Identification of the root cause of these failures, specifically related to vibrations.
- Evaluation of existing monitoring systems and procedures for cooling tower fan maintenance.
- Corrective actions, including the installation of a vibration monitoring system, to enhance the reliability and performance of the cooling tower fans.

3. Observations

- Past incidents of bearing failures have been attributed to excessive vibrations in the cooling tower fans.
- Vibration levels in the cooling tower fans were found to exceed recommended thresholds, especially during operational cycles.
- There were no dedicated systems in place for real-time vibration monitoring of the cooling tower fans.
- Bearing failures resulted in unplanned downtime, affecting both units' operational efficiency and maintenance schedules.

27/06/2017.

Er. M. K. Deb
Chartered Engineer (India)
014403 / AM093054-5
Issued by :-
The Institution of Engineers (India)

4. Analysis

Why:

- The cooling tower fans are critical components in maintaining the operational stability of the plant, as they are responsible for cooling the steam turbine's circulating water. Bearings in cooling tower fans are susceptible to mechanical stress and excessive vibrations, which can lead to premature failure.
- Inadequate monitoring of vibration levels increases the risk of unnoticed wear and tear in fan components, particularly the bearings. This results in mechanical failures and operational inefficiencies.
- Cooling tower fans operate under dynamic loads, particularly those in large industrial settings like OTPC. Over time, these can cause misalignment, imbalance, and increased stress on rotating components, leading to significant vibration levels.

How:

- The high vibration levels in the fans are often caused by imbalances in the fan blades, misalignment of components, or wear and tear of the bearings. These vibrations put stress on the bearings, leading to premature failure.
- Vibration monitoring systems provide real-time data on vibration levels across different components, enabling the early identification of abnormal vibrations. It helps to detect imbalances, misalignments, and potential bearing damage before they lead to failure.
- Vibration sensors installed on crucial components such as bearings, motor shafts, and blades allow the system to track the operational state of the fans continuously. Early detection of unusual vibration patterns can prompt maintenance teams to perform corrective actions, such as balancing or alignment, before severe damage occurs.

5. Recommendations

i. **Install Vibration Monitoring System:** A dedicated vibration monitoring system for the cooling tower fans gearboxes in both Unit 1 and Unit 2 is recommended. This system will continuously monitor vibration levels and provide real-time data on the operational health of the fan's gearbox bearings.

ii. **Vibration Thresholds and Alerts:** Set vibration thresholds that, when exceeded, trigger alerts for the maintenance team to investigate and take corrective action. This can prevent further damage by addressing imbalances or misalignments before they lead to bearing failures.

iii. **Periodic Maintenance and Calibration:** Incorporate routine checks and calibrations of the vibration monitoring system to ensure accurate data collection and early detection of faults. This will help maintain the longevity of the cooling tower fans and reduce unexpected downtime.

iv. **Proactive Corrective Actions:** Based on the data from the vibration monitoring system, the maintenance team should prioritize actions such as rebalancing the fan blades, realigning components, and replacing worn-out bearings. This will prevent failures and improve the fans' energy efficiency and overall performance.

6. Conclusion

The recurring bearing failures in the cooling tower fans of Unit 1 and Unit 2 have been primarily caused by excessive vibrations. The lack of a dedicated monitoring system has hindered early detection and timely corrective actions. By implementing a vibration monitoring system, OTPC can proactively manage vibration levels, reduce mechanical stress on critical components, and extend the operational lifespan of the cooling tower fans. This system will ultimately enhance the reliability of the fans, reduce maintenance costs, and prevent unplanned downtime, contributing to more efficient and uninterrupted plant operations.

CHAPTER-2 *(VFD Panel for 30 KW LPBFP)*

AREA:- Low Pressure Boiler Feed Pumps

EQUIPMENT/SYSTEM:- VFD Panel for 30 KW LPBFP

1. Introduction

The power plant's low-pressure boiler feed pump (LPBFP) currently operates with a motor at a constant speed. As a result, the output is regulated by throttling in the Low Pressure Feed Control stations. This inefficient method of controlling output leads to unnecessary energy consumption and wear on components due to throttling loss. A Variable Frequency Drive (VFD) can provide a more efficient solution by adjusting the speed of the LPBFP motor according to the required output. This chapter reviews the current operational inefficiency and installing VFDs to optimize energy consumption and improve operational efficiency.

2. Scope of Works

This scope covers:

- A review of the plant's operational efficiency of the Low-Pressure Boiler Feed Pump (LPBFP).
- Analysis of current pumping and throttling practices.
- Evaluation of the potential benefits of installing a Variable Frequency Drive (VFD) for the LPBFP.
- Assessment of the energy savings and operational improvements that could be achieved by adopting VFD technology.

3. Observations

- The LPBFP operates with a constant speed motor, which results in a fixed output irrespective of demand and, hence, constant energy consumption.
- Output control is achieved by throttling the flow in the Low-Pressure Feed Control stations, which is inefficient and consumes more power.
- The throttling process leads to energy losses due to the pressure drop and mechanical wear on valves and other components.
- There is no current system in place to adjust the speed of the pump based on the variable load

conditions, leading to excessive energy consumption during part-load operations.

4. Analysis

Why:

- The LPBFP is crucial for supplying water to the boiler at the desired pressure, but its current operation with a constant-speed motor is inefficient. Throttling the output by reducing the flow restricts the plant's ability to operate efficiently, especially during low-load conditions.
- The energy consumption associated with constant speed pumping and throttling results in excessive power consumption. During part-load operation, the system still consumes the same amount of energy despite the reduced output.
- The throttling method causes pressure drops in the system, further wasting energy and placing unnecessary strain on mechanical components like valves and control systems.

How:

- Installing a Variable Frequency Drive (VFD) on the LPBFP motor allows the pump speed to be adjusted according to demand. VFD technology enables the pump to operate at the optimal speed, directly correlating the motor speed with the required flow and pressure.
- A VFD-controlled pump will provide a more precise and energy-efficient solution, eliminating the need for throttling and reducing auxiliary power consumption. By adjusting the speed, the pump can deliver the required output, thus reducing overall energy consumption and enhancing system efficiency.
- The reduction in pump speed will directly reduce the motor's power consumption, resulting in significant energy savings, particularly during part-load conditions when the demand for boiler feed water is lower.

5. Recommendations

i. **Install VFD for Low-Pressure Boiler Feed Pump:** It is recommended that a Variable Frequency Drive (VFD) be installed on the 30 kW motor of the Low-Pressure Boiler Feed Pump (LPBFP). This will allow for precise pump speed control according to the operational requirements.

ii. **Optimize Energy Use:** The VFD will help optimize energy use by adjusting the motor speed to match the required output, thereby avoiding unnecessary throttling and reducing auxiliary power consumption.

iii. **Regular Monitoring and Calibration:** Once the VFD is installed, it is recommended to

establish a regular monitoring and maintenance program to ensure that the system operates efficiently and that the VFD is calibrated to provide the best energy savings.

iv. **System Integration:** Ensure that the VFD is integrated with the plant's control systems to allow seamless communication and coordination between the pump operation and other plant processes.

6. Conclusion

The current operation of the Low-Pressure Boiler Feed Pump with a constant speed motor and throttling control is inefficient and leads to higher energy consumption. Installing a Variable Frequency Drive (VFD) on the pump motor is a cost-effective solution that will optimize energy use by adjusting the pump speed to match operational demand. This will reduce power consumption, extend the life of mechanical components, and improve the plant's overall efficiency. The proposed VFD installation will result in significant energy savings, especially during part-load operations, and contribute to the plant's sustainability efforts by reducing operational costs.

CHAPTER-3 (*Online Moisture Removal System)*

AREA:- Inter Connecting Transformers and Line Reactors

EQUIPMENT/SYSTEM:- Online Moisture Removal System

1. Introduction

This chapter evaluates the inter-connecting transformers (ICTs) and line reactors at the OTPC Palatana Plant, emphasizing their reliability, moisture management, and maintenance practices under extreme operating conditions.

2. Scope of Works

This scope covers:

- The performance of ICT-1, ICT-2, Line Reactor-1, and Line Reactor-2 transformers.
- Moisture management and its impact on insulation longevity.
- Existing condition monitoring systems and potential improvements.

3. Observations

- *Transformer Fleet:* Four out of eleven transformers are subjected to high load variations due to line fault surges, leading to stress on insulation materials.
- *Condition Monitoring:* Online transformer condition monitoring systems are installed for generator transformers but not for ICT-1, ICT-2, Line Reactor-1, and Line Reactor-2.
- *Moisture and Acidity Issues:* Moisture release from cellulose decomposition, combined with carboxylic acid formation, accelerates insulation degradation and affects dielectric properties.
- *Current Maintenance Gaps:* Traditional oil filtration systems are insufficient to remove dissolved moisture, which requires advanced, continuous removal techniques.

4. Analysis

Why:

- *Impact on Insulation Longevity:* Moisture accelerates cellulose aging, reducing transformer insulation's mechanical strength and dielectric properties. Over time, this increases the risk of dielectric breakdowns and catastrophic failures.

- *Load Variation Effects:* Extreme load surges caused by line faults release additional moisture due to thermal stress, compounding the risk of failures. This is particularly critical for ICT-1, ICT-2, and the line reactors exposed to such conditions.
- *Traditional Maintenance Limitations:* Conventional oil filtration systems only remove free water, not dissolved or bound moisture. This creates a long-term risk of insulation weakening even with regular maintenance cycles.

How:

- *Continuous Monitoring:* These systems provide real-time moisture content data, allowing operators to take proactive corrective actions.
- *Enhanced Moisture Removal:* Unlike traditional systems, advanced adsorption technologies remove both dissolved and free moisture. This ensures a stable operating environment for the transformers.
- *Reliability Gains:* These systems reduce insulation stress by maintaining optimal moisture levels, enhancing transformer reliability, and extending operational lifespan.

5. Recommendations

the following measures are recommended to mitigate the identified risks and improve system reliability, Procure and Install Online Moisture Removal Systems:

- Install advanced moisture removal systems for ICT-1, ICT-2, Line Reactor-1, and Line Reactor-2 to ensure continuous moisture control.

ii. *Expand Online Monitoring Infrastructure:*

- Extend the online transformer condition monitoring system to include the switchyard transformers for comprehensive asset management.

iii. *Integrate Moisture Control in Maintenance Protocols:*

- Incorporate routine diagnostics using online data to proactively address moisture-related issues.

iv. *Conduct Training and Awareness Programs:*

- Train maintenance personnel on the use and benefits of online moisture removal and monitoring systems.

6. Conclusion

Effective moisture management is critical for transformer reliability, especially under extreme load conditions. Installing online moisture removal systems and extending monitoring capabilities will enhance operational efficiency, reduce unplanned outages, and ensure the long-term stability of the OTPC Palatana Plant's power transformers.

CHAPTER-4 (*Self-Propelled Diesel Articulated Boom Lift)*

AREA:- Safe working at heights for maintenance, painting etc.

EQUIPMENT/SYSTEM:- Self-Propelled Diesel Articulated Boom Lift

1. Introduction

This chapter evaluates the safety practices and equipment used for height-related tasks at the OTPC Plant's 400 KV and 132 KV switchyards. The aim is to identify risks and recommend measures to improve worker safety and operational efficiency.

2. Scope of Works

This scope covers:

- Maintenance practices for switchyard equipment and lighting.
- Worker safety during height-related tasks.
- Existing equipment and operational challenges.

3. Observations

i. *Switchyard Infrastructure:*
  - The plant operates 400 KV and 132 KV switchyards with equipment heights ranging from 7 to 16 meters.
  - Maintenance requires direct climbing on porcelain bushings using safety belts, posing significant fall risks.

ii. *Lighting Maintenance:*
  - Streetlights at approximately 15.5 meters and outdoor building lights require frequent maintenance, which is challenging and unsafe with current practices.

iii. *Safety Risks:*
  - Despite safety precautions, the absence of proper height-access equipment increases the likelihood of falls and injuries.
  - Current practices are inefficient, unsafe, and time-consuming, with potential delays in maintenance.

iv. *Ease of maintenance:* Current practices are insufficient to provide an environment of ease of

maintenance to the workforce.

4. Analysis

Why *Current Practices Are Inadequate*

i. *Risk of Falls:* Climbing directly on equipment lacks stability and exposes workers to a high risk of falls, even when using safety belts.
ii. *Operational Inefficiency:* Manual climbing slows down maintenance tasks, increasing downtime for critical equipment and lighting systems.
iii. *Limited Versatility:* Current methods are unsuitable for tasks requiring frequent movement between heights or over extended areas.

How *a Self-Propelled Diesel Articulated Boom Lift Addresses These Issues*

i. *Enhanced Safety:*
- Provides stable platforms with guardrails, significantly reducing fall risks during height-related tasks.
- Built-in safety features, such as emergency stops and anti-tip mechanisms, further ensure worker protection.

ii. *Improved Efficiency:*
- Enables faster and more accurate completion of tasks by providing easy access to multiple points without manual climbing.
- Reduces worker fatigue, enhancing productivity.
- It can carry sufficient and right tools to work at the point.

iii. *Versatility:*
- Suitable for multiple applications, including switchyard equipment maintenance, streetlight servicing, outdoor building light repairs, crane repair, and civil department tasks like painting structures with height, tree cutting, and cleaning of bushes.

5. Recommendations

i. *Procurement of Self-Propelled Diesel Articulated Boom Lift:*
- Acquire a man lifter designed to operate at heights of up to 16 meters for use in the switchyard and other height-related tasks.

ii. *Integration into Maintenance Protocols:*
- Incorporate the man lifter into routine maintenance schedules for streetlights, switchyard equipment, and building lights.

iii. *Training for Safe Usage:*

- Train maintenance and civil department staff in operating and maintaining the boom lift to maximize safety and efficiency.

iv. *Periodic Safety Audits:*

- Conduct regular reviews of height-related maintenance practices to ensure continued compliance with safety standards.

6. Conclusion

The adoption of a self-propelled diesel articulated boom lift will significantly enhance safety for workers performing height-related tasks while improving operational efficiency across the OTPC Plant. This investment will reduce fall risks, streamline maintenance activities, and ensure uninterrupted plant operations.

CHAPTER-5 (*Generator Flux monitoring)*

AREA:- Generators

EQUIPMENT/SYSTEM:- Generator Flux monitoring

1. Introduction

This chapter evaluates the current health monitoring systems for gas turbine generators at OTPC, focusing on monitoring rotor and shaft conditions in real-time, and plans corrective maintenance of generators before catastrophic failure. The recommendations address potential risks associated with rotor flux and shaft voltage to enhance generator reliability and prevent failures.

2. Scope of Works

This scope covers:

- Existing generator health monitoring practices.
- Risks associated with rotor flux and shaft voltages.
- Mitigation measures to prevent rotor and bearing failures.

3. Observations

i. *Recent Rotor Failure:*
- Unit-1 Gas Turbine generator experienced rotor failure, highlighting gaps in monitoring capabilities.

ii. *Existing Monitoring Systems:*
- Does not have rotor flux and shaft voltage monitoring features.

iii. *Shaft Voltage Risks:*
- Shaft voltages, induced by various operational and design factors, pose risks to bearings, oil seals, and lubrication systems.
- High shaft voltages (up to 150 V AC or 200 V spikes) can lead to uncontrolled shaft currents, causing damage to the Generator rotor.

iv. *Root Causes of Shaft Voltages:*
- Rotor winding ground faults or excitation system spikes.
- Magnetic asymmetry due to design, manufacturing defects, or stator core faults.
- Axially magnetized parts of turbines and generators.

- Electrostatic effects from steam or lubricants.

v. *Grounding and Insulation Challenges:*

- Bearings and oil films currently act as insulation but are insufficient without proper shaft grounding and monitoring.

4. Analysis

Why *Advanced Monitoring is Necessary*

i. *Rotor Health:* Rotor flux monitoring allows early detection of abnormalities in the magnetic field, preventing rotor failures.

ii. *Shaft Voltage Control:* Unmonitored shaft voltages can result in bearing pitting, oil seal damage, and altered lubrication properties, leading to premature equipment wear or failure.

iii. *Preventive Maintenance:* Shaft monitoring systems can alert operators to issues such as poor grounding performance or the presence of high voltages, enabling timely corrective action.

How the Recommended Systems Address the Issues

i. *Rotor Flux Monitoring:*

- Provides real-time data on rotor magnetic flux, ensuring early detection of potential faults.
- Enhances overall rotor oversight, reducing the likelihood of catastrophic failures.

ii. *Shaft Voltage Monitoring and Grounding:*

- Monitors voltage levels and alerts operators to grounding failures or high shaft voltages.
- Minimizes shaft currents by ensuring proper grounding using high-performance brushes (e.g., carbon, silver, or copper).
- Prevents bearing damage, oil degradation, and potential system downtime.

5. Recommendations

i. *Install Rotor Flux Monitoring Systems:*

- Enhance generator health monitoring by introducing rotor flux sensors for all gas turbine generators.

ii. *Implement Advanced Shaft Monitoring Systems:*

- Install shaft voltage monitoring instruments to track voltage levels and grounding efficiency.

- Ensure the system detects:
  - Poor grounding brush performance.
  - Presence of additional grounds.
  - High voltage spikes or AC components on the shaft.

iii. *Upgrade Grounding Mechanisms:*

- Use high-performance grounding brushes (carbon, silver, or copper) for effective voltage dissipation.
- Insulate one or both generator shaft bearings to minimize current flow through bearings.

iv. *Conduct Periodic Testing:*

- Regular testing and maintenance of shaft grounding devices shall be performed to ensure optimal performance.

v. *Staff Training:*

- Train maintenance personnel on using and interpreting rotor flux and shaft monitoring systems for effective fault management.

6. Conclusion

Introducing rotor flux and shaft voltage monitoring systems will significantly improve generator health monitoring at OTPC. Combined with robust grounding mechanisms, these systems will enhance operational reliability, reduce risks of rotor and bearing failures, and extend the generator's lifespan.

CHAPTER-6 (*Portable Generator Set with accessories)*

AREA:- Safety during welding

EQUIPMENT/SYSTEM:- Portable Generator Set with accessories

1. Introduction

This report evaluates welding practices at the OTPC Palatana Plant, identifying safety risks and inefficiencies caused by reliance on nearby SLPs (Substation Lighting Panels). Recommendations aim to enhance safety and operational flexibility through the introduction of a Portable Generator Set.

2. Scope of Works

This report covers:

- Current welding practices and associated safety hazards.
- Power dependency for welding and auxiliary tasks at remote locations.
- Equipment and logistical challenges in executing welding tasks safely.

3. Observations

i. *Current Practices:*

- Welding tasks are conducted by connecting to the nearest SLP, which increases the risk of electrical hazards, including short circuits and equipment overloads.
- SLP dependency limits operational flexibility, especially for tasks in remote areas like the 18-nos watchtowers, helipad area, river water pump house etc.

ii. *Safety Risks:*

- Using SLPs for welding poses potential risks, such as:
  - Overloading SLP circuits.
  - Electrical shocks due to improper connections.
  - Proximity hazards for operators working near live electrical systems.

iii. *Remote Area Challenges:*

- Watchtowers and other remote locations lack easy access to stable and safe power sources, hindering the efficient execution of welding and auxiliary tasks.

iv. *Power Reliability Issues:*

- Welding activities at critical locations face delays or interruptions due to inconsistent power availability from SLPs.

4. Analysis

Why Current Practices Are Unsafe and Inefficient

i. *Safety Hazards:*

- Connecting welding equipment directly to SLPs bypasses essential safety mechanisms, increasing the risk of electrical accidents.

ii. *Operational Constraints:*

- The limited reach of SLPs reduces flexibility in performing welding tasks at remote sites like watchtowers, leading to inefficiencies.

iii. *Power Dependency:*

- Relying on fixed power sources for mobile tasks creates logistical challenges and delays, especially in emergencies.

How a Portable Generator Set Addresses These Issues

i. *Improved Safety:*

- Eliminates direct connections to SLPs, reducing risks of electrical overloads and shocks.
- Provides a controlled and isolated power source, enhancing operator safety.

ii. *Enhanced Flexibility:*

- Enables welding tasks and auxiliary power supply at remote locations without dependency on fixed infrastructure.

iii. *Reliable Backup Power:*

- A portable diesel generator offers up to 8–10 hours of uninterrupted power, ensuring efficient task completion even during power outages.

iv. *Multi-Purpose Utility:*

- Powers both welding machines and auxiliary equipment, streamlining operations at remote and inaccessible sites.

5. Recommendations

i. *Procurement of Portable Generator Set:*

- Acquire a diesel-powered portable generator with a capacity sufficient for welding and auxiliary power requirements.

ii. *Integration into Maintenance Operations:*

- Utilize the generator for tasks at remote locations, including the 18 nos watchtowers, helipad area, river water pump house etc, ensuring safe and flexible operations.

iii. *Operator Training:*

- Train staff on safe operation and maintenance of the portable generator to maximize efficiency and safety.

iv. *Periodic Safety Inspections:*

- Regular generator and welding accessories inspections shall be conducted to ensure continued compliance with safety standards.

v. *Emergency Preparedness:*

- Use the portable generator as a reliable backup during power outages to avoid operational delays.

6. Conclusion

Introducing a portable diesel generator set will significantly enhance safety during welding operations by eliminating unsafe SLP dependencies. It will also improve operational flexibility and efficiency across the OTPC Palatana Plant, particularly in remote areas like watchtowers, ensuring reliable power for welding and auxiliary tasks.

CHAPTER-7 (*Cable position locator and fault locator*)

AREA:- Cable position locator and fault locator for safety purposes

EQUIPMENT/SYSTEM:- Cable position locator and fault locator

1. Introduction

This chapter evaluates the current methods to detect and identify underground and overground cables at the OTPC Palatana Plant, mainly focusing on the safety risks involved in excavation, jungle cutting, and construction activities. The report recommends procuring and using a Cable Position Locator and Fault Locator to address identified safety concerns and improve operational efficiency.

2. Scope of Works

This report covers:

- The current cable identification process for excavation and construction work.
- Safety risks associated with cable identification in dense jungle areas and underground cable tracing.
- The effectiveness of existing practices in preventing accidents and improving work safety.

3. Observations

i. *Safety Risks and Near-Miss Incidents:*
  - Several near-miss incidents where unidentified cables led to potential accidents during excavation and construction activities were recorded.
  - The risk of damaging live cables, especially in dense jungle areas or underground settings, is a critical safety concern for personnel and equipment.

ii. *Challenges in Cable Detection:*
  - Identifying overground cables in dense jungle areas is extremely challenging due to the thick vegetation and natural obstructions.
  - Tracing underground cables without the proper equipment is virtually impossible, leading to unsafe working conditions and unplanned disruptions.

iii. *Lack of Proper Detection Instruments:*
  - Currently, no reliable tool is in place for locating and tracing cables, which increases

the likelihood of human error and undetected risks.

4. Analysis

Why the Current Practices Are Inadequate

i. *Safety Hazards:*
- The risk of accidental cable damage or electrocution during excavation work is high without accurate detection tools. This compromises worker safety and poses operational risks.

ii. *Operational Inefficiency:*
- Manual methods of locating cables or relying on memory and maps are prone to errors, causing delays and inefficiencies in construction or modification tasks.

iii. *Limited Risk Mitigation:*
- Current practices do not adequately mitigate the risk of accidental cable hits or damage during activities like jungle cutting, excavation, and construction, putting both personnel and equipment at risk.

How the Cable Position and Fault Locator Can Address These Issues

i. *Accurate Cable Detection:*
- The proposed "Underground/Overground Cable Locator" can detect both live and dead cables, whether underground or overground, with a detection depth of up to 3 meters. This significantly improves the accuracy of cable identification.

ii. *Enhanced Safety:*
- By providing precise location data for cables, this equipment helps prevent accidental cable damage, reducing the risk of electrocution and fires during excavation or construction activities.

iii. *Efficient Fault Tracing:*
- The device can also detect faults along the cable path, alerting operators to potential issues and reducing the risk of unplanned downtime or equipment failure.

iv. *Sound Alert Mechanism:*
- The integrated buzzer or beep mechanism will immediately indicate cable faults, further enhancing safety during excavation or construction tasks.

v. *Regulatory Compliance:*
- With the ability to accurately locate and trace cables, the equipment will assist in issuing

valid "Excavation Work Permits," ensuring compliance with safety regulations.

5. Recommendations

i. *Procure an Underground/Overground Cable Locator:*

- Invest in a high-quality cable position and fault locator capable of detecting both live and dead cables at depths of up to 3 meters.

ii. *Integrate into Standard Operating Procedures (SOPs):*

- Implement the cable locator as a mandatory tool for all excavation, jungle cutting, and construction-related tasks to identify and trace all cables before work begins.

iii. *Training for Personnel:*

- Provide training for maintenance and construction staff on properly using the cable locator, ensuring accurate and safe cable detection.

iv. *Regular Safety Inspections:*

- Incorporate the cable locator as part of routine safety checks and audits for all high-risk work areas where cable identification is critical.

v. *Periodic Calibration and Maintenance:*

- Establish a regular maintenance schedule for the cable locator to ensure its optimal functioning and accuracy in cable detection.

6. Conclusion

Introducing the Underground/Overground Cable Locator and Fault Locator will significantly enhance the safety and efficiency of excavation, jungle cutting, and construction activities at the OTPC Palatana Plant. The equipment will reduce the risk of accidents related to cable strikes, improve operational productivity, and facilitate the safe issuance of excavation permits, ensuring a safer working environment for all personnel.

CHAPTER-8 (*Mobile Foam Trolley)*

AREA:- Fire and Safety

EQUIPMENT/SYSTEM:- Mobile Foam Trolley

1. Introduction

This chapter evaluates the need for a Mobile Foam Trolley as an essential addition to OTPC Palatana Plant's fire safety infrastructure. The report highlights the rationale for the recommendation based on operational needs, regulatory compliance, and risk mitigation.

2. Scope of Works

This report covers:

- The current fire safety measures are in place at the OTPC plant.
- The fire hazards associated with gas-based operations include hydrocarbon and liquid fires.
- The adequacy of existing fire suppression equipment and the need for a Mobile Foam Trolley.

3. Observations

i. *Current Fire Safety Equipment:*

- The plant is equipped with general fire suppression systems, which may not be fully effective against specific hazards posed by gas-based operations and hydrocarbon fires.

ii. *Regulatory and Legal Requirements:*

- Fire safety regulations, including those specific to gas-based operations, mandate the availability of specialized fire-fighting equipment, such as foam systems, to address the heightened risks.

iii. *Operational Hazards:*

- OTPC Palatana Plant handles highly flammable gases, including natural gas, which significantly increases the risk of fire. Conventional fire extinguishing methods may not be sufficient in such environments, highlighting the need for foam-based suppression systems.

iv. *Response Time and Mobility Issues:*

- The plant contains several zones, some of which may be remote or difficult to access

quickly. Without highly mobile fire-fighting equipment, response times during fire emergencies may be delayed, increasing the potential for fire spread and damage.

4. Analysis

Why the Current Fire Safety Measures are Inadequate

i. *Ineffectiveness Against Hydrocarbon Fires:*
- Conventional fire extinguishers are often ineffective in suppressing fires caused by hydrocarbons or flammable gases. Foam-based suppression systems are better suited to handle these specific types of fires, especially in environments like gas power plants.

ii. *Response Time and Plant Layout Challenges:*
- Existing fire safety measures may not be quickly deployable in remote or difficult-to-reach areas. This can lead to delays in addressing fire incidents, increasing the potential for substantial damage and prolonged operational downtime.

iii. *Non-Compliance with Regulatory Standards:*
- Inadequate fire suppression equipment, especially for dealing with gas and hydrocarbon fires may result in non-compliance with industry safety regulations and standards.

How a Mobile Foam Trolley Will Address These Issues

i. *Enhanced Fire Safety for Gas-Based Operations:*
- The Mobile Foam Trolley provides rapid deployment of foam, a proven method for suppressing fires involving hydrocarbons, natural gas, and oil by-products. This will significantly improve OTPC's ability to handle such specific fire types.

ii. *Improved Mobility and Response Time:*
- Its mobility allows quick movement across the plant, ensuring fire suppression can be initiated immediately, especially in hard-to-reach or remote areas like the watchtowers and control rooms.

iii. *Regulatory Compliance:*
- A Mobile Foam Trolley meets fire safety requirements specific to gas-based industries, helping OTPC comply with local regulations and international safety standards.

iv. *Minimized Damage and Downtime:*
- Early foam application can significantly reduce the extent of fire damage, thereby minimizing the downtime associated with fire-related disruptions and protecting plant assets.

v. *Employee Safety and Confidence:*

- The presence of advanced fire-fighting equipment increases employee confidence, knowing that effective and specialized systems are in place to handle fire emergencies swiftly.

vi. *Cost-Effectiveness:*

- The Mobile Foam Trolley is a cost-effective long-term solution despite an initial investment cost. It will likely reduce major fire damage and downtime expenses while ensuring operational continuity.

5. Recommendations

i. *Procurement of Mobile Foam Trolley:*

- Acquire a Mobile Foam Trolley equipped with the necessary foam application systems capable of handling fires caused by hydrocarbons and other flammable gases.

ii. *Integration into Fire Safety Protocols:*

- Integrate the Mobile Foam Trolley into existing fire safety protocols, ensuring its availability during high-risk activities and in fire-prone areas of the plant.

iii. *Employee Training on Foam Usage:*

- Provide training for emergency response personnel on the proper use of the Mobile Foam Trolley, focusing on quick deployment, foam application techniques, and emergency response procedures.

iv. *Periodic Maintenance and Inspection:*

- Establish a regular maintenance and inspection schedule for the Mobile Foam Trolley to ensure that it is always in optimal working condition when required.

v. *Review of Fire Safety Strategy:*

- Incorporate the Mobile Foam Trolley into the broader fire safety strategy, considering potential hazards in plant operations and ensuring the appropriate level of fire suppression resources across all zones.

6. Conclusion

Introducing a Mobile Foam Trolley at OTPC Palatana Plant is crucial to enhancing fire safety, ensuring compliance with regulations, and improving operational efficiency. By providing quick and effective fire suppression for hydrocarbon and gas-related fires, the Mobile Foam Trolley will protect plant assets and safeguard employees' health and safety. This investment will reduce the risk of catastrophic damage, minimize downtime, and boost overall operational resilience.

CHAPTER-9

AREA:- Fire and Safety

EQUIPMENT/SYSTEM:- Portable fire pump

1. Introduction

This report assesses the current fire safety provisions at OTPC Palatana Plant, focusing on addressing the plant's specific fire risks, particularly in oil-related installations. The audit examines the adequacy of current fire fighting equipment, including fire tenders, and provides recommendations for improving fire suppression capabilities by introducing foam trolleys and portable fire pumps. These additions will enhance the plant's ability to effectively manage fires, especially oil-related fires, in areas that may be difficult to reach with the existing equipment.

2. Audit Scope

This report covers on:

- Assessing the existing fire fighting equipment (fire tenders) and their suitability for fighting oil fires.
- Identifying gaps in foam-making capabilities for oil-related fire hazards.
- Reviewing the need for portable fire pumps and foam trolleys to address areas where fire tenders cannot reach.
- Providing recommendations to improve fire fighting capabilities and ensure compliance with safety regulations.

3. Observations

i. *Current Fire Fighting Equipment:*

- OTPC Palatana Plant currently operates two water-type fire tenders, which are not equipped with foam-making arrangements.
- While effective for general fire-fighting, fire tenders are not fully equipped to address the specific needs of oil fires, which require foam-based suppression.

ii. *Oil Installations in the Plant:*

- The plant includes oil installations, which present a higher risk of oil fires that cannot

be efficiently extinguished using water alone. Conventional fire tenders without foam are inadequate for addressing these fire types.

iii. *Access Challenges in Emergency Situations:*

- In some emergency-situations, fire tenders may not be able to reach certain parts of the plant, particularly in areas with limited access or with obstructions such as dense infrastructure or rugged terrain.

iv. *Need for Foam and Portable Fire Pumps:*

- Foam is essential for tackling oil fires effectively, and portable fire pumps with foam-making capabilities are needed to provide greater flexibility in responding to fire incidents in hard-to-reach areas.

4. Analysis

Why the Current Equipment is Inadequate

i. *Inability to Tackle Oil Fires:*

- The water-type fire tenders lack foam-making equipment, rendering them ineffective against oil fires or flammable liquid fires. Water can spread oil fires rather than extinguish them, which poses a severe risk in oil installation areas.

ii. *Limited Reach of Fire Tenders:*

- Despite their capacity, fire tenders may not always be able to access every area within the plant, particularly in the event of a widespread fire or in areas where the infrastructure prevents easy access.

iii. *Lack of Foam-Making Arrangement:*

- Without foam-making equipment (such as foam branches, inline inductors, and foam compounds), the fire tenders are ill-equipped to suppress fires involving flammable liquids, a key concern in a plant with oil installations.

How Portable Fire Pumps and Foam Trolleys Will Address These Issues

i. *Enhanced Foam Suppression for Oil Fires:*

- Foam trolleys, equipped with foam-making branches, hoses, inline inductors, and foam compounds, will provide a reliable method for tackling oil and hydrocarbon-based fires, which water cannot suppress effectively. This equipment is specifically designed for flammable liquid fires, making it essential for OTPC's operations.

ii. *Improved Access in Emergency Situations:*

- Portable fire pumps, equipped with suction hoses and strainers, offer mobility and flexibility, ensuring fire suppression can be initiated even in areas where fire tenders cannot reach. The portable nature of these pumps makes them ideal for deployment in remote or obstructed plant sections.

iii. *Backup and Relay Support:*

- The portable fire pumps will provide a solution for areas where fire tenders cannot access and support relay operations, allowing for a coordinated and effective fire response across multiple zones.

iv. *Regulatory Compliance and Risk Mitigation:*

- OTPC will align with fire safety regulations specific to oil-gas-based industries by equipping the plant with foam trolleys and portable fire pumps. These measures will reduce the risk of catastrophic damage due to oil fires and help mitigate the potential loss of life and assets.

5. Recommendations

i. *Procurement of Foam Trolleys:*

- Two foam trolleys should be procured, complete with the necessary foam-making branches, hoses, inline inductors, and foam compounds. These trolleys will provide a mobile solution to address oil and hydrocarbon fires.

ii. *Procurement of Portable Fire Pumps:*

- Acquire two portable fire pumps equipped with suction hoses and strainers to support fire-fighting efforts in areas difficult for fire tenders to access. These pumps should be versatile and capable of being deployed rapidly to various parts of the plant.

iii. *Integration into Emergency Response Plans:*

- The portable fire pumps and foam trolleys should be integrated into OTPC's emergency response procedures, with clear guidelines for their deployment in different fire scenarios. Regular drills should be conducted to familiarize staff with the equipment's use.

iv. *Training for Personnel:*

- Provide specialized training for fire safety personnel on the operation of foam trolleys and portable fire pumps, including the correct deployment techniques, maintenance, and troubleshooting procedures.

v. *Regular Maintenance and Testing:*

- Establish a regular maintenance and testing schedule for the foam trolleys and portable fire pumps to ensure they are always in a state of readiness. This includes checking foam concentrates, hoses, pumps, and related accessories.

6. Conclusion

Adding foam trolleys and portable fire pumps to OTPC Palatana Plant's fire safety infrastructure is essential to ensure that the plant is well-equipped to handle oil-related fires and other emergencies. These measures will significantly enhance the plant's fire-fighting capabilities, particularly in challenging environments where fire tenders cannot access. By implementing these recommendations, OTPC will improve its compliance with regulatory fire safety standards, mitigate risks, and safeguard plant assets and personnel in case of a fire.

CHAPTER-10 (*Self-Contained Breathing Apparatus)*

AREA:- Fire and Safety

EQUIPMENT/SYSTEM:- Self Contained Breathing Apparatus (SCBA)

1. Introduction

The OTPC Palatana Plant relies on natural gas as its primary feedstock for power generation. This inherently involves significant risks, such as gas leaks, combustion by-products, and accidental discharges, which can result in hazardous and life-threatening conditions for workers. To address these risks, it is critical that the plant is equipped with Self-Contained Breathing Apparatus (SCBA) sets. This report evaluates the need for SCBA units at OTPC, analyzing the potential risks associated with the plant's operations and outlining the regulatory and safety standards that necessitate the procurement and use of SCBAs.

2. Scope of Works

This chapter covers:

- The hazards associated with gas-based power generation at OTPC Palatana Plant.
- The current safety measures are in place for managing air quality and respiratory risks.
- The necessity and benefits of providing SCBAs to OTPC personnel, including emergency response teams.
- Compliance with relevant safety regulations and industry standards.

3. Observations

i. *Hazardous Gaseous Emissions in Gas-Based Power Generation:*

- OTPC Palatana Plant uses natural gas for electricity generation, a process that, if not controlled, can release dangerous gases such as carbon monoxide, Sulphur compounds, and nitrogen oxides. OTPC also uses chlorine gas, HCL, and H_2SO_4 in its water treatment facility, which is required for power generation.
- These gases pose significant risks to personnel, especially during emergencies involving gas leaks or fires, where oxygen depletion and the presence of toxic gases can rapidly create unsafe working conditions.

ii. *Current Respiratory Protection Measures:*

- While OTPC has implemented various safety measures, including gas leak detection systems and emergency evacuation protocols, there is currently no specific mention of SCBA units for personnel working in hazardous environments.

iii. *Regulatory Compliance:*

- The Factories Act of 1948 and associated rules stipulate the requirement for adequate safety equipment in environments involving hazardous substances. This includes respiratory protection for workers exposed to dangerous gases.
- The National Fire Protection Association (NFPA) standards, particularly NFPA 1500 and NFPA 1981, further underscore the need for SCBA equipment to protect workers during fire and emergency-situations in industries that handle toxic or flammable gases.

4. Analysis

Why *SCBA Equipment is Critical for OTPC Palatana Plant*

i. *Protection Against Toxic and Insufficiently Oxygenated Air:*

- SCBAs are designed to provide breathable air to workers in environments with insufficient oxygen or where toxic gases, such as carbon monoxide, chlorine, or Sulphur compounds, are present. These gases can lead to serious health issues, including poisoning, respiratory failure, or even death. SCBAs ensure that workers can safely navigate through hazardous zones, especially during emergencies.

ii. *Enhanced Safety During Gas Leaks and Fires:*

- Given the high likelihood of gas leaks or fires at gas-based power plants, SCBAs offer essential protection during these incidents. Combustible gases, like methane and its by-products, increase the risk of sudden fires or explosions. SCBAs allow operators and emergency responders to effectively carry out their duties, including leak containment, fire suppression, and rescue operations, without being compromised by toxic fumes.

iii. *Regulatory Requirements and Industry Standards:*

- The Factories Act of 1948 and the National Fire Protection Association (NFPA) standards mandate the availability of respiratory protection, especially in industries dealing with dangerous gases. Failure to comply with these regulations could expose OTPC to legal liabilities and safety violations and undermine the plant's operational safety standards.

iv. *Cost of Non-Compliance:*

- In the absence of SCBA units, OTPC may face increased operational risks, including potential fatalities or injuries, which could result in significant costs associated with lost productivity, legal claims, insurance premiums, and damage to the company's reputation.

How SCBAs Will Mitigate These Risks

i. *Enhanced Emergency Preparedness:*

- By equipping emergency responders with SCBAs, OTPC ensures that they can quickly and safely address gas leaks, fires, or other hazardous situations without compromising their health. SCBAs also allow responders to operate longer in high-risk areas before needing to evacuate for fresh air.

ii. *Compliance with Safety Regulations:*

- Procuring and utilizing SCBA units ensures that OTPC complies with legal and regulatory requirements, thereby mitigating legal and operational risks.

iii. *Improved Worker Confidence:*

- Providing SCBA equipment enhances employee confidence in OTPC's commitment to safety. Knowing that adequate protective equipment is available fosters a safer working environment, which can positively affect employee morale and performance.

5. Recommendations

i. *Procurement of SCBA Units:*

- It is recommended that OTPC Palatana Plant procure an adequate number of SCBA sets based on the plant's size, number of employees, and the nature of the risks involved. The SCBAs should be suitable for various emergency scenarios, including gas leaks, fires, and confined space rescues.

ii. *Routine Inspection and Maintenance:*

- Establish a regular maintenance schedule for SCBAs to ensure they are in proper working condition. This should include regular checks of air tanks, masks, and valves and ensure the devices are fully charged and operational.

iii. *Training and Drills:*

- Conduct periodic training for employees, especially emergency response teams, on using SCBAs properly. This training should include how to operate, and maintain the equipment and emergency scenarios where SCBAs would be necessary.

iv. *Integration into Emergency Response Plans:*

- The use of SCBAs should be an integral part of OTPC's emergency response procedures. Emergency plans should outline when and how to use the SCBAs, ensuring that all personnel are familiar with their deployment in the event of a gas leak, fire, or other hazardous situations.

6. Conclusion

The procurement and use of Self-Contained Breathing Apparatus (SCBA) units at OTPC Palatana Plant is critical in enhancing the safety of personnel working in hazardous environments. Given the plant's reliance on natural gas and the inherent risks of gas leaks, fires, and exposure to toxic gases, SCBAs will provide essential protection and ensure that OTPC meets legal and regulatory fire safety requirements. By implementing these recommendations, OTPC can improve emergency response effectiveness, ensure compliance with safety regulations, and mitigate the risks associated with its operations.

CHAPTER-11 (*Bush Cutter Machine)*

AREA:- Fire and Safety

EQUIPMENT/SYSTEM:- Bush Cutter Machine

1. Introduction

The OTPC plant's boundary walls are frequently encroached upon by unwanted vegetation, such as bushes, shrubs, and jungle growth. This poses a potential security risk and hinders the free movement of security personnel responsible for maintaining watch and ward within the premises. Currently, the vegetation around the plant is manually cut about 3 to 4 times a year, which presents safety concerns for workers, such as snake bites and cuts or bruises from handling sharp tools. This report evaluates the need to introduce brush-cutting machines to improve efficiency, safety, and security within the OTPC plant.

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2. Scope of Works

This chapter covers:

- The current method of vegetation control at the OTPC plant boundary wall.
- The safety hazards associated with manual jungle cutting.
- The potential benefits of utilizing brush-cutting machines for vegetation management.
- The impact of brush-cutting machines on plant operations, security, and worker safety.

3. Observations

i. *Vegetation Growth and Encroachment:*

- Unwanted plants, bushes, and jungle growth have consistently overrun the boundary wall of the OTPC plant. This obstructs the movement of security personnel and could lead to undetected intrusions or security breaches.
- Dense vegetation also makes it difficult for security personnel to have a clear line of sight, hindering surveillance and response during security checks.

ii. *Current Manual Jungle Cutting:*

- The current practice involves manual cutting of the vegetation 3 to 4 times a year. While this process addresses the issue of encroaching plants, it is time-consuming and poses several safety risks.
- The manual cutting method exposes workers to hazards such as snake bites, sharp tool injuries (e.g., cuts, bruises), and physical strain from prolonged manual labor.

iii. *Safety Concerns:*

- Security and maintenance personnel are at risk of snake bites, particularly in dense jungle areas where snakes may hide. The lack of protective equipment increases the risk of workers being injured during manual cutting.
- The manual cutting process often results in cuts, abrasions, and muscle strains, all contributing to reduced worker productivity and morale.

4. Analysis

Why Brush Cutting Machines Are Necessary

i. *Increased Efficiency:*

- Brush-cutting machines can significantly reduce the time required for vegetation management. These machines can clear large areas of jungle, bushes, and thick vegetation in a fraction of the time it takes for manual labor, improving overall productivity and reducing the need for frequent interventions.

ii. *Enhanced Safety:*

- Brush-cutting machines provide a safer alternative to manual cutting by reducing direct contact with sharp objects, plants, and potential wildlife. With proper training and protective gear, personnel can operate the machines without the risk of snake bites or physical injuries from sharp plants or tools.
- The machinery also minimizes the physical strain on workers, reducing the likelihood of fatigue-related injuries and improving worker well-being.

iii. *Improved Security:*

- Using brush-cutting machines to maintain the boundary wall ensures that the plant's security personnel have access to all areas unobstructed. Clear visibility allows for better surveillance and more effective monitoring of the plant's perimeter.
- With reduced vegetation, the risk of hiding places for unauthorized personnel or wildlife decreases, enhancing the overall security of the OTPC plant.

iv. *Cost-Effectiveness:*

- While the initial investment in brush-cutting machines may seem significant, the long-term savings from reduced labor costs, improved efficiency, and reduced injuries make this solution cost-effective. Moreover, fewer manual laborers will be required for this task, allowing them to focus on other critical activities.

How Brush Cutting Machines Address the Issue

i. Safety:

- Brush-cutting machines reduce the need for workers to use manual tools like sickles and machetes, which pose a greater risk of injury. These machines have protective designed enclosures to reduce the risk of accidental cuts or bruises.
- Using machinery eliminates the risk of snake bites, as the cutting machines can quickly clear dense vegetation where snakes may be hiding.

ii. *Security:*

- With the enhanced capability to clear vegetation quickly, security personnel will have unobstructed access to all areas of the boundary wall, enabling improved surveillance and monitoring of the plant's premises.

iii. *Environmental Impact:*

- Brush-cutting machines are more environmentally friendly than traditional methods as they reduce the need for herbicides or other chemical treatments to control vegetation. Clearing vegetation also allows for natural growth control, preventing the overgrowth of hazardous plants.

5. Recommendations

i. *Procure Brush Cutting Machines:*

- It is recommended that OTPC procure brush-cutting machines to replace manual jungle cutting for boundary wall maintenance. These machines should be selected based on their ability to handle the dense vegetation around the plant, with a focus on durability, safety features, and ease of operation.

ii. *Training and Protective Equipment:*

- Personnel operating the brush-cutting machines should undergo proper training on using and maintaining the equipment. Additionally, protective gear such as gloves, safety goggles, and sturdy footwear should be provided to reduce the risk of injury.

iii. *Regular Maintenance and Inspection:*

- Implement a regular maintenance and inspection schedule for the brush-cutting machines to ensure optimal performance. Machines should be serviced at recommended intervals to maintain their reliability and effectiveness.

iv. *Safety Protocols for Jungle Cutting:*

- Develop and enforce a set of safety protocols for operating the brush-cutting machines, including guidelines for protective equipment, handling hazardous situations (e.g., encountering wildlife), and emergency response procedures.

v. *Set Clear Vegetation Management Schedule:*

- Establish a schedule for vegetation management, including periodic checks to ensure that the boundary wall remains clear of obstructions. Depending on the growth rate of the vegetation, the frequency of machine use can be adjusted accordingly.

6. Conclusion

The procurement of bush-cutting machines to maintain the vegetation around the OTPC plant's boundary wall is a necessary safety and security improvement. It will mitigate the risks associated with manual jungle cutting, such as snake bites, cuts, bruises, and physical strain on workers. In addition, using these machines will improve security by providing clear visibility and access for security personnel. Investing in brush-cutting machines will enhance efficiency, reduce operational costs, and ensure compliance with safety standards. By adopting these recommendations, OTPC can provide its employees with a safer, more secure working environment while ensuring smooth, uninterrupted plant operations.

CHAPTER-12 (*Roof shade over CO_2 tanks)*

AREA:- Gas Turbine Fire Protection

EQUIPMENT/SYSTEM:- Roof shade over CO_2 tanks

1. Introduction

The OTPC Gas Turbine Units (Unit I and Unit II) rely on CO_2 fire suppression systems to protect against potential fires within the gas turbine compartments. However, it has been observed that there is no protective cover or roof shade over the CO_2 tank areas for both units. As a result, these tanks and the associated instruments are exposed to weather conditions, leading to gradual degradation due to environmental exposure. This report analyzes the current situation, evaluates the risks associated with the lack of protection for the CO_2 tanks, and recommends the construction of a roof shade to protect the CO_2 tanks and their associated systems.

2. Scope of Works

This report evaluates:

- The condition of the CO_2 tanks and associated equipment/instruments in Unit I and Unit II.
- The impact of environmental exposure on the functionality of equipment /instruments of CO_2 tanks and associated fire protection systems.
- The safety risks posed to the plant by the potential failure of the equipment /instruments of CO_2 fire suppression system.
- To mitigate the risks, the benefits and feasibility of installing a roof shade over the CO2 tank areas.

3. Observations

i. *Absence of Roof Shade:*

- Any roof shade or enclosure does not protect the CO_2 tank areas in Unit I and Unit II. As a result, the CO_2 tanks, valves, and other associated instruments are exposed to direct sunlight, rain, and other weather elements, which can cause long-term damage.

ii. *Weather Impact on Equipment:*

- The continuous exposure of CO_2 tanks and associated instruments to adverse weather conditions can lead to the malfunction of critical instrument components. Over time,

this degradation could affect the overall functionality of the CO_2 fire protection system.

iii. *Potential Risk of Fire Protection Failure:*

- CO_2 is a crucial component in the fire suppression system for the gas turbine compartments. If the CO_2 tanks or their associated instruments fail to function correctly due to weather-related damage, the risk of an ineffective fire suppression system increases. This could potentially lead to serious safety hazards in case of a fire emergency within the gas turbine units.

iv. *Lack of Functional Reliability:*

- Without adequate protection, the CO_2 fire suppression system's reliability may diminish, and the instruments may not perform optimally during emergency-conditions. This presents a critical risk to plant safety and operational continuity.

4. Analysis

Why *Roof Shade over CO2 Tanks is Necessary*

i. *Protection from Environmental Effects:*

- Exposure to environmental elements such as rain, UV radiation, and extreme temperatures accelerates the degradation of the CO_2 tanks associated instruments
- By installing a roof shade, the CO_2 tanks and associated systems will be shielded from these weather effects, prolonging their lifespan and ensuring their functionality.

ii. *Ensuring Fire Protection System Reliability:*

- The CO_2 fire suppression system is crucial for safeguarding the gas turbine units. Any failure in the CO_2 system could result in catastrophic consequences during a fire emergency. A roof shade will prevent environmental factors from interfering with the performance of the system, ensuring that the fire suppression equipment functions as expected during a crisis.
- Having a shield over the CO_2 tanks will also ensure that the equipment remains in the desired operating condition, reducing the risk of fire protection failure when needed.

iii. *Regulatory Compliance:*

- Industry standards and regulations require that safety equipment be maintained and protected from damage. By providing a roof shade, OTPC can align with these safety guidelines, enhancing compliance with regulations that govern fire protection systems in power plants.

iv. *Cost Savings in the Long Term:*

- Protecting the CO_2 tanks with a roof shade will prevent weather-induced degradation, thus reducing the need for frequent repairs, replacements, and maintenance of damaged equipment. This results in long-term cost savings while ensuring optimal fire suppression system performance.

How Roof Shade Addresses the Issue

i. *Prevents Direct Exposure:*

- A roof shade will cover the CO_2 tank areas, preventing direct exposure to sunlight, rain, and wind. This will preserve the tanks' integrity and associated components/ instruments, keeping them functional for extended periods.

ii. *Maintains Optimal Functionality:*

- By shielding the tanks from harsh weather conditions, the equipment/ instruments will be better protected, ensuring that the CO_2 fire suppression system works as intended in case of an emergency. This will improve plant safety by ensuring that fire protection systems are reliable and ready for use when required.

iii. *Improves Operational Safety:*

- The roof shade will also reduce the risk of accidents or safety hazards that could result from a malfunctioning CO_2 fire protection system. This proactive measure will contribute to a safer working environment for plant personnel and enhance the overall security of the OTPC plant.

5. Recommendations

i. *Construct Roof Shade over CO_2 Tanks:*

- It is recommended that OTPC proceed with the construction of a roof shade over the CO2 tank areas in both Unit I and Unit II. The roof should be made of durable, weather-resistant materials that provide adequate protection from environmental elements.

ii. *Design Considerations:*

- The roof should be designed to cover the CO2 tanks fully, with enough space for regular maintenance access. The design should also ensure proper drainage to prevent water accumulation on the roof, which could lead to additional risks.
- Ensure that the roof shade does not obstruct the necessary airflow to the CO_2 tanks, as sufficient ventilation is required to maintain optimal pressure and performance.

iii. *Maintenance and Inspections:*

- Implement a regular inspection and maintenance schedule for the roof shade to ensure it continues providing efficacious protection. This should include checking for signs of wear, such as rusting or structural damage, and making necessary repairs promptly.

iv. *Monitor CO_2 System Performance:*

- After installing the roof shade, monitor the performance of the CO_2 tanks and associated fire protection systems to ensure they meet the required standards. Regular checks will help identify any potential issues before they become critical.

v. *Safety Training for Personnel:*

- Conduct training for plant personnel to ensure they understand the importance of the CO_2 fire protection system and the impact environmental exposure can have on the equipment's performance. This will reinforce the need for proper maintenance and proactive protection measures.

6. Conclusion

Installing a roof shade over the CO_2 tank areas in Unit I and Unit II is necessary to protect the fire suppression equipment/ instruments from weather-related damage. This will ensure the continued functionality of the CO_2 fire protection system and enhance plant safety by reducing the risk of fire protection system failure during emergencies. The recommendation for constructing a roof shade is aligned with best practices in operational safety, regulatory compliance, and long-term cost-effectiveness. By implementing this recommendation, OTPC will significantly improve the reliability of its fire suppression systems and ensure a safer working environment for its personnel.

CHAPTER-13 (*Equipment for Ambient Air Quality Monitoring)*

AREA:- Main Plant

EQUIPMENT/SYSTEM:- Equipment for Ambient Air Quality Monitoring

1. Introduction

The OTPC gas-based power plant operates in compliance with various environmental standards that ensure emissions do not exceed regulatory limits, safeguarding the surrounding environment from harmful pollutants. Ambient Air Quality Monitoring (AAQM) equipment is vital for continuously measuring and reporting air pollutants in the plant's vicinity as part of maintaining regulatory compliance and promoting environmental sustainability. This report evaluates the need for installing or modifying AAQM equipment at the OTPC plant based on the recommendation made by the Ministry of Environment, Forest and Climate Change (MoEF) and the Tripura State Pollution Control Board (TSPCB), as well as the legal obligations under the Air (Prevention and Control of Pollution) Act, 1981, and the Environment Protection Act, 1986.

2. Scope of Works

This report covers:

- The current status of air quality monitoring at the OTPC plant.
- Compliance with environmental regulations related to ambient air quality.
- There is a need to install AAQM equipment to ensure continuous monitoring of air quality.
- Integrating the AAQM system with regulatory reporting obligations to MoEF and TSPCB.
- Recommendations for equipment installation and system modifications to meet the required standards.

3. Observations

i. *Current Status of Air Quality Monitoring:*

- It was observed that while the OTPC plant conducts some air quality monitoring, the equipment used is outdated, inadequate, or not in line with the latest regulatory requirements.

- The existing system does not fully comply with the standards set by the Ministry of Environment, Forest and Climate Change (MoEF) or the Tripura State Pollution Control Board (TSPCB).

ii. *Regulatory Compliance Gaps:*

- During a site visit by MoEF, it was highlighted that OTPC's air quality monitoring capabilities need enhancement to ensure compliance with national and state environmental standards.
- MoEF recommends that OTPC improve its monitoring system to ensure that the plant's emissions do not exceed legal limits and are transparently reported to TSPCB.

iii. *Environmental and Operational Impact:*

- Failure to implement an updated, reliable AAQM system may lead to unreported air quality issues, possibly resulting in environmental harm, non-compliance fines, and operational inefficiencies.
- Additionally, there is a risk of exceeding permissible emission levels, which can negatively impact the health of local communities and the environment.

iv. *Need for Continuous Monitoring:*

- Continuous monitoring is critical for providing real-time air quality data, enabling OTPC to take corrective actions proactively in case of air quality deviations. Without this, the plant may not be aware of potential pollution spikes in time to mitigate them.

4. Analysis

Why *Ambient Air Quality Monitoring Equipment is Necessary*

i. *Legal and Regulatory Requirements:*

- The Air (Prevention and Control of Pollution) Act 1981 and the Environment Protection Act 1986 mandate continuous ambient air quality monitoring for industrial plants like OTPC. Non-compliance can result in penalties, shutdowns, or loss of operating permits.
- MoEF's site visit highlighted the need for improved air quality monitoring systems to ensure continued adherence to these legal obligations. Fulfilling this recommendation will prevent potential violations of environmental laws and demonstrate OTPC's commitment to responsible corporate practices.

ii. *Ensuring Compliance with Environmental Standards:*

- By installing state-of-the-art AAQM equipment, OTPC will be able to continuously measure and report various pollutants such as sulfur dioxide (SO2), nitrogen oxides

(NOx), particulate matter (PM), and carbon monoxide (CO). This will help ensure that the plant's emissions do not exceed the permissible limits set by the Ministry and local authorities, promoting environmental sustainability.

- It will also help OTPC fulfill its obligation to submit monthly reports on air quality data to TSPCB, thereby maintaining transparency and accountability.

iii. *Preventing Environmental Hazards:*

- Adequate air quality monitoring is essential to prevent potential long-term health hazards to the local community and surrounding ecosystems. Continuous air quality data will allow OTPC to take immediate corrective actions, such as adjusting operations or implementing mitigative measures to prevent pollution peaks.

iv. *Operational Efficiency:*

- An updated AAQM system will provide OTPC with valuable real-time data, which can be used to optimize plant operations. For example, it can highlight any operational inefficiencies leading to high emissions, allowing for process improvements to minimize pollution and increase overall plant efficiency.
- Having real-time data ensures that OTPC is proactive rather than reactive in managing air quality, leading to better environmental performance.

How *Installation of AAQM Equipment Addresses the Issues*

i. *Continuous Monitoring and Data Reporting:*

- The installation of advanced AAQM equipment will enable OTPC to continuously monitor ambient air quality in real-time. This system will track various pollutants, helping OTPC ensure that emissions stay within regulatory limits.
- Automated data reporting capabilities will streamline the process of submitting monthly air quality reports to TSPCB, fulfilling regulatory requirements and avoiding manual errors or delays in reporting.

ii. *Improved Regulatory Compliance:*

- With the proper AAQM system in place, OTPC will meet the requirements laid out by MoEF, TSPCB, and the Environment Protection Act. This will reduce the risk of non-compliance penalties and improve OTPC's standing with regulatory authorities.

iii. *Real-Time Decision Making:*

- The monitoring equipment will allow OTPC to make data-driven decisions regarding emissions control. In case air quality readings show deviations from acceptable levels, OTPC can quickly implement corrective measures such as adjusting combustion

processes, optimizing fuel use, or improving emission control technologies.

iv. *Public and Stakeholder Confidence:*

- Transparent and accurate reporting of air quality data will build public trust in OTPC's commitment to minimizing environmental impacts. It will also demonstrate to stakeholders that OTPC prioritizes sustainability and corporate responsibility in its operations.

5. Recommendations

i. *Procure and Install Advanced AAQM Equipment:*

- It is recommended that OTPC invest in the latest AAQM equipment capable of measuring a wide range of air pollutants. This equipment should meet the guidelines and specifications outlined by MoEF and TSPCB, ensuring compliance with national and state regulations.

ii. *Integrate Real-Time Data Collection and Reporting Systems:*

- The AAQM system should be integrated with real-time data collection and automated reporting capabilities to streamline monthly air quality reports submission to TSPCB. This will ensure timely and accurate data transmission and compliance with reporting obligations.

iii. *Conduct Regular Maintenance and Calibration:*

- It is essential to conduct regular maintenance, calibration, and testing of the AAQM equipment to ensure accurate and reliable data. A preventive maintenance schedule should be established to keep the equipment in optimal condition.

iv. *Train Personnel on AAQM System Operation:*

- OTPC should provide training to relevant personnel on how to operate and maintain the AAQM system. This will ensure that employees can handle the system and interpret data accurately.

v. *Periodic Review and Updates:*

- OTPC should periodically review the performance of the AAQM system and assess the need for any upgrades or modifications to ensure that the equipment continues to meet regulatory requirements and technological advancements.

6. Conclusion

The installation and modification of Ambient Air Quality Monitoring (AAQM) equipment at the OTPC plant are necessary to ensure compliance with environmental regulations, safeguard the surrounding environment, and improve operational efficiency. This equipment will enable continuous air quality monitoring, ensuring that emissions from the plant remain within permissible limits and that corrective actions can be taken promptly in case of deviations. By fulfilling the recommendations made by MoEF and meeting the legal obligations under the Air (Prevention and Control of Pollution) Act, OTPC will demonstrate its commitment to environmental protection, corporate responsibility, and sustainable operations.

CHAPTER-14 *(SGA-Overground ERW piping)*

AREA:- Fire-water piping at inside 400KV switchyard

EQUIPMENT/SYSTEM: SGA-Overground ERW piping for spray and hydrant water.

1. Introduction

OTPC's fire water system is critical for ensuring the safety and protection of all equipment, i.e., ICT-1, Line Reactor, Bus Reactor, and the Switchyard Control Room inside the 400kV switchyard. The plant currently utilizes buried fire water piping to distribute water for fire-fighting purposes. However, repeated leakages have been observed due to piping joints and material corrosion. This has led to safety concerns, prolonged downtimes, and difficulties in leak detection and repairs, which impact the operational efficiency and safety of the facility.

2. Scope of Works

The chapter primarily focuses on assessing the condition and operational effectiveness of the buried fire water piping system in the 400kV switchyard area, specifically the SGA-Over Ground ERW piping for spray and hydrant systems. The scope includes identifying the causes of repeated leakages, evaluating the risks associated with the current setup, and recommending improvements to mitigate safety hazards and enhance system reliability.

3. Observations

- **Corrosion of Weld Joints and Pipe Material:** Repeated leakages have been observed, primarily due to the corrosion of welded joints and the parent material of the buried pipes. These leaks occur at multiple locations, leading to operational disruptions and increased maintenance efforts.
- **Difficulties in Leak Detection and Repair:** Since the fire water piping is buried, detecting leaks and performing efficient repair is challenging. The buried nature of the system prevents effective pressure testing, and the repair work often requires excavation in hazardous conditions.
- **Extended Repair Times and Safety Hazards:** Leak repairs require ground excavation, which increases downtime and introduces safety risks to personnel. The repair work often takes longer

- due to the need for slanting excavation and access challenges around cable trenches and surface drains.

4. Analysis

- **Why this Issue Exists:**
  - The buried piping system is exposed to environmental conditions that accelerate the corrosion process, particularly at weld joints and pipe material.
  - Since the system is underground, it cannot be easily monitored or subjected to regular pressure tests, which makes it difficult to detect leaks early and address them promptly.
  - Excavation work required for repairs introduces a high safety risk, as the leakage locations are often below finished ground levels or near critical infrastructure like cable trenches and surface drains.
- **How This Affects Operations and Safety:**
  - The extended repair times due to the buried nature of the piping disrupt the fire water supply, affecting the plant's ability to respond quickly in case of a fire emergency.
  - Prolonged outages of the fire water system also increase the risk of operational downtime and potential damage to critical plant assets.
  - The safety risks associated with excavation—such as the potential for injury or exposure to buried power cables—pose significant operational and personnel risks.

5. Recommendations

- **Switch to Over-Ground Piping:** It is recommended that the current buried fire water piping be replaced with over-ground piping. This will offer the following advantages:
  - *Faster Repair Times:* Over-ground piping is more accessible, making leak detection and repairs faster and less disruptive to plant operations.
  - *Safety Improvements:* The over-ground setup eliminates the need for excavation, reducing the safety risks associated with repair work.
  - *Enhanced System Availability:* Over-ground piping will provide continuous fire water supply to the 400kV switchyard, ensuring that fire protection is always available for critical electrical equipment.
- **Implementation Steps:**

a. *Engineering Design:* A detailed engineering study should be conducted to design the over-ground piping system. The design should focus on ensuring ease of access, corrosion

resistance, and integration with existing fire water infrastructure.

b. *Procurement and Installation:* Materials should be sourced for the over-ground system, including corrosion-resistant pipes, valves, and fittings. Installation should be planned to avoid any obstructions and ensure accessibility for future maintenance.

c. *Testing and Commissioning:* Once the over-ground piping is installed, a comprehensive pressure test should be conducted to verify system integrity. The system should be commissioned after confirming that it meets all operational and safety standards.

6. Conclusion

The current buried fire water piping system in the 400kV switchyard has shown significant issues due to corrosion and the difficulty of accessing leak points for repairs. These issues pose safety risks to personnel, increase operational downtime, and may compromise the plant's fire safety capabilities. By transitioning to an over-ground piping system, OTPC can improve repair times, reduce safety hazards, and enhance the overall reliability of the fire water system, ensuring continuous protection for critical equipment. Implementing these recommendations will result in safer operations and greater compliance with fire safety standards, ultimately contributing to the long-term sustainability and safety of the OTPC plant.

CHAPTER-15 (*Chlorine Neutralization Pit)*

AREA:- Chlorination Plant

EQUIPMENT/SYSTEM:- Construction of Chlorine Neutralization Pit

1. Introduction

The OTPC plant operates a chlorination process as part of its water treatment system. Chlorine is used to purify water, and the chlorination plant plays a vital role in ensuring the quality of water for the plant's operations. However, chlorine handling presents significant safety risks due to its toxic and hazardous nature. Chlorine leaks, whether accidental or due to equipment failure, can seriously threaten the safety of plant personnel and surrounding communities. Installing a Chlorine Neutralization Pit as a safety measure for the containment and neutralization of chlorine gas in the event of a leak to enhance safety, mitigate risks, and comply with industry safety standards. This report analyzes the current safety measures and recommends the construction of the neutralization pit.

2. Scope of Works

The scope of this chapter involves assessing the current chlorine safety measures in place at the OTPC chlorination plant, identifying any gaps in safety procedures and equipment, and recommending improvements. The focus is specifically on the risk of chlorine leakage and the requirement for a chlorine neutralization pit as per the guidelines set by the Petroleum and Explosives Safety Organization (PESO). The audit also covers evaluating the existing control systems in place to manage chlorine leaks and the effectiveness of these systems in preventing or mitigating potential hazards.

3. Observations

- *Current Chlorine Handling Practices:* Chlorine is used as an additive in the plant's water treatment process. The chlorination plant is equipped with various safety measures, including emergency control systems, to manage the risks associated with chlorine leakage.
- *Lack of Neutralization Pit:* While the plant has control systems in place for managing chlorine leaks, there is no dedicated chlorine neutralization pit in place to neutralize the toxic gas in case of a leak, which could lead to safety hazards.
- *PESO Guidelines:* According to the Petroleum and Explosives Safety Organization (PESO)

guidelines, installing a chlorine neutralization pit is mandatory for facilities handling chlorine to ensure the safety of workers and the surrounding communities in case of accidental leaks, especially on the chlorine toner, so that toner can be dumped inside the neutralization pit for neutralization.

- *Safety Risks to Personnel and Communities:* Without the neutralization pit, exposure to toxic chlorine gas increases, which could jeopardize plant workers and nearby residents.

4. Analysis

Why *This Issue Exists:*

- *Absence of Neutralisation Facility:* The OTPC chlorination plant lacks a neutralisation pit, an essential safety feature for handling chlorine leaks. Although the plant has control systems, these systems may not be sufficient in all circumstances, especially during a large-scale chlorine release from the chlorine toner.
- *Compliance with PESO Guidelines:* The absence of a chlorine neutralization pit may result in non-compliance with the PESO guidelines, which mandate that facilities using chlorine must have such systems in place to ensure safety.

How *This Impacts Safety:*

- *Health Risks:* Chlorine gas is highly toxic and can cause respiratory issues, eye damage, and even death at high concentrations. Without a neutralization pit, chlorine gas could spread uncontrollably in the event of a leak, putting personnel and residents at risk.
- *Environmental Impact:* Chlorine leaks can have a significant environmental impact, especially in the surrounding areas, potentially affecting water and air quality.
- *Regulatory Non-compliance:* The absence of the neutralization pit could lead to non-compliance with safety regulations and could result in legal implications, fines, and reputational damage for OTPC.

5. Recommendations

To mitigate the risks associated with chlorine leakage and to enhance the overall safety of the plant, it is recommended to:

- *Construction of a Chlorine Neutralization Pit:* Installing a neutralization pit in the chlorination plant is recommended to manage any chlorine gas leaks safely. This pit should be designed according to the guidelines provided by PESO and should include provisions for neutralizing chlorine gas using appropriate chemicals.

- *Enhance Safety Systems:* Besides the neutralization pit, further improvements in emergency control systems, such as gas leak detection and automatic shut-off systems, should be considered to enhance safety.
- *Training and Preparedness:* Regular training should be conducted for plant personnel on handling chlorine emergencies and the operation of the new neutralization pit. The emergency response plans should also be updated to reflect the installation of the new system.

6. Conclusion

The construction of a chlorine neutralization pit is a critical step in enhancing the safety of the OTPC chlorination plant. It will ensure compliance with PESO guidelines and protect the health and safety of plant personnel and nearby communities. By implementing this recommendation, OTPC will demonstrate its commitment to maintaining the highest safety standards while mitigating the risks associated with chlorine use in water treatment. The neutralization pit will provide an additional layer of protection in case of chlorine leaks, ensuring the continued safe operation of the plant.

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