AGENDA
FOR
207TH OCC MEETING

Date: 15.09.2023
Eastern Regional Power Committee
14, Golf Club Road, Tollygunge
Kolkata: 700033

EASTERN REGIONAL POWER COMMITTEE

AGENDA FOR 207TH OCC MEETING TO BE HELD ON 15.09.2023 (FRIDAY) AT 10:30 HRS

PART – A

ITEM NO. A.1: Confirmation of Minutes of 206th OCC Meeting held on 31st August 2023 virtually through Microsoft teams Online platform.

The minutes of 206th Operation Coordination sub-Committee meeting held on 31.08.2023 was circulated vide letter dated 13.09.2023.

Members may confirm the minutes of 206th OCC meeting.

PART B: ITEMS FOR DISCUSSION

ITEM NO. B.1: Approval from ERPC for seeking PSDF grant for implementation of WAMS(Wide Area Monitoring System)in JUSNL under Jharkhand State.– JUSNL

Objective:

WAMS system uses Phasor Measurement Unit (PMU) as smart sensor. The PMU measures the system state viz. voltage and angle of a particular location at a rate of multiple samples per second (say 25/50 samples per second). This data is then time stamped through a common reference of GPS time and transmitted to the Phasor Data Concentrator (PDC) installed at a nodal point, through high speed wideband communication medium (such as Optical Fiber).

In view of the above WAMS System provides the greater visibility of Grid to make decision on real time basis with implementing the WAMS applications.

- Phasor data is valuable for online as well as off-line investigation of grid disturbances, improving both the speed and quality of analysis.
- It helps in quicker post-mortem analysis, sequence of events & root cause analysis.
- Dynamic model verification: Generator model calibration, CT/PT calibration, Load characterization
- Base-lining: Assess dynamic performance of the grid, Steady-state angular separation, System disturbance impact measures.

Purpose:

- Post Event Analysis Tools with Accurately Time-Tagged Data
- Oscillation Monitoring, Detection & Location Tool (Non-Control Room Initially)
- Offline Planning Model Validation Tool
- Wide Area Visibility and Situational Awareness in Control Room
- Monitoring of V, f, df/dt, P, Q, and Angle Difference at Boundaries
- Enhanced System Oscillation Monitoring, Detection & Location (Online)
- Asset Commissioning and Compliance Monitoring

According to guidance of FOR Technical Committee this Project is classified as per clause 5.1(c) of the PSDF Guidelines for disbursements of Funds from PSDF – "Installation of standard & special protection schemes, pilot and demonstrative projects, projects for setting right the discrepancies identified in protection audits on regional basis, any communication/ measurement/ monitoring scheme including installation of Phasor Measurement Unit (PMU's) etc.

As per PSDF scheme, a certain percentage which is up to 90 % of total project cost utility may receive as a grant and can be utilized for **WAMS (Wide Area Monitoring System) in JUSNL under Jharkhand State.** Accordingly, approval from BoD of JUSNL has been obtained regarding infusion State Government fund as grant to JUSNL for balance fund after approval from PSDF.

Proposal for WAMS:

The analog & digital information related to the power system, measured at the substation level is presented (typically, every 10 seconds) to the Load Dispatch Centre through the SCADA/ EMS, whereas Phasor Measurement Units (PMU's) can report as many as 60 measurement per second. High-speed monitoring can detect and record events that SCADA fails to capture, enabling much better visibility into grid conditions.

The beneficiaries of the project are State of Jharkhand in particular JUSNL and Consumers connected to JUSNL Grid. With implementation of the scheme, the JUSNL grid, part and person of one grid, will run more efficiently and more effectively. So, reliability of the grid can be achieved.

JUSNL don't have enough infrastructure for implementation of WAMS in Jharkhand. Presently 53 nos. GSS are running. Also due to unavailability of financial resources, JUSNL is not able to implement WAMS at its own cost. DPR had been prepared for implementation of WAMS.

DPR had been submitted to NLDC - Grid India (Nodal agency of PSDF) (**Annexure B1.2**) for approval of grant. DPR was placed before TESG (Techno Economic Sub-Group of PSDF) for examination of the DPR(**Annexure B1.1)**.

During 56th meeting of TESG of PSDF held on 07.07.2021, following observations were raised by the committee regarding submitted DPR.

(i) Approval of BoD JUSNL seeking grant from PSDF is required.

(ii) "It is suggested that the scheme may be discussed in the ERPC to confirm the locations of PMUs, quantity as per optimal placement method and MoM of the same may be provided to TESG."

(iii) "TESG asked the entity to submit the approval from Standing Committee on Power communication system planning for the subject work. Entity shall ensure that there should not be repetition of PMUs."

JUSNL Board in its 53rd meeting on 26th June 2023 accorded approval for seeking grant from PSDF upto 90% for implementation of Wide Area Monitoring System (WAMS) in JUSNL. Now, DPR of WAMS along with recommendation of BoD, JUSNL is being put up before ERPC

List of important 132 kV GSS for WAMS implementation attached at (**Annexure B1.3)**

Point of Decision:

In light of observation of TESG, ERPC may confirm the locations of PMUs, Quantity as per optimal placement method and provide MoM of the same for submission before PSDF.

JUSNL may update. Members may discuss.

ITEM NO. B.2:	**Approval from ERPC for seeking PSDF grant for implementation of Reconductoring of Existing 132kV Line by HTLS (High Temperature Low Sag) Conductor for Relieving Congestion in JUSNL under Jharkhand State– JUSNL.**

Objective

As per the Load Flow Study conducted by M/s Power Research and Development Consultants Pvt. Ltd. (PRDC) on request of JUSNL for the year 2020-21 to 2025-26, few of the 132 kV Transmission Lines were observed with loading higher than 100% of its rated capacity during N-1 Condition. In order to increase the Overall Reliability of the JUSNL network and to relieve congestion, renovation of these lines are necessary.

The overall reliability and to relieve congestion of the JUSNL network can be achieved through construction of new transmission lines or increasing the power transmission capacity through use of higher capacity conductor.

Under several Transmission Projects of JUSNL, new Transmission Lines are under construction which will relieve congestion at several extent. Still, necessity of re-conductoring of Existing 132 kV Trans Lines of JUSNL with higher capacity conductor (HTLS) has multiple benefits:

1. Can transfer up to twice the power carried by conventional conductor
2. Lesser transmission losses
3. Uses the existing towers
4. Lower sag than the conventional conductor at the higher operating temperatures
5. Usage of Existing Trans Line corridor leading to no additional clearances are required (Forest, Land acquisition, etc.)
6. Faster implementation

The Central Transmission Utility, Different State Transmission Utilities and Private Transmission Utilities have already used HTLS conductors for replacing existing overloaded trans line conductors and performance is satisfactory fulfilling the purposes as follows:

1. Overall improvement in redundancy and reliability of the transmission system
2. Faster implementation
3. No requirement of separate right of way or land acquisition
4. Increased Revenue
5. Reduced Capital Cost
6. Reduction in Trans Lines losses

As per the old system study report (2021-22) & a Detailed Project Report (DPR) was prepared by M/s TATA Power DDL (Special Consultant) appointed by JUSNL submitted to PSDF considering 02 Nos of Transmission Lines only, which is as follows:

1. Existing 132kV D/C line from Ramchandrapur (220/132/33kV substation) to Adityapur (132/33kV substation) loaded upto 85.2 % of its rated capacity.
2. Existing 132kV D/C line from Golmuri (132/33 kV substation) to Chandil (220/132 kV substation) with one circuit LILO at Mango (132/33 kV substation) loaded up to 90.9% of its rated capacity.

Detailed Project Report (DPR) **(Annexure B2.1).** prepared by the consultant was submitted to NLDC-Grid India **(Annexure B2.2).** (Nodal agency of PSDF) and during 55th meeting of TESG of PSDF held on 14.06.2021, observations raised by the committee regarding submitted DPR is as follows:

(i) "The requirement of re-conductoring of the transmission lines with HTLS conductors needs to be justified with proper system study report and vetting by Eastern Regional Power Committee (ERPC)."

(ii) "Statutory approvals are required for the project from Regional Power (standing) Committee (Transmission Planning) or in case if the proposed line is incidental to the Interstate Transmission System (ISTS) than approval is required from National Committee (Transmission Planning) i.e. standing committee".

In the meanwhile, as per the recommendation of New System Study Report (2025-26) & Addendum Report prepared and submitted by M/s PRDC, there are total Seven (07) Transmission Lines in which Element outage causes Over-Loading & during N-1 Contingency, which are considered for HTLS reconductoring W.R.T. future loading and N-1 contingency as follows:

1. 132kV D/C line from Ramchandrapur (220/132/33kV substation) to Adityapur (132/33kV substation) is loaded up to 110.1 % of its rated capacity.
2. 132kV S/C line from Sikidri (132/33 kV substation) to Namkum (132/33 kV substation) is loaded up to 125.4 % of its rated capacity.
3. 132kV D/C line from Hatia New (220/132/33 kV substation) to Hatia old (132/33 kV substation) is loaded up to 135.9 % of its rated capacity.
4. 132kV D/C line from Dumka Madanpur (220/132/33 kV substation) to Dumka Maraho (132/33 kV substation) is loaded up to 191.7 % of its rated capacity.
5. 132kV S/C line from Adityapur (132/33 kV substation) to Rajkharsawan (132/33 kV substation) is loaded up to 107.8 % of its rated capacity.
6. 132kV S/C line from Chandil (220/132/33kV substation) to Rajkharsawan (132/33 kV substation) is loaded up to 112.2 % of its rated capacity.
7. 132kV D/C line from Ramchandrapur (220/132/33kV substation) to Jadugoda (132/33kV substation) is loaded up to 130.2 % of its rated capacity.

On the basis of recommendation of New System Study Report (2025-26) & Addendum Report and observations of TESG meeting, DPR has been revised by the Consultant which consists of Estimate for the project in which rates has been considered after escalation of 10% of the rates in the SOR of JUSNL for FY 2022-23 after comparing the rates in SOR of JUSNL for FY 2022-23 with the orders issued by the other utilities, which was approx. 10% higher than the rates in SOR of JUSNL for FY

2022-23, resulting to an Estimated Project Cost of Rs 170.55 Crore inclusive of GST.

JUSNL don't have enough infrastructure for implementation of HTLS in Jharkhand. Presently 53 Nos. of Grid Substations are running. Also, due to unavailability of sufficient financial resources, JUSNL may utilise the PSDF fund as grant upto 75% of this Transmission Project and Balance Fund as grant will be requested from Govt. of Jharkhand after approval of PSDF for which approval of Board of Directors of JUSNL has already been obtained.

Fund Proposition for this Project
75% of the Project Cost Estimate as grant from PSDF
Balance fund of the Project Cost Estimate as grant from Energy Department, Govt. of Jharkhand.

Point of Decision:
Approval of Eastern Region Power Committee (ERPC) is solicited on Detailed Project Report for Implementation of Reconductoring of Existing 132 kV Transmission Lines by High Temperature Low Sag (HTLS) Conductor for Relieving Congestion in JUSNL under Jharkhand State.

JUSNL may update. Members may discuss.

ITEM NO. B.3: Highest outage duration of Eastern Region Generators–ERLDC.

ERLDC has done analysis on unit tripping data for the last 5 months i.e., April to August 2023. Some of the few findings are as follows:

a. Unit-wise analysis:

It was found that at least 19 nos of units have gone under outage more than 5 times and 22 units have outage period more than 500 hours. CGS/IPP units are also in this list.

The list of units having more than 5-time outages:

Unit name	No of Forced Outages (Apr-Aug'23)	Total Outage hours (Apr-Aug'23)	No of forced Outages (Yr. 22-23)	Total Outage hours (Yr. 22-23)
BARH - UNIT 1	11	696	21	1914
NORTH KARANPURA - UNIT 1	10	504	3	44
KHSTPP - UNIT 3	6	467	7	395
FSTPP - UNIT 1	6	312	1	66
FSTPP - UNIT 4	6	120	14	478
MPL - UNIT 2	6	384	6	427

The list of units having more than 500 hours outages:

Unit name	No of Forced Outages (Apr-Aug'23)	Total Outage hours (Apr-Aug'23)	No of Forced Outages (Yr. 22-23)	Total Outage hours (Yr. 22-23)
ADHUNIK - UNIT 2	2	2304	10	558
Sterlite - UNIT 2	8	1109	10	1279
KHSTPP - UNIT 3	6	467	7	395
BARH - UNIT 1	11	697	21	1914
GMR - UNIT 1	4	578	5	355

b. Reason Analysis for Forced outage

In case of forced outage, boiler tube leakage is the major reason for the outage of units. A total of 97 nos of tripping were registered under any kind of tube leakage for the total period of 6888 hours. Other than Annual maintenance, boiler tube leakage is the top reason for the outage for planned and forced outages in both categories. Other reasons such as ash handling, flame failure, Air preheater issue & Electrical fault or protection etc. are significantly less. However, these issues also need to be addressed.

Reason wise list is as per the following table:

Type of Fault	No of Outage	Total Outage hours
Tube leakage	97	6888
Electrical Fault/protection	41	9888
Ash Related	22	4488
Preheater	7	288
Flame failure	26	240

c. Timely Intimation of Unit Outage /Revival:

We have noticed a critical issue concerning the lack of timely intimation for unit desynchronization and tentative revival times. This oversight has resulted in significant financial losses for our beneficiaries as they struggle to manage their demand portfolios. This problem is further exacerbated by the nationwide power shortage and high spot market prices. A similar incident has been reported by the representative of WBSEDCL for Farakka's unit #4 sudden outage and delayed intimation.

It is requested to communicate (through email to the ERLDC control room) the information (Tripping time/lighting up details as well as tentative synchronization time/deferment time) regarding the units for advance intimation to respective beneficiaries.

ERLDC may update. All SLDCs and Gencos may respond.

ITEM NO. B.4: Shutdown proposal of generating units for the month of October 2023. – ERPC

Maintenance Schedule of Thermal Generating Units of ER during 2023-24 in the month of October'2023

System	Station	Unit No.	Capacity (MW)	Period (as per LGBR 2023-24)		No. of Days	Reason
				From	To		
DVC	Mejia TPS	5	250	25.10.2023	28.11.2023	35	COH-Boiler, Turbine, Gen,FGD & DeNOx
WBPDCL	Bakreshwar TPS	1	210	30.08.2023	03.10.2023	35	COH
WBPDCL	Santaldih TPS	6	250	09.10.2023	18.10.2023	10	PG Test/ Boiler License Renewal
CESC	Southern	2	67.5	06.10.2023	15.10.2023	10	Not Specified
NTPC	Barh-I	1	660	22.10.2023	25.11.2023	35	Boiler +Generator
KBUNL	KBUNL	3	195	21.08.2023	04.10.2023	45	Boiler + Turbine +Generator
GMRKEL	GMR	2	350	25.09.2023	09.10.2023	15	AOH

Members may update.

ITEM NO. B.5: Deferred overhauling of NTPC units in ER-I

Overhauling of NTPC units had been deferred due to various reasons in previous OCC meetings.

Overhauling of following units was deferred considering high demand of beneficiaries as per the decision of 197th as well as 202nd OCC meetings and in line with MOP guidelines.

Station	Unit	LGBR date	Deferment reason	New dates		Bihar share
NPGC	Unit 2 (660 MW)	01.07.2023 to 18.09.2023 (80 days)	202nd OCC as per Bihar request	25-11-2023	13-02-2024	545 MW
KBUNL	Unit 3 (195 MW)	21.08.2023 to 04.10.2023 (45 days)	In line with MOP guidelines for anticipated peak demand in September'23	25-11-2023	09-01-2024	141 MW

Barh	Unit 4 (660 MW)	01.12.2022 to 14.01.2023 (45 days)	197th OCC as per Bihar request & 202nd OCC on condition of Unit 2 COD again deferred due to high demand in September'23	25-11-2023	09-01-2024	570 MW
BRBCL	Unit 1 (250 MW)	01-12-2023 to 14-01-2023 (45 days)		01-12-2023	14-01-2023	23 MW

All the dates proposed are after completion of important festivals viz Durga Puja and Chhathh. Communication regarding overhauling was given to Bihar however no response has been received till date.

Following points may also be considered:

1. Last overhauling dates of KBUNL Unit 3 - January 2021 and Barh Unit 4 is February 2020. Around **3 years** have passed for both units without overhauling.
2. NPGCL overhauling involves boiler modification which cannot be delayed further.
3. **Mobilization** for overhauling takes time and decision regarding same may be given in time for proper planning and execution.

NTPC may update. Members may discuss.

ITEM NO. B.6: Extension of shutdown 400KV-Kh-Barh-1 up to 31.10.2023 and 400KV Bus MAIN BUS-IV of Kahalgaon STPS for Isolator Jumper disconnection – NTPC.

- Shutdown of 400KV-Kh-Barh-1 Line was received on OCB basis from 04.08.2023 to 20.09.2023 vide ERLDC Ref. No. ERLDC/ddmmyy/Rev- Dtd. 03.08.2023 at Sl No. 12.
  The equipment Up-gradation work for the aforesaid 400KV-Kh-Barh-1 is in progress at site, however we are facing several hindrances during execution of Foundation & Civil works due to incessant rain in the area and relatively high water table, which needs continuous de-watering and also movement of construction equipment is also restricted for long time.
  In view of the above, the existing Shutdown for 400KV-Kh-Barh-1 from 04.08.2023 to 20.09.2023 may be extended up to 31.10.2023.

- 400KV Bus MAIN BUS-IV of Kahalgaon STPS for Isolator Jumper disconnection for appx. 4 hr.

NTPC may update. Members may discuss.

ITEM NO. B.7: Request to furnish the data for preparation of LGBR 2024-25 of Eastern region – ERPC.

As per the IEGC Clause **32.3**(**a**) & (**b**) issued by CERC on 2**9**.0**5**.20**23**, "RPCs shall prepare and finalize the annual outage plan for the next financial year in respect of grid elements of their

respective regional grid*", "RPCs shall prepare Load Generation Balance Report (LGBR) for the respective region based on the LGBR submitted by SLDCs for their respective states and the data submitted by the regional entity generating stations, inter-State transmission licensees and other entities directly connected to ISTS in such format as may be stipulated by the RPCs and shall prepare annual outage plan for generating units and transmission elements in their respective region after carrying out necessary system studies in order to ensure system security and resource adequacy."*

In this regard, Load Generation Balance Report (LGBR) for the year 2024-25 in respect of Eastern Region is to be finalized by September, 2023 (as advised by CEA vide mail dated. 14.08.2023). The approved programme of planned maintenance in respect of Thermal and Hydro stations in the region, along with the estimated monthly generation programme, the estimated monthly energy requirement (MU) and estimated monthly peak/off-peak demand (MW) for the year 2024-25 of each state / utility shall be the input for preparation of LGBR of Eastern Region for 2024-25.

To prepare the LGBR of Eastern Region, the following data/ information for the financial year 2024-25(April'2024 to March'2025) in respect of the constituents/ generators of Eastern Region is required:

State and Central Sector Generators/IPPs/CPPs/SLDCs/Utilities

i) The Unit-wise and Station-wise monthly energy generation proposed from existing units during 2024-25 (thermal, hydro and RES).
ii) Annual maintenance programme for each of the generating units (thermal, hydro and RES)
iii) Generating units under R&M/ long outage indicating date of outage and reasons of outage and expected date of return (thermal and hydro both).
iv) Partial and forced outage figures (in %) of generating units and auxiliary power consumption for the last 3 years.
v) Month-wise peak/off-peak demand (MW) – restricted and unrestricted.
vi) Month-wise energy requirement (in MU) – restricted and unrestricted.
vii) Month-wise and source-wise power purchase and sale plan (both MU & MW).
viii) Schedule of commissioning of new generating units during 2024-25 and unit-wise monthly generation programme (in MU) upon COD.
ix) Allocation of power from new generating units.

ISTS/STU/Transmission licenses in the states and Central Sector

i) Monthly and annual planned outage of transmission system (Transmission lines 220kV and above / ICTs / Reactors/ other elements (TCSC, SC etc.)).

It is therefore requested to provide the above information (as applicable), at earliest, for compilation of data and preparation of draft **LGBR of ER for the year 2024-25.**

ERPC may update. Members may discuss.

ITEM NO. B.8: Poor quality of cable received with Genus meters – NTPC

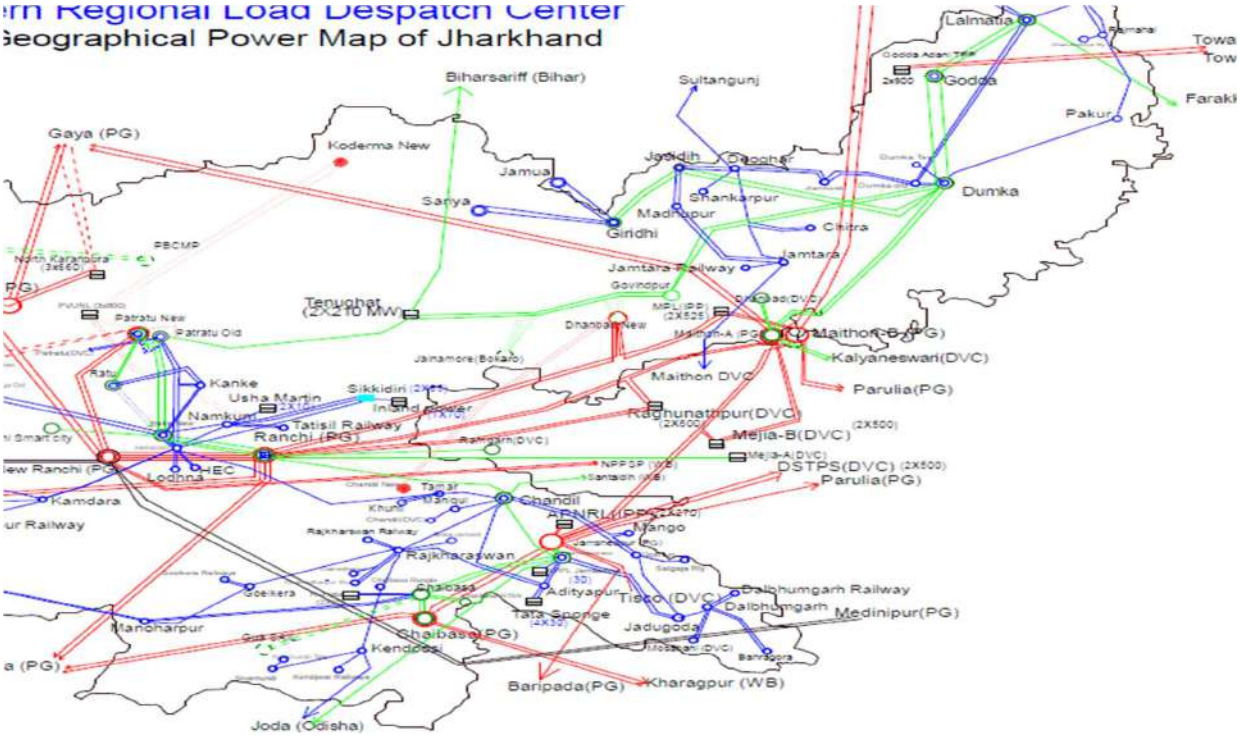
Downloading cables received with Genus meters provided by Powergrid are of poor quality and are failing frequently. This poses serious concerns related to downloading of SEM data for accounting purposes.

NTPC may update. Members may discuss.

ITEM NO. B.9: Transmission constraints in Jharkhand network - ERLDC.

Maximum Demand of Jharkhand has already crossed 1900 MW. With the increase in demand, it is observed that 220 kV Maithon Dumka D/C fails to meet the N-1 reliability criteria. Loading of this line is also aggravated due to the long outage of 220 kV Farakka-Lalmatia S/C. The proposed LILO of 220 kV Tenughat-Govindpur at 400/220 kV Dhanbad (NKTL) is also long pending.

Apart from this , voltage of 220 kV Tenughat continuously hovers on the higher side. This resulted in teeting issues while first time charging 400 kV Tenughat-PUVNL S/C line. As this line will be used for drawing of startup power by PUVNL ,proper voltage management at Tenughat by regulating the VAR exchane of 2 x 210 MW units needs to be maintained.



ERLDC may update. Members may discuss.

ITEM NO. B.10: Lack of UFR Telemetry data- ERLDC

Real time Telemetered data of the feeders (MW power flow in Real Time and circuit breaker status) having UFR and df/dt relays are not available at ERLDC. As we are aware that IEGC 2023 is going to be implemented w.e.f 01.10.2023, thus we need to ensure the availability of Real Time Telemetry data of the feeder under UFR scheme as per the following clause of IEGC 2023:Clause no 13 (d):-

"SLDC shall ensure that telemetered data of feeders (MW power flow in real time and circuit breaker status) on which UFR and df/dt relays are installed is available at its control centre. SLDC shall monitor the combined load in MW of these feeders at all times. SLDC shall share the above data with the respective RLDC in real time and submit a monthly exception report to the respective RPC. RLDC shall inform SLDCs as well as the concerned RPC on a quarterly basis, durations during the quarter when the combined load in MW of these feeders was below the level considered while designing the UFR scheme by the RPC. SLDC shall take corrective measures within a reasonable period and inform the respective RLDC and RPC, failing which suitable action may be initiated by the respective RPC."

Members may discuss.

ITEM NO. B.11: Review of UFR setting– ERLDC.

Based on the last event (11:52hrs, 15th May) of triggering of Under frequency relay, it was found that load relief was inadequate. ERLDC collected and compiled State-wise UFR status, additional intentional time delay kept by the states other than the measurement delay and Relay type etc. Percentage of UFR installed with respect to the highest demand met is also calculated. For Bihar it seems very low while same for other states also may be reviewed.

State	STG-I/49.4	STG-II/49.2	STG-III/49	STG-IV/48.8	Total	Maximum Demand Met	Percentage laod relief by UFR(%)	Remarks
DVC	122	145	147	138	552	3751	**14.7**	100 Ms Intentional delay, Al are Numerical relay
BIHAR	84.5	104.5	133	82.5	404.5	7578	**5.3**	Uneven stage wise distribution, No intentional delay but mostly Static relay
WEST BENGAL	381	374	390	386	1531	11868	**12.9**	200 Ms Intentional Delay, with mostly Numerical type.
ODHISHA	183	184	184	186	737	7192	**10.2**	No time delay with mostly numerical type.
JHARKHAND	70	69	45	79	263	1923	**13.7**	Uneven stage wise distribution, No intentional delay with all numerical relays.
CESC	65	90	125	120	400	2606	**15.34919417**	
Sikkim	**No UFR Installed**							

As per the IEGC 2023 , the following shall be factored in while designing and implementing the UFR and df/dt relay schemes:

a) Demand disconnection shall not be set **with any time delay in addition to the operating time** of the relays and circuit breakers.
b) There shall be **a uniform spatial spread of feeders selected for UFR and df/dt disconnection**.

SLDC shall report the actual operation of UFR and df/dt schemes and load relief to the concerned RLDCs and RPCs and publish the monthly report on its website.

ERLDC may update. Members may discuss.

ITEM NO. B.12: Standing approval for idle charging of 220 kV Balimela-U.Sileru line-SLDC,Odisha.

Since many years,the subject line is kept under idle charged condition to avoid theft of conductor & maintain healthiness.

In past it was mutually decided to keep this line charged from Odisha(Balimella P.H)-Andhra Pradesh(U.Sileru) end alternatively for a fortnight,to avoid continuous loss from either end.

While practically implementing above, as the both states are in different regions,the release of idle charging code for changeover operation takes a lort of time.In this regard, it is requested to decide upon quick code issue mechanism for once in a month to idle charge from either end for facilitating changeover operation.

Matter may be deliberated in forthcoming OCC meeting and support in favour of this genuine requirement is requested.

SLDC,Odisha may update. Members may discuss.

PART C: ITEMS FOR UPDATE

ITEM NO. C.1: ER Grid performance during August 2023.

The average and maximum consumption of Eastern Region and Max/Min Demand (MW), Energy Export for the month August-2023 were as follows:

AVERAGE CONSUMPTION (MU)	MAXIMUM CONSUMPTION(MU)/ DATE	MAXIMUM DEMAND (MW)	MINIMUM DEMAND (MW)	SCHEDULE EXPORT	ACTUAL EXPORT
		DATE/TIME	DATE/TIME	(MU)	(MU)
568 MU	622 MU 31-08-2023	28711 MW, 10-08-2023 at 19:03 Hrs.	20188 MW, 26-08-2023 at 08:21 Hrs.	3849	3806

ERLDC/ERPC may highlight the performance of the ER grid.

ITEM NO. C.2: Latest Status of States ATC/TTC declared by States for the month of June-2023.

To harmonize the ATC/TTC calculation methodology and timeline One to one meeting and hands on training with each SLDC was conducted in the month of Sep-21 and Oct-21. As per the common agreed procedure and timeline ATC/TTC calculation in three-month advance and reconciliation of the TTC/ATC figure for the upcoming month between RLDC and SLDC has started from month Dec-21. Reconciled ATC/TTC figures for **June-2023** are as follows:

As per the agreed philosophy the status of month wise ATC/TTC submission is as follows:

Sl No	State/Utility	TTC (MW)		RM(MW)		ATC Import (MW)		Remark
		Import	Export	Import	Export	Import	Export	
1	BSPTCL	6990	--	0	--	6850	--	May-23
2	JUSNL	1586	--	39	--	1547	--	June-23
3	DVC	**1940**	**3371**	72	56	**1868**	**3315**	June-23
4	OPTCL	3898	1338	145	70	3753	1268	June-23
5	WBSETCL	6475	--	450	--	6025	--	June-23
6	Sikkim	170	--	1	--	169	--	May-23

As per the agreed philosophy the status of month wise ATC/TTC submission is as follows:

State / Month	Bihar	Jharkhand	DVC	Odisha	West Bengal	Sikkim
May-23	Submitted	Submitted	Submitted	Submitted	Submitted	Submitted

June-23	Pending	Submitted	Submitted	Submitted	Submitted	Pending
July-23	Pending	Submitted	Submitted	Submitted	Submitted	Pending
Aug-23	Pending	Pending	Submitted	Submitted	Pending	Submitted
Sep-23	Pending	Pending	Pending	Pending	Pending	Pending

Declaration of TTC/ATC on SLDC Website

Sl No	SLDC	Declared on Website	Website Link	Constraint Available on Website	Type of Website Link
1	BSPTCL	Yes	http://www.bsptcl.in/ViewATCTTCWeb.aspx?GL=12&PL=10	Yes	Static Link-Table
2	JUSNL	Yes	http://www.jusnl.in/pdf/download/ttc_atc_nov_2020.pdf	Yes	Static link – pdf file
3	DVC	Yes	https://application.dvc.gov.in/CLD/atcttcmenu.jsp#	Yes	Static Link-Word file
4	OPTCL	Yes	https://www.sldcorissa.org.in/TTC_ATC.aspx	Yes	Static Link-pdf file
5	WBSETCL	Yes	http://www.wbsldc.in/atc-ttc	No (Not updating)	Static Link-Table
6	Sikkim	No	https://power.sikkim.gov.in/atc-and-ttc	No (Not updating)	Static Link-Excel file

All the states having net export schedule should declare their export TTC. In view of the same West Bengal is once again requested to share export TTC. Sikkim are requested to share the ATC/TTC on regular basis. All states are again requested to follow the time line and make necessary changes for being able to calculate TTC on 11 month ahead basis once T-GNA regulation comes into effect.

PART D: OPERATIONAL PLANNING

ITEM NO. D.1: Anticipated power supply position during October 2023.

The abstract of peak demand (MW) vis-à-vis availability and energy requirement vis-à-vis availability (MU) for the month of October 2023 were prepared by ERPC Secretariat (**Annexure D.1**) on the basis of LGBR for 2023-24 and feedback of constituents, keeping in view that the units are available for generation and expected load growth etc.

Members may update.

ITEM NO. D.2: Major Generating Units/Transmission Element outages/shutdown in ER Grid (as on 07.09.2023)

a) Thermal Generating Stations outage report:

SL No	STATION	STATE	AGENCY	UNIT NO	CAPACITY (MW)	REASON(S)	OUTAGE DATE
1	DPL	WEST BENGAL	WBPDCL	8	250	Unit taken for overhauling from 01.08.2023. Earlier it was out due to poor fuel stock w.e.f 00:00 hrs on 14.07.2023. Before poor fuel stock, unit was out due to leakage in low temperature super heater.	11-Jul-2023
2	FSTPP	WEST BENGAL	NTPC	4	500	Initially out due to GT Y-phase oil leakage & Generator Hydrogen pressure low. Further Generator Stator bar developed some leakages.	16-Jul-2023
3	BARAUNI TPS	BIHAR	NTPC	7	110	Poor condenser vacuum	19-Jul-2023
4	BARAUNI TPS	BIHAR	NTPC	6	110	Low vacuum	22-Jul-2023
5	BARAUNI TPS	BIHAR	NTPC	9	250	Generator internal fault	07-Aug-2023
6	GMR 3	ODISHA	GMRKEL	3	350	Annual Overhauling	14-Aug-2023
7	IB.TPS	ODISHA	OPGC	1	210	Annual Overhauling	20-Aug-2023
8	BAKRESHWAR	WEST BENGAL	WBPDCL	1	210	Boiler turbine generator overhauling activity	22-Aug-2023
9	BARH	BIHAR	NTPC	1	660	Boiler Tube Leakage	03-Sep-2023
10	HEL HIRANMAYEE	WEST BENGAL	HEL	2	150	High vibration in PA Fan 2A	05-Sep-2023
11	MEJIA TPS	DVC	DVC	6	250	Boiler Tube Leakage	06-Sep-2023
12	KHSTPP	BIHAR	NTPC	6	500	Boiler Tube Leakage	07-Sep-2023
13	MEJIA TPS	DVC	DVC	3	210	coal feeding issue.	07-Sep-2023
14	MEJIA TPS	DVC	DVC	1	210	CHP coal feeding issue.	07-Sep-2023
15	MEJIA TPS	DVC	DVC	2	210	Coal feeding problem	07-Sep-2023

16	TENUGHAT	JHARKHAND	TVNL	1	210	PA Fan tripped	07-Sep-2023

All Generating stations are requested to update expected restoration time and reason outage to ERLDC/ERPC on weekly basis in case of any change at their end.

b) Major Generating stations Out on Reserve Shutdown due to low system demand:

NIL

c) Hydro Unit Outage Report:

S. NO	STATION	STATE	AGENCY	UNIT NO	CAPACITY (MW)	REASON(S)	OUTAGE DATE
1	BALIMELA HPS	ODISHA	OHPC	3	60	The unit taken out under R&M since 08/07/2022 for 18 months.	08-Jul-22
2	BALIMELA HPS	ODISHA	OHPC	4	60	The unit taken out under R&M since 08/07/2022 for 18 months.	08-Jul-22
3	INDRAVATI	ODISHA	OHPC	4	150	Capital maintenance for 6 Months, New stator change by OEM,Turbine OH	09-Dec-22
4	U. KOLAB	ODISHA	OHPC	2	80	Rotar earth Fault	25-Aug-2023
3	BURLA HPS/HIRAKUD I	ODISHA	OHPC	6	43.65	Mixing of oil and water at UGB chamber	26-Aug-2023

d) Long outage report of transmission lines (As on 14.06.2023):

Transmission Element / ICT	Outage From	Reasons for Outage
400 KV IBEUL JHARSUGUDA D/C	29.04.2018	As information gathered, around 40-50 nos of towers were collapsed and conductor theft more than 400Ckm and restoration work is in progress
220/132KV 100 MVA ICT II AT LALMATIA	22.01.2019	Commissioning work of 220/132KV, 100MVA Transformer and its associated control Panel under progress.
220 KV PANDIABILI - SAMANGARA D/C	03.05.2019	Tower Collapsed during Cyclone FANI (Restoration project is entrusted upon PGCIL & 220kV Samangara-Pandiabili ckt-I&II are anti-theft charged from Pandiabili end from loc no.01 to loc no.74)
220/132KV 100 MVA ICT 3 AT CHANDIL	30.04.2020	Due to Fire hazard ICT damaged and burnt.
400/220KV 315 MVA ICT 4 AT JEERAT	09.04.2021	Due to Fire hazard ICT damaged and burnt. New Transformer procurement under pipeline and shall be replaced in the near future.
220KV-FSTPP-LALMATIA-I	21.04.2021	Conductor stringing 12.965 km has been completed and Stringing between Tower Loc. no. 152 to 159 is under progress. Transmission line is idle charged between Lalmatia GSS end to Tower Loc.no.169
220KV-MUZAFFARPUR(PG)-GORAUL(BH)-1	11.06.2022	To rectify the CVT voltage missing issue
220KV-WARIA-BIDHANNAGAR-1 & 2	08.06.2022	To control overloading of 220 kV Waria-DSTPS (Andal) D/C line
400/220KV 315 MVA ICT 2 AT PATRATU	27.09.2022	ICT tripped on few occasions due to Buchholz later DGA violation found, internal fault in

		transformer to be rectified. (DGA violation)
220/132KV 160 MVA ICT 1 AT MALDA	04.01.2023	For 132 KV GIS Commissioning work (GIB erection of ICT-I)
132KV-BARHI-RAJGIR-1	25.03.2023	Dismantling of tower no. 227, 228, and 229 crossing the premises of Mahabodhi Cultural centre along with Destringing of conductor of both circuits and Earthwire between tension tower no. 218-237 in same line.
132KV-NALANDA-BARHI(DVC)-1	25.03.2023	
220KV-TSTPP-MEERAMUNDALI-2	10.06.2023	Tower collapse at loc no 41, 42 (from Meramundali end). Ckt1 charged through ERS.
400KV-KHSTPP-BARH-1	04.08.2023	Upgradation of Bay equipments at KHSTPP
400/220KV 315 MVA ICT 1 AT TSTPP	09.08.2023	Acetylene violation in ppm during routine DGA analysis
220KV-BUDHIPADAR-KORBA-2	16.08.2023	For Checking and rectification work for Both Main and Check meter at Korba end
220KV-KARAMNASHA (NEW)-PUSAULI-1	04.09.2023	Tripped on Y-Ph Fault. Tower bending was observed after patrolling. It is under the process of restoration.
400/220KV 315 MVA ICT 2 AT TSL KALINGANAGAR	04.09.2023	Yearly Maintenance & connection of cable at LV side of the ICT

Transmission licensees/ Utilities are requested to update expected restoration date & work progress regarding restoration regularly to ERLDC/ERPC on monthly basis by 5th of each month so that status of restoration can be reviewed in OCC. Utilities are also requested to update outage of any elements within their substation premises like isolator/breaker to ERLDC/ERPC regularly. (Reported as per Clause 5.2(e) of IEGC)

ITEM NO. D.3: Commissioning of new units and transmission elements in Eastern Grid in the month of August-2023

The details of new units/transmission elements commissioned in the month of August -2023 based on the inputs received from beneficiaries:

LIST OF NEW ELEMENTS CHARGED DURING AUGUST, 2023

GENERATING UNITS

SL. NO.	Location	OWNER/UNIT NAME	Unit No/Source	Capacity added (MW)	Installed Capacity (MW)	DATE	Remarks
NIL							

ICTs/ GTs / STs

SL. NO.	Agency/ Owner	SUB-STATION	ICT NO	Voltage Level (kV)	CAPACITY (MVA)	DATE	Remarks
1	WBSETCL	Durgapur (Biddhanagar)	3	400/220	315	17-08-2023	ICT 3 was first time charged on 17-08-2023 at 19:37 Hrs. with charging code ER/08/C/00805. Format IV was issued on 17-08-2023.

TRANSMISSION LINES

SL. NO.	Agency/ Owner	LINE NAME	Length (KM)	Conductor Type	DATE	Remarks
1	JUSNL	400 kV Tenughat – Patratu S/C Line anti-theft charging from Tenughat end [upto 64 kms] (upto Patratu gantry)	64	ACSR Twin Moose	16-08-2023	Line was first time anti- charged on 16-08-2023 at 13:02 Hrs with code ER/08/AC/00733 from Tenughat end upto gantry of Patratu. Format IV was issued on 16-08-2023.

2	PGCIL	400 kV Sitamarhi (PGCIL) - Dhalkebar (Nepal) Line 1 anti-theft charge from Sitamarhi end upto Indian portion along with associated Main bay and Tie bay at Sitamarhi end	35.744	ACSR Moose	01-09-2023	Line was anti-theft charged on 01-09-2023 at 00:25 Hrs with code ER/09/AC/00002 & NL/0001 upto Indian portion. Format IV was issued on 31-08-2023.
3	PGCIL	400 kV Sitamarhi (PGCIL) - Dhalkebar (Nepal) Line 2 anti-theft charge from Sitamarhi end upto Indian portion along with associated Main bay and Tie bay at Sitamarhi end	35.744	ACSR Moose	01-09-2023	Line was anti-theft charged on 01-09-2023 at 00:47 Hrs with code ER/09/AC/00007 & NL/0002 upto Indian portion. Format IV was issued on 31-08-2023.
4	PGCIL	400 kV Maithon (PGCIL) - Maithon RB (MPL) Line 1 after re-conductoring work along with associated bays at both ends	31.5	Twin HTLS	05-08-2023	Line was first time charged on 05-08-2023. Format IV was issued on 04-08-2023.
5	PGCIL	400 kV Maithon (PGCIL) - Maithon RB (MPL) Line 2 after re-conductoring work along with associated bays at both ends	31.5	Twin HTLS	05-08-2023	Line was first time charged on 05-08-2023. Format IV was issued on 04-08-2023.
6	NTPC	33 kV Darlipalli (NTPC) - Dulanga CMP Line 2	8.3 (OH) + 0.8 (XLPE cable)	Panther	31-08-2023	Line was charged for the first time on 31-08-2023 at 18:37 Hrs. with charging code ER/08/C/01548. Format IV was issued on 29-08-2023.

LILO/RE-ARRANGEMENT OF TRANSMISSION LINES

SL. NO.	Agency/ Owner	Line Name/LILO at	Length (KM)	Conductor Type	DATE	Remarks
NIL						

BUS/LINE REACTORS

SL. NO.	Agency/ Owner	Element Name	SUB-STATION	Voltage Level (kV)	DATE	Remarks
1	WBSETCL	400 kV 125 MVAR Bus Reactor 2 at Durgapur (Bidhannagar-WB) [Bay Number 412]	Durgapur (Biddhan agar)	400	31-08-2023	Reactor was first time charged on 31-08-2023 at 18:31 Hrs. with charging code ER/08/C/01552. Format IV was issued on 31-08-2023.

HVDC /AC Filter bank / FACTS DEVICE associated System

SL. NO.	Agency/ Owner	Element Name	SUB-STATION	Voltage Level (kV)	DATE	Remarks
NIL						

BAYS

SL. NO.	Agency/ Owner	Element Name	SUB-STATION	Voltage Level (kV)	DATE	Remarks
NIL						

Bihar: Nil

Odisha:

Elements charged for first time in August-2023			
Sl No.	Name of the element charged first time	Date	Time
1	132kV DC line (4 conductor) from 132/33kV GSS, Brajarajnagar to Belpahar RTSS Ckt-I & II	23/08/2023	14:51HRS & 14:52HRS

Members may note.

ITEM NO. D.4: UFR operation during the month of August 2023.

Frequency profile for the month as follows:

MONTH	MAX (DATE/TIME)	MIN (DATE/TIME)	% LESS IEGC BAND	% WITHIN IEGC BAND	% MORE IEGC BAND
Aug, 2023	50.29 Hz on 24-08-2023	49.50 Hz on 31-08-2023	7.1	77.3	15.6

	at 13:02 hrs	at 22:25 hrs			

Hence, no report of operation of UFR has been received from any of the constituents.

Members may note.

****

TITLE

DETAILED PROJECT REPORT

FOR

IMPLEMENTATION OF WIDE AREA MONITORING SYSTEM (WAMS) AT JUSNL GRID

PROJECT:

PROVIDING SPECIAL CONSULTANCY SERVICES FOR PREPARATION OF ROAD MAP AND PMC FOR IMPLEMENTATION OF SMART GRID TECHNOLOGIES, WAMS, SAMAST AT JUSNL IN JHARKHAND STATE

OWNER:

JHARKHAND URJA SANCHARAN NIGAM LIMITED

June 2023

TCE.11252A-EL-4021-DP-06

Revision Status

R4/16-06-2023	SN	MP	AKN	AKN
R3/26-09-2022	MP	SR	AKN	AKN
R3/19-02-2021	AP/PRS	AKN/PB	AKN/DR. FK	AKN
R2/15-11-2019	SRN	AKN/PB	AKN/DR. FK	AKN
R1/28-05-2019	AK/SRN	AK/PRS	AKN/DR. FK	AKN
R0/15-03-2019	AK/SRN	AK/PRS	AKN/DR. FK	AKN
P0/22-01-2019	AK/SRN	AK/AJJ	AKN	AJJ
REV NO. / DATE	PREPARED BY	CHECKED BY	CLEARED BY	APPROVED BY

TABLE OF CONTENTS

DISCLAIMER

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Abbreviations

The following abbreviations are used in this Inception Report:

Abbreviation	Full Name
AC	Alternating Current
CEA	Central Electricity Authority
CTU	Central Transmission Utility
CPP	Captive Power Plant
DPR	Detail Project Report
EHV	Extra High Voltage
ERLDC	Eastern Region Load Dispatch Centre
FOTE	Fiber Optic Terminal Equipment
GOI	Government of India
GOJ	Government of Jharkhand
GSS	Grid Substation
Hz	Hertz
HV	High Voltage (as per Indian Electricity Rules)
ICAO	International Civil Aviation Organization
IEC	International Electrotechnical Commission
IEEE	Institution of Electrical and Electronic Engineers
IEGC	Indian Electricity Grid Code
IIOT	Industrial Internet of Things
IS	Indian Standard
ISO	International Standards Organization
JSEB	Jharkhand State Electricity Board
JUSNL	Jharkhand Urja Sancharan Nigam Limited
JPSIP	Jharkhand Power System Improvement Project
KV	Kilo Volt
KW	Kilo Watt
MVA	Mega Volt Ampere
O&M	Operation and Maintenance
OPGW	Optical Ground Wire
PSDF	Power System Development Fund
TCE	Tata Consulting Engineers Ltd.
TPDDL	Tata Power Delhi Distribution limited

SUMMARY OF PROPOSAL

Format A1

Page 1 of 2

For Official Use - To be filled by the Nodal Agency	
Project Proposal Number : _____	Date of Receipt : _____

To be filled by the Requesting Organization / Project Entity	
1. Name of the requesting Organization / Utility :	Jharkhand Urja Sancharan Nigam Limited
2. Short Summary of Project / Scheme / Activity	
a. Name and location of the Project / Scheme / Activity :	Implementation of Wide Area Monitoring System (WAMS) at JUSNL Grid
b. Objective of the Project / Scheme / Activity:	Implementation of Wide Area Monitoring System (WAMS) at JUSNL Grid
c. Authorized Person For this Project / Scheme / Activity	Name : Shri Arun Kumar_____ E-mail ID : sldcranchi@gmail.com,_____ Land line No : _____ Mobile No. : 7070816390_____ Fax No : _____
d. Nature of the Project / Scheme / Activity: Inter – State / Intra – State (Please Specify)	Intra State
e. Identified Beneficiaries	The state of Jharkhand in particular JUSNL, JBVNL and Consumers connected to JUSNL Grid
f. Merits of the scheme	• Post Event Analysis Tools with Accurately Time-Tagged Data • Oscillation Monitoring, Detection & Location Tool (Non-Control Room Initially) • Offline Planning Model Validation Tool • Wide Area Visibility and Situational Awareness in Control Room • Monitoring of V, f, df/dt, P, Q, and Angle Difference at Boundaries • Enhanced System Oscillation Monitoring, Detection & Location (Online) • Asset Commissioning and Compliance Monitoring

g. Limitations, if any	No limitation envisaged. Only partial shutdown is required to replace one circuit keeping the other circuit of the double circuit line live. This can be managed judiciously.
h. Time frame for Implementation	The scheme is scheduled to be completed within 18 months progressively from the date of receipt of sanction of the fund/grant from PSDF
i. Estimated Cost of Project / Scheme / Activity	Rs. 38.10 Crores/- (Rupees Thirty Eight Crores and Ten Lakhs Only) including GST. (As per the DPR prepared by M/s. TPDDL/TCE the estimate cost is Rs. 38.10 Crores based on the PMU's & PDC considered in JUSNL Grid)
j. Category under which the project is classified (Please refer Para 5.1 of the Guidelines/Procedure)	Project is classified as per clause 5.1(c) of the PSDF Guidelines for disbursements of Funds from PSDF – "Installation of standard & special protection schemes, pilot and demonstrative projects, projects for setting right the discripancies identified in protection audits on regional basis, any communication/ measurement/ monitoring scheme including installation of Phasor Measurement Unit (PMU's) etc.".

Date: _____

Signature: _____

Name: Arun Kumar_____

(Authorized Representative)

Format A2

DETAILED PROPOSAL (DP)

1. Details of the Requesting Organization / Project Entity

1.1 Details of Organization / Entity

Name of Organization / Entity	Jharkhand Urja Sancharan Nigam Limited
Acronym or Abbreviation (if applicable)	JUSNL

1.2 Details of Head of the Organization

Name (Mr / Ms / Mrs)	Mr. K K Verma
Designation	Managing Director
E-mail Address	md@jusnl.in, mdjusnl@gmail.com
Landline No.	
Fax No.	
Address	JUSNL Building, Kusai Colony
City	Ranchi
Postal Code	834002

1.3 Details of Project Incharge / Project Manager (Authorized Person) for this project/ scheme/ activity
(Not below the rank of Dy. General Manager / Superintending Engineer)

Name (Mr / Ms / Mrs)	Mr. Arun Kumar
Designation	General Manager, SLDC
E-mail Address	sldcranchi@gmail.com
Landline No.	
Mobile No.	7070816390
Fax No.	
Address	JUSNL Building, Kusai Colony
City	Ranchi
Postal Code	834002

Any Change in above mentioned details may be notified to the Nodal Agency of PSDF immediately.

Signature: _____

Name: Arun Kumar_____

(Authorized Representative)

2. *Justification of the proposal*

The analog & digital information related to the power system, measured at the substation level is presented (typically, every 10 seconds) to the Load Despatch Centre through the SCADA/ EMS, whereas Phasor Measurement Units (PMU's) can report as many as 60 measurement per second. High-speed monitoring can detect and record events that SCADA fails to capture, enabling much better visibility into grid conditions. Also, angular separation between coherent groups of generators within a synchronous grid is representative of the stress in the grid. Unfortunately, the measurement of angular separation and its telemetry at the control centre level in SCADA/ EMS has limitations. Therefore, the load angle is either 'estimated' from the available SCADA data or the angular separation between a pair of substations is derived offline with the help of power flow on the line, impedance of the line and respective terminal voltages. Both these methods have their limitations due to low resolution, data latency and inaccuracies inherent in SCADA/ EMS System. This has resulted in a poor visibility of grid health leading to blackouts and cascade failures.

WAMS system uses Phasor Measurement Unit (PMU) as smart sensor. The PMU measures the system state viz. voltage and angle of a particular location at a rate of multiple samples per second (say 25/50 samples per second). This data is then time stamped through a common reference of GPS time and transmitted to the Phasor Data Concentrator (PDC) installed at a nodal point, through high speed wideband communication medium (such as Optical Fibre). The PDC aligns the time synchronized data and presents it to the User/Historian. The Historian archives the data for retrieval and post-dispatch analysis of the grid. Following are a few applications of phasor data:

- Phasor data is valuable for online as well as off-line investigation of grid disturbances, improving both the speed and quality of analysis.
- It helps in quicker post-mortem analysis, sequence of events & root cause analysis.
- Dynamic model verification: Generator model calibration, CT/PT calibration, Load characterization
- Base-lining: Assess dynamic performance of the grid, Steady-state angular separation, System disturbance impact measures.

- Protection & Control: Primary frequency (governing) response, monitoring electro-mechanical oscillations, Dynamic Island Management.

In view of the above WAMS System provides the greater visibility of Grid to make decision on real time basis with implementating the WAMS applications as listed above.

2.1 Target benificiaries

The beneficiaries of the project are State of Jharkhand in particular JUSNL, JBVNL and Consumers connected to JUSNL Grid.

With implementation of the scheme, the JUSNL grid, part and person of one grid, will run more efficiently and more effectively. So, reliability of the grid can be achieved.

2.2 Identified source of funding

90% of the total project cost is to be funded through grant from PSDF. Balance amount will be contributed from internal resources.

2.3 Details of Activities for Project/Scheme/Activity

After getting approval of the DPR towards funding, the following activites will be carried out for successful implementation of WAMS System.

All the technical specifications required for the execution works and material procurement works will be prepared as per the guidelines in applicable International, Indian standards and CEA recommendations.

JUSNL will invite open tenders on e-procurement platform.

After award of contract on L1 basis the work will be supervised and monitored at site till successful implementation.

2.4 Executing Agency

The project will be implemented through the Contractor selected based on open tendering process.

JUSNL which functions as the State Transmission Utility, has appointed TataPowerDDL and TCE as consultant for preparation of DPR, Tender document and providing support to JUSNL in implementation of the project.

All the work involved will be implemented in close association of JUSNL Engineering and O&M teams at various zones.

2.5 Time Line for Implementation of Project/Scheme/Activity

Time line for implementing this project is given below considering zero/start date as receipt of PSDF grant approval.

Timeline of the Project / Scheme / Activity	
Duration of Project (in Months)	18 Months
Likely Start Date	July-2023
Likely Completion Date	December, 2024

FOR TIMELINE OF ACTIVITIES, PLEASE REFER ANNEXURE 4

Date:

Signature: _____

Name: Arun Kumar

(Authorized Representative)

Summary of Detailed Project Report (DPR)

A Detailed Project Report (DPR) is attached which include Background, Project Objectives, Benefits and beneficiaries, Technologies, cost estimates and BOQ.

Summary of DPR given – Yes

Copy of the DPR attached. – Yes

Date:

Signature: _____

Name: Arun Kumar

(Authorized Representative)

Financial Implication of the Scheme

Format A4

1. Summary

S.No.	Item	Amount in Rs.
1.	Total Cost Estimate	Rs. 38.10 Crores/- (including GST)
2.	Funding Proposed from PSDF	90%
3.	Contribution from Internal Sources	10%
4.	External Borrowings	NIL

2. Details

2.1 Cost Estimate

The cost estimate for all equipment/material in the project is based on the DPR prepared by JUSNL/TPDDL/TCE in respect of WAMS for JUSNL network. Summary is given below. Details of cost estimate is given in attached Annexures. Costs are based on market rate and same are verifired with vendors.

Sr. No	Technology	Cost in Crores (Excluding GST) INR	Cost in Crores (Including GST) INR	Annexures Reference
1	PMU AND ITS HARDWARE COST AT SUBSTATIONS	14.81	17.48	Annexure 2
2	PDC & APPLICATION COST (INCLUDING HARDWARES, SOFTWARES) AT SLDC	17.32	20.61	
	TOTAL	**32.14**	**38.10**	

3. Funding

3.1 Funding Proposed from PSDF as grant

90% grant from PSDF is requested for successful implementation of the project for existing substations and Grid in a time bound manner.
JUSNL is already estabilishing 60 new substations and associated lines of 400kV, 220kV and 132kV under various mode i.e. State funded, World Bank funded and PPP. There is already lot of financial burden on JUSNL due to existing commitments towards 24x7 power supply. As such JUSNL is not in position to take more financial burden.

3.2 Contribution from Internal Sources

Balance amount will be contributed from internal sources.

3.3 External Borrowings

No external borrowings will be necessary.

UNDERTAKING

I, Mr. Arun Kumar resident of Ranchi working as General Manager, SLDC in JUSNL here by undertake to comply with the following terms and conditions with regard to funding of the **"IMPLEMENTATION OF WIDE AREA MONITORING SYSTEM (WAMS) AT JUSNL GRID"** with disbursement from PSDF:

- No tariff shall be claimed for the portion of the scheme funded from PSDF.
- Amount of grant shall be refunded in case of transfer/disposal of the facility being created under this proposal to any other scheme for funding.
- Shall specifically mention if for the scheme under the proposal, the grant from any other agency is being taken / proposed to be taken.
- The grant shall be refunded back to PSDF in case of non-utilisation of the grant within one year of release of instalment.

Date:

Signature: _____

Name: Arun Kumar_____

(Authorized Representative)

Brief Details of the Project Appraisal by CTU / STU / RPC

The applicant utility shall submit project appraisal by CTU / STU / RPC In the given format and a copy of the Appraisal Report should be attached at Annexure

Item	Details to be filled by Applicant Utility	
Appraisal By	**CTU** [ ] **STU** [JUSNL] **RPC** [ ]	
Date of Submission to CTU / STU / RPC for approval		
Name of the Scheme	Project on "IMPLEMENTATION OF WIDE AREA MONITORING SYSTEM (WAMS) AT JUSNL GRID" in Jharkhand State.	
Details of the Appraisal Report by CTU / STU / RPC (Attached to Annexure)	Refer to Detailed Project report.	
Summary of observations from CTU/STU/RPC Appraisal Report	Summary of Proposal Appraised	Jharkhand Urja Sancharan Nigam Ltd (JUSNL), the State Transmission Utility (STU) of Jharkhand owns and operates intra-state transmission system of Jharkhand and is responsible for transmission of electricity to the Distribution entity of Jharkhand from the Generating Plants of the State as well as from Central Generating Utilities and the power contracted from other sources. At present, JUSNL has 01 number of 400kV GSS, 14 nos. of 220kV GSS and 39 nos. of 132kV GSS having transformation capacity of appx 6500 MVA and appx 4000 CKM of transmission line of different voltage level to cater power supply in Jharkhand state. Power system in the state is expanding very fast and with increased number of interconnections between Regions, many new technologies are being implemented. In addition, Grid is characterized by wide variation of Power flow due to variation in demand/generation during day/seasons. Further, consumer aspiration for quality and reliable power supply is increasing. In view of increase in complexilty in network has to be monitored closely by proposing WAMS so thet preventive action can be taken for Grid

		Management and avoid cascaded tripping and black out. Hence JUSNL requests funding from PSDF for installations of PMUs and MPLS router at optimised substation locations and PDC with necessary hardware and analytic software at SLDC in Ranchi.
Summary of observations from CTU/STU/RPC Appraisal Report	Technical Observations	WAMs applications have an element of both offline analysis and real-time control room use (such as model validation, phasor-based analytics, and black-start / system recovery) but it must be noted that there are strict data security, reliability and redundancy requirements imposed on control room processes. Control room implementation, therefore, necessitates robust and accurate WAMS applications which may take several years of deployment and development before they can be used in real-time or automated processes. In addition to above mentioned applications, below is a list of applications WAMS system and can be classified as Post event analysis, Planning and Control applications. • Post Event Analysis Tools with Accurately Time-Tagged Data • Oscillation Monitoring, Detection & Location Tool (Non-Control Room Initially) • Offline Planning Model Validation Tool • Wide Area Visibility and Situational Awareness in Control Room • Monitoring of V, f, df/dt, P, Q, and Angle Difference at Boundaries • Enhanced System Oscillation Monitoring, Detection & Location (Online) • Asset Commissioning and Compliance Monitoring Implementation of scheme involves the following activities. It is proposed to install two nos. PMUs and accessories at 01 number of 400kV/220kV existing substation, 14 nos. 220kV/132kV existing substations and at 21 nos. 132/33kV existing substations to enable observability of complete existing JUSNL network and its interconnections with various source of power like PGCIL, IPPS, DVC etc. CT/PT inputs to PMUS will be extended from CRP panels nearby in Control room. In order to have necessary bandwidth in communication over OPGW, MPLS-IP FOTE is proposed at each 35 substation locations by replacing existing SDH FOTE. AC/DC supply to PMUs, MPLS terminal equipment and PDC and accessories will be extended from existing ACDB and DCDB by

		suitable cabling. Dual PDC sets will be provided in existing SLDC along with all hardware, PDC software and Analytic software. This will provide necessary observability to operators in control room.
	Financial Observations	i) Total cost of the scheme works out to **Rs. 38.1 Crores.** ii) 90% grant is expected from PSDF. ***90% grant is required for as there is financial burden on JUSNL due to various projects undergoing for expansion of network to meet load growth.***
	Compliance of Grid Standards/ Codes by the Applicant	JUSNL is government owned state utility of Jharkhand State and follows the guidelines and regulations issued from time to time by relevant authorities like CEA, CERC, JERC, ERPC, MoP of Govt. of India Ltd.
	Limitations/ Shortcomings pointed out by CTU/ STU/ RPC if any	Implementation of the scheme, if is to be taken up by JUSNL with its internal financial resources will take substantially longer time of around 8 to 10 years and will always be lagging behind the up to date requirements of future improvements. Hence grant from PSDF is essentially required to provide PMU based Wide Area Monitoring System to meet the present day requirements of grid operations, load management and smooth and unhindered operation of power system in the state of Jharkhand.
	Recommendations of CTU/STU/PRC	JUSNL recommended and firmly believes that the proposed scheme is qualified for grant from PSDF.

Date:_____ Signature:_____

Name:_Mr. Arun Kumar

(Authorized Representative)

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UNDERTAKING

(On a Non-judicial Stamp paper of Rs. 50 only duly notarized and attested)

I, Dr./ Mr./ Ms……son/daughter/wife of…….
resident of……..(full address) and presently working as …… in the……

hereby undertake to comply with the following terms and conditions with regard to funding of the ……(name of the scheme) with disbursement from PSDF:

- **No tariff shall be claimed for the portion of the scheme funded from PSDF.**
- **Amount of grant shall be refunded in case of transfer/disposal of the facility being created under this proposal to any other scheme for funding.**
- **Shall specifically mention if for the scheme under the proposal, the grant from any other agency is being taken / proposed to be taken.**
- **The grant shall be refunded back to PSDF in case of non-utilisation of the grant within one year of release of installment.**

Date: _____

Signature: _____

Name:
_____

(Authorized Representative)

DETAILED PROJECT REPORT

WIDE AREA MONITORING SYSTEM (WAMS)

1. INTRODUCTION

Complex power systems need better observability and visualization capabilities to handle critical situations effectively. Synchro-phasor measurements provide intra second visibility to power system dynamics and enable faster control actions. Further, the phasors computed are time synchronized enabling power system state determination and analysis of dynamic phenomenon using the information. The wide area visibility based on remote measurements, and two-way communication makes this technology suitable for adaptive relaying, adaptive islanding etc.

A key element in the development of smart power transmission systems over the past decade is the tremendous advancement of the Wide-Area Monitoring System (WAMS) technology, also commonly referred to as the Synchro-phasor technology.

Sophisticated digital recording devices called Phasor Measurement Units (PMUs) are currently being installed at different points to record and communicate GPS-synchronized, high sampling rate, dynamic power system data.

Power system operators are assured that Synchronized Measurement Technology (SMT) will significantly improve the stability of future power systems, and that a SMT-based WAMs system will be the only way for managing and monitoring and the future power systems.

This topic covers the core components of a WAMPs system, e.g. measurement devices, data concentrators and communication technologies, and their connectivity.

2. DESCRIPTION

Conventionally the analog & digital information related to the power system, such as circuit breaker status, frequency, voltage and power flow (MW/MVAr) measured at the substation level is presented (typically, every 10 seconds) to the Load Despatch Centre through the Supervisory Control and Data Acquisition/ Energy Management System (SCADA/ EMS) whereas, Phasor Measurement Units (PMUs) can report as many as 60 measurements per second. This high-speed monitoring can detect and record events that SCADA fails to capture, enabling much better visibility into grid conditions. Also, angular separation between coherent groups of generators within a synchronous grid is representative of the stress in the grid. Unfortunately, the measurement of angular separation and its telemetry at the control centre level in SCADA/ EMS has limitations. Therefore, the

load angle is either 'estimated' from the available SCADA data or the angular separation between a pair of substations is derived offline with the help of power flow on the line, impedance of the line and respective terminal voltages. Both these methods have their limitations due to low resolution, data latency and inaccuracies inherent in SCADA/ EMS System. This has resulted in a poor visibility of grid health leading to blackouts and cascade failures

WAMS system uses Phasor Measurement Unit (PMU) as smart sensor. The PMU measures the system state viz. voltage and angle of a particular location at a rate of multiple samples per second (say 25/50 samples per second). This data is then time stamped through a common reference of GPS time and transmitted to the Phasor Data Concentrator (PDC) installed at a nodal point, through high speed wideband communication medium (such as Optical Fibre). The PDC aligns the time synchronized data and presents it to the User/Historian. The Historian archives the data for retrieval and post-dispatch analysis of the grid. Following are a few applications of phasor data:

- Phasor data is valuable for online as well as off-line investigation of grid disturbances, improving both the speed and quality of analysis .
- It helps in quicker post-mortem analysis, sequence of events & root cause analysis.
- Dynamic model verification: Generator model calibration, CT/PT calibration, Load characterization
- Base-lining: Assess dynamic performance of the grid, Steady-state angular separation, System disturbance impact measures.
- Protection & Control: Primary frequency (governing) response, monitoring electro-mechanical oscillations, Dynamic Island Management.

Figure below shows a generally accepted architecture of WAMS system:

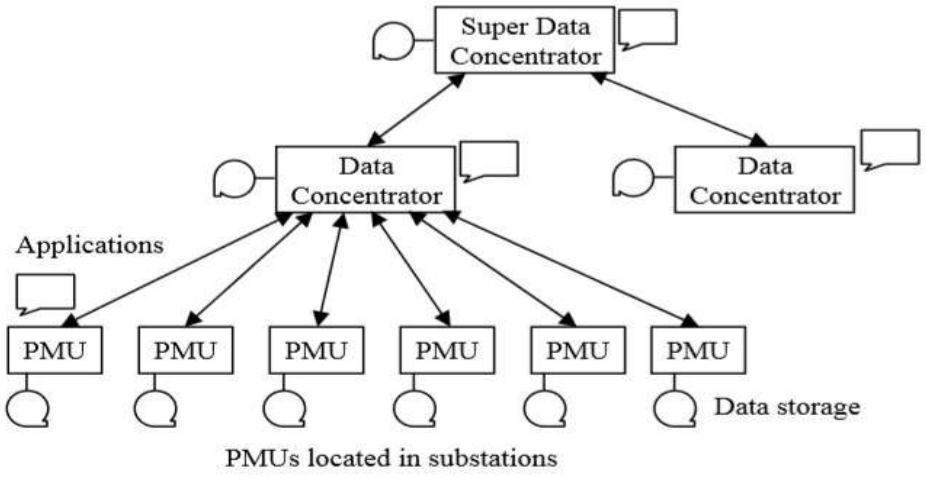


Figure 1: Hierarchy of the Phasor Measurement Systems

PMUs located in substations collect real-time data, usually from the existing potential and current transformers. It generates IEEE C37.118 compliant data frame after GPS time stamping. The PMUs are connected to a high-speed communications system to stream these data frames to applications and data archives. Multiple data streams may converge at phasor data concentrators (PDCs) located between the PMU and the application. The PDC compiles measurement samples taken at the same time and time-aligns them for storage and analysis. A PDC generally performs other functions such as rejecting bad data or archiving the data streams. The data streamed into a PDC may be used for immediate analysis or relayed on a highspeed wide-area communications network to a higher-level PDC or to historian. It may involve analytical applications such as wide-area visualization tools, state estimators, and alarm processors.

3. EXISTING STANDARDS

Various standards are available covering different aspects of WAMS system which includes data streaming, exchange and retrieval with PMU/PDC/Historian and other power grid sub-systems including merging units, IEDs, Process bus, and station bus. The list of these standards is provided below.

- IEEE Standard 1344 is the first standardized protocol developed for synchronization and transmission of phasor measurements.
- IEEE C37.118- Synchrophasor Streaming Data
- IEEE C37.111- COMTRADE file format for synchrophasors

- IEEE C37.244- Guide for Phasor Data Concentrator Requirements for Power System Protection, Control, and Monitoring.
- IEEE C37.233- for system testing of protection systems. Various elements of this document are relevant to PMU, PDC, and synchrophasor system testing.
- IEEE C37.239- This standard applies if the PMU is capable of collecting event data and storing it in the COMFEDE format. If desired, the PDC may need to have the ability to retrieve files in the IEEE Common Format for Event Data Exchange (COMFEDE) from the PMU.
- IEEE C37.240- Standard for Cyber Security Requirements for Substation Automation, Protection, and Control Systems, defines cyber security requirements for substation automation, protection, and control systems. It presents sound engineering practices that can be applied to achieve high levels of cyber security of automation, protection, and control systems independent of voltage level or criticality of cyber assets.
- IEC 61850 standard provides interoperable foundation for data exchange among various intelligent devices. Of special interest to WAMS is the Technical Report IEC 61850-90-5 specifying synchrophasor data mapping and wide area transport using IEC 61850 generic object-oriented substation event (GOOSE) and sample values (SV) data services. It also specifies UDP mapping for both message types and security mechanisms necessary for reliable synchrophasor data transmission.
- IEC 61970- PDC data may be stored in a common database that requires all data to be represented in the common information model (CIM) format. In that case, the test may include a check of an ability of a PDC to store data in the IEC 61970 (CIM) format.
- IEEE 1613- This standard defines environmental and testing requirements for communications networking devices in electric power substations. It has been compiled from the relevant clauses in IEEE Std C37.90TM-1989, IEEE Std C37.90.1TM-2002, IEEE Std C37.90.2TM-1995, and IEEE Std C37.90.3TM-2001. In addition, it requires that the transmit/ receive functions be activated during the

application of the transients and establishes two Performance Classes. In Performance Class 1, the communication functions may be disrupted during the application of the transients but recover without human intervention when the transient is removed. Performance Class 2 requires that the communication functions are not disrupted during the application of the transients. Given the severity of these transients, Class 2 essentially mandates the use of fiber-optic cable for all communications.

- Distributed Network Protocol (DNP3)
- IEC 60870-6 Inter-Control Center Protocol (ICCP)
- IEEE 1379 Data Communications between IED's & RTU's in a Substation
- IEEE 1525 Standard for Substation Integration Communications
- IEEE 1588 Precision Time Protocol
- IEEE 1686 Substation Intelligent electronic Devices (IEDs) Cyber Security Standards Key Interoperability Barriers
- IEEE 1711 Trial Use Standard for a Cryptographic Protocol for Cyber Security of substation Serial Links

4. APPLICATIONS OF WAMS

Some of the WAMs applications have an element of both offline analysis and real-time control room use (such as model validation, phasor-based analytics, and black-start / system recovery) but it must be noted that there are strict data security, reliability and redundancy requirements imposed on control room processes. Control room implementation, therefore, necessitates robust and accurate WAMS applications which may take several years of deployment and development before they can be used in real-time or automated processes.

In addition to above mentioned applications, below is a list of applications WAMS system and can be classified as Post event analysis, Planning and Control applications.

4.1. Post Event Analysis

a. Analysis of faults / Grid incidents

Fault detection, classification and analysis

- Stress in the grid
- Faults in Transmission Line, power station/grid substation
- Tripping due to lack of protection co-ordination/Instrument error.
- Faults involving high impedance
- Faults cleared by back up protections
- Real time angle difference between the nodes
- Dynamic line rating
- Visualization of PSS testing

b. Detection and analysis of oscillations in the power system

Low frequency Oscillation (LFO) monitoring and damping

- Inter Area Oscillation
- Inter Plant Oscillation
- Inter & Intra Plant Oscillation

c. Post-dispatch analysis of grid operation

- Detection of coherent group of generators
- Island Detection & Resynchronization to Grid
- Dynamic Model Validation

d. **Enhancing situational awareness, alarming**

- Monitoring during blackouts and cascade failures

4.2. System Planning Applications

The use of time-synchronised measurements through WAMS delivers similar benefits to system planning through improved analysis accuracy and capabilities. WAMS facilitates or supports the following applications to system planning activities:

- Dynamic model validation and calibration
- Backup to the existing SCADA
- Achieve marginal boundary increases, deferring major reinforcements until the need case is firm

- Asset Performance indication
- Line Parameter Estimation
- Data analytics (Complex Event Processing)
- Black-Start planning
- Condition control measures and optimise settings

4.3. Control Room (Real-Time System Operation) Benefits

The continuous observation of oscillatory stability can be used to validate the accuracy of dynamic models of the system by identifying differences in modelled and observed performance that highlight areas to prioritise for more detailed investigations. Where there is uncertainty in the model-based evaluation of the stability of the system, the detailed information that can be extracted from time-synchronised measurements offer a greater understanding of system dynamics, improving the model tuning and validation process.

In terms of the applications which have been investigated to date, the following are considered to provide benefit to real-time operation of the system:

- Monitoring and alarming: V, f, df/dt, P, Q, angle difference
- Oscillation Monitoring
- Oscillation Source Location
- Improve State Estimation using Hybrid State Estimation (HSE)

5. BENEFITS OF WAMS

WAMS analysis applications provide the basis for new and improved insight and alarming capabilities to utilities. Time-synchronised measurements offer benefits to both real-time operations in the control room and activities undertaken away from the control room, i.e. applications used for offline post-event analysis (including model validation) and system planning, whereas control room applications involve real-time actions directly affecting the network.

The relationship between cost and benefits area is illustrated in the figure below.

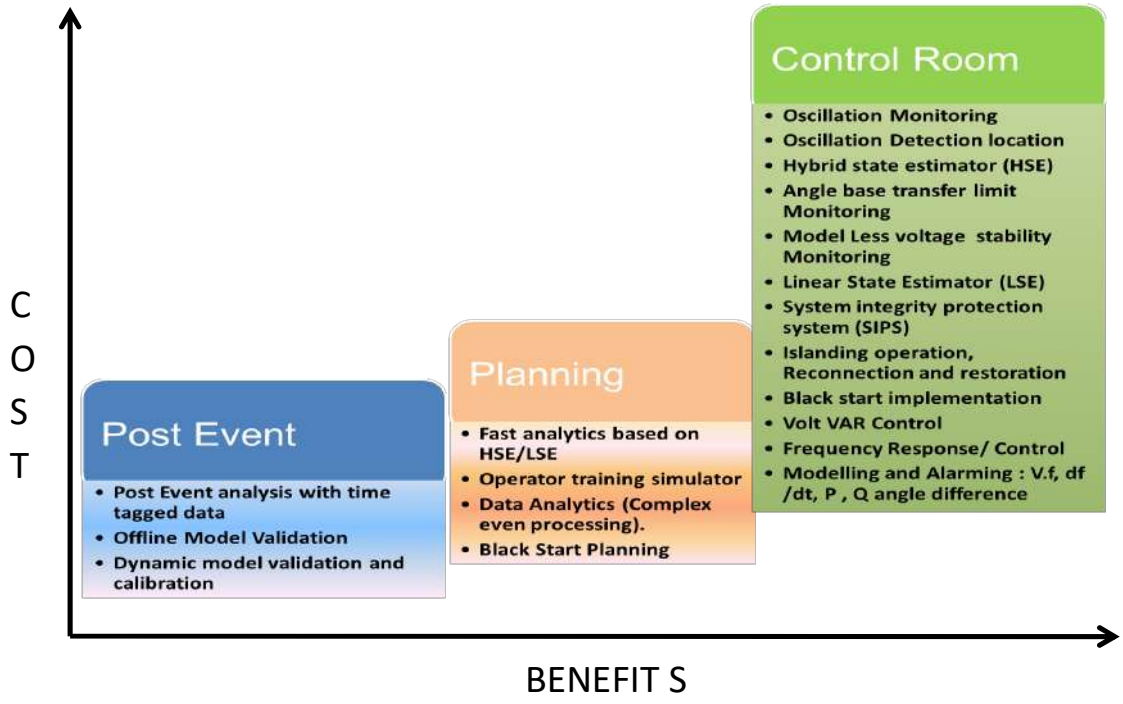


Figure 2: Cost Vs Benefits

The new wide-area monitoring capabilities and analysis tools have proven benefit by increasing visibility and enhance understanding and situational awareness specifically in relation to system dynamics and providing early warning of system risks. The table below captures Application, their benefits in post event, planning stage or control room.

Sr. No.	Benefits	Post Event	Planning	Control Room
A	**Post Event Analysis Tools with Accurately Time-Tagged Data**			
1	Enhancing existing practices by easier and quicker data extraction and time-alignment of multiple sources following an event, which may improve system restoration times and reduce engineer time	√	√	
2	Synchronised measurements facilitate quicker and better accuracy of other applications such as line parameter estimation, to the benefit of system planning.	√	√	

Sr. No.	Benefits	Post Event	Planning	Control Room
3	Enhancing existing practices by easier and quicker data extraction and time-alignment of multiple sources following an event, which may improve system restoration times and reduce engineer time.	√	√	
4	Synchronized measurements facilitate quicker and better accuracy of other applications such as line parameter estimation, to the benefit of system planning.	√	√	
5	Future development could include automated actions and analysis following alarms or on a routine basis.	√	√	
B	**Oscillation Monitoring, Detection & Location Tool (Non-Control Room Initially)**			
1	Improving the monitoring capability of the network by detecting oscillations that would otherwise go undetected and that perhaps may eventually lead to outage or plant damage. Post-Event activities could investigate to determine the cause and potential mitigation actions.	√	√	
2	Incorporating oscillation visibility will provide additional unique insight into system behavior following an event, and the ability to validate system studies and to confirm compliance of grid support services and controlled response.	√	√	
3	Ability to baseline observed behaviour and trends to determine severity, where SSO re-occur.	√	√	
C	**Offline Planning Model Validation Tool**			
1	Synchronized measurements can greatly improve model validation via improved line parameter calculations and dynamic system response, improving accuracy and confidence in model-based applications and analysis.		√	
2	Near-term, this benefits system planners to analyse		√	

Sr. No.	Benefits	Post Event	Planning	Control Room
	network capacity more accurately.			
3	More accurate network models will unlock additional benefits with regards to state estimation and system limits determination.		√	
4	Future development would look to introduce dynamic model validation capability.		√	
D	**Wide Area Visibility and Situational Awareness in Control Room**			
1	Integrating WAMS into the control room offers improved visibility & situation awareness of real-time system dynamics.			√
2	Validate true dynamic system behaviour with expectations. Allows for baselining normal/abnormal operating conditions.			√
E	**Monitoring of V, f, df/dt, P, Q, and Angle Difference at Boundaries**			
1	Ability to better understand dynamic behaviour across power transfer boundaries, including the ability to determine frequency and transient response.	√	√	√
2	Better overall understanding enhances system stability management.	√	√	√
F	**Enhanced System Oscillation Monitoring, Detection & Location (Online)**			
1	Provides the enhanced oscillation awareness capability to detect and locate SSO in real-time which may otherwise go undetected and, if necessary, perform mitigation actions.	√	√	√
2	In the event of an outage, operators can verify whether an oscillation/interaction may have been the cause, improving situational awareness and recovery times.	√	√	√

Sr. No.	Benefits	Post Event	Planning	Control Room
3	Continuous monitoring for SSO allows base lining normal and abnormal operating conditions over time to build understanding so that future oscillations are effectively mitigated or prevented.	√	√	√
G	**Asset Commissioning and Compliance Monitoring**			
1	Utilize WAMS data for commissioning and compliance testing	√	√	√
2	May enable 'remote' commissioning/compliance testing	√	√	√
3	Processes can be developed for real-time or automated operation	√	√	√

TABLE 1: BENEFITS OF WAMS

6. TYPICAL WAMS ARCHITECTURE

Designing a large-scale WAMS system is extremely difficult; meticulous work needs to be done to overcome the unique challenges that will exist for each individual WAMS system.

First of all, a large-scale WAMS system involves a large number of entities (e.g. power utilities, Independent System Operators (ISOs), regional organizations). Each entity has its own specific needs that they wish to have satisfied by the PMU applications.

Secondly, the WAMS system needs to support a large range of applications to satisfy the participants, thus it must accommodate a diverse range of technical requirements, such as data reporting rate, reliability of communication network.

Thirdly, as more power utilities become aware that SMT is essential for the next generation of power systems, a number of new clients will join the WAMS system and the number of PMUs will increase.

Therefore, the system must be scalable and flexible, so that it is capable of accommodating increasing quantities of PMU data and the requirements of the new WAMS participants and clients.

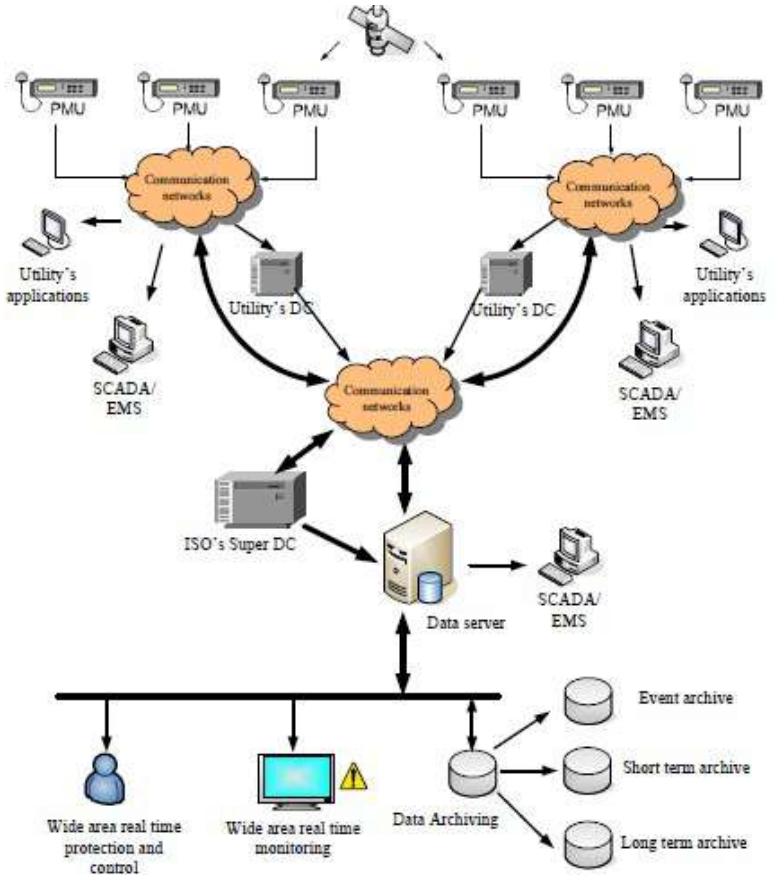


FIGURE 3: TYPICAL ARCHITECTURE OF WAMS

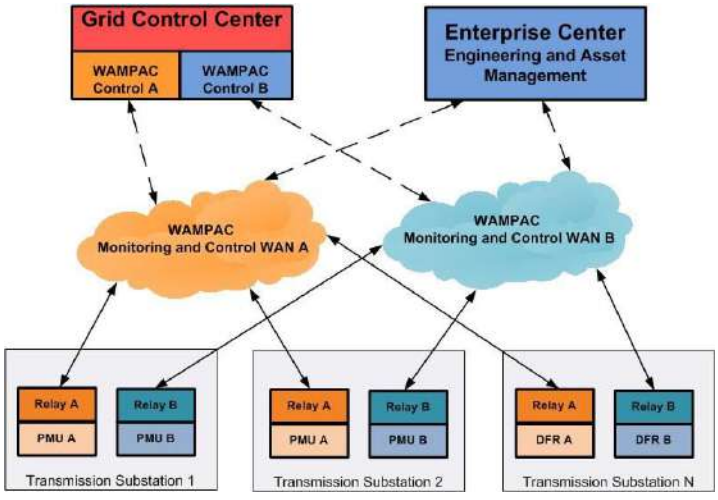


FIGURE 4: REDUNDANT ARCHITECTURE

7. JUSNL WAMS ARCHITECTURE

Typical Architecture in Jharkhand state is shown in below figure

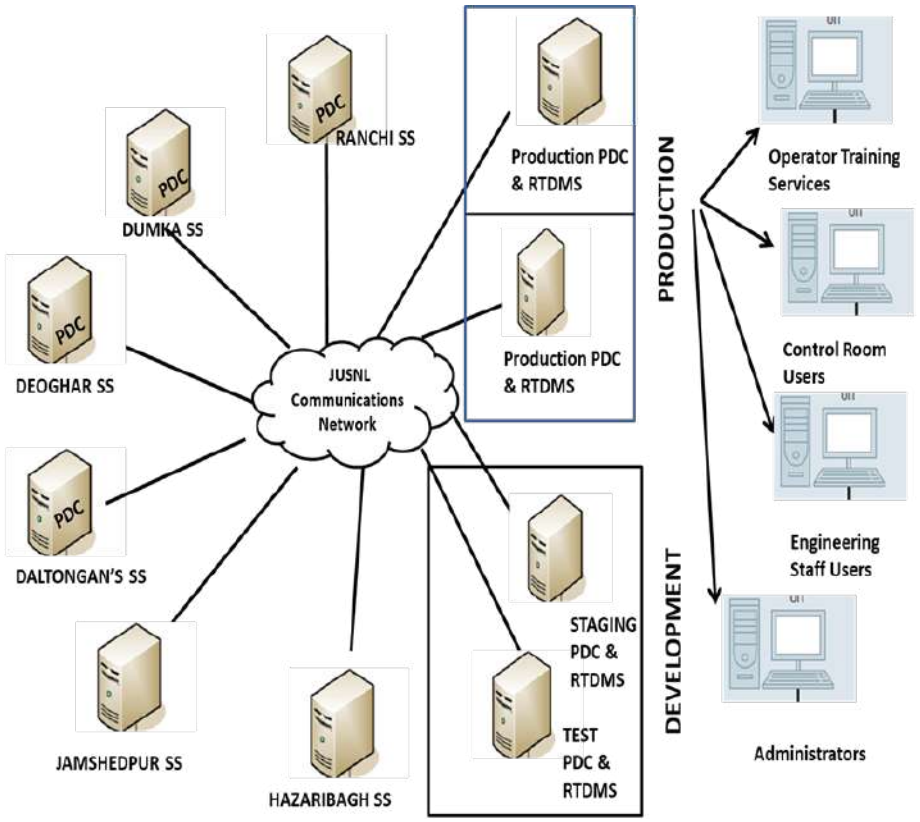


FIGURE 5: TYPICAL WAMS ARCHITECTURE FOR JUSNL

The procedure taken to identify existing structure, standards and gaps, which will need new standardization activities, is described. A top-down approach is adopted. The major applications of Smart Grids are based on the Smart Grid drivers.

a. A detailed procedure is described below as requirements building blocks:

Capturing and describing all the functional and system management requirements of electric energy operations

- Organize operations into domains (e.g. market operations)
- Identify all functions (e.g. distribution automation, generation dispatch) that are/will be/could be used for operations
- Describe each function very briefly
- Identify key interfaces between entities for each function

- Determine all system management requirements (data management, security, etc.) for supporting each function
    - Evaluate and rate the impact of each functional and system management requirement on the design of an architecture.
    - Identify and briefly assess those functions which could have significant impact on architectural designs

b. All general requirements are investigated. One major common requirement for most of the Smart Grid applications and use cases is a high level of interoperability of an increased number of intelligent devices, solutions and organizations. The classical definition of interoperability is given below.

"The ability of two or more systems or components to exchange information and to use the information that has been exchanged."

c. Therefore, interoperability includes operability and controllability of an ever more complex power grid. One main precondition for a smarter grid is intelligent devices, which are required to generate and provide the necessary information. Interoperability has different aspects which will be present in most of the applications. Syntactic interoperability is the ability of two or more systems to communicate and exchange data. This is mainly done through standardized data formats and protocols and therefore is a typical domain for standardization. Syntactic interoperability is the precondition of a higher level of interoperability. The next step is the ability of two or more systems to automatically interpret the exchanged data. This is called semantic interoperability. To achieve this, one must accept a common information exchange reference model. This again is a major domain of standardization.

d. Communication in the above described aspects is a general requirement for all Smart Grid functionalities. The increased exchange and automatic interpretation of information across all major domains of a future power network is therefore investigated in detail. Another common requirement is security. Security is protection against

danger, loss and any criminal actions. Security must include provisions for actions which are intended to prevent harm. Since power grids are considered as critical infrastructures there are already many regulations and requirements through government agencies. However, through the initiation of Smart Grid, information exchange and the controllability of this critical infrastructure will increase significantly. Therefore, Smart Grid requires a new level of cyber security, especially for these aspects.

8. REQUIREMENTS/ KEY CHALLENGES

Based on the experiences of implementing WAMS system in India and abroad, following key technical challenges are identified:

8.1. Communication Backbone

The amount of data collected in WAMS system is relatively large. This makes adequacy of communication infrastructure as one of the biggest challenges in executing the Synchrophasors projects. PMUs are required to be installed at substations which are geographically spread over large area and are at remote locations. Availability of communication infrastructure at the substation is important factor while deciding optimal PMU placement. Some of the PMUs either have to be re-located to different substation having communication feasibility or use of corporate Wide Area Network where communication path is shared with other applications thus compromising data reliability/latency. In general, dedicated fibre channel are required for reliability of real time data.

Therefore, a robust, reliable and future-proof communications architecture is vital to facilitate the increased WAMS data transfer and analysis requirements addressing the cyber security. The solution must be secure to penetration testing. High availability assigned to the end to end asset management services is the key.

The current monitoring services need to be modified to a more secure and resilient service. Data storage is an active issue as the volumes of WAMS data grows and how this data is accessed and archived. One possible solution is to consider the use of substation or regional PDCs reducing the burden on centralised PDCs.

8.2. Different Timescales

Various measurement, protection and control applications require data at different rates, accuracy and timeliness. It is important to recognize the savings that can be accomplished by designing a WAMS to provide data to the most demanding applications (for example system protection or stability monitoring) and to be able to also provide data to other less demanding applications. A well designed WAMS can decimate data and provide data to any application at the rate, accuracy and timeliness required by the specific application.

8.3. Interoperability issues in multi-vendor/multi-protocol system

Generally, substations will have equipment from different vendors communicating with various protocols. WAMS is an emerging area wherein various vendors and protocols are being explored. Popular WAMS standard C37.118 has undergone various iterations beginning 2004 to 2011 till 2014. Equivalent IEC standard i.e, IEC 61850-90-5, is also picking up the momentum. PDC standardization efforts have resulted in IEEEC37.244. it is widely accepted by many utilities all over world to exchange the synchrophasor data in COMTRADE format for typical events. Choosing right PMU/PDC communication and exchange protocol while supporting multi-vendor nature is a challenging task in designing WAMS architecture.

Data validation & reliability of synchro-phasor data : It is important that the data be validated and characterized in terms of accuracy and timeliness before used by applications. Again because of the large amount of data, distributed validation and characterization of the data is very important. It has been observed in ongoing WAMs deployment that a good number of PMUs are out of synchronization for various reasons like GPS Antenna position misalignment, non-visibility of satellites and problems in GPS receivers. Even with a healthy PMU in place, there had been instances of data losses due to communication link issues between PMU and control center.

8.4. Challenges in computation, analytics and storage of data

Historian is used to do calculation on incoming data stream from PDC (phasor, analog measurements). Considering least PMU to PDC reporting rate of 25 frames/seconds, there is a new measurement available at PDC

or historian at every 40msec. Hence before arrival of next measurement, calculation output should be available to visualization or other specified application. So it is expected to have execution speed better than 20 msec for 25 frames/second rate. For 50 frames/second system, execution speed should be 10 msec or better. WAMS architecture should be designed such that PDC, analytics and historian can work within allowable latencies. Also, PDC and Historian need to provide Application Program Interface (API) required to develop custom applications.

8.5. Challenges in cyber security

WAMS system is exposed to cyber layer and hence is vulnerable to cyber-attacks, if not designed properly. There is no single cyber security solution that can assure security of all WAMS implementations. For example, the security objectives differ for standalone and fully integrated WAMS networks. Securing WAMS infrastructures, per the NIST model, is a process that needs to be repeated when the environment or regulatory requirements change. The data provided to a control center by a WAMS network is similar to SCADA data; message availability and integrity are the primary security objectives. As WAMS data is incorporated into more and more applications, efforts to ensure the message itself can be explicitly trusted become increasingly important. Further research is also needed to address vulnerabilities associated with GPS spoofing, the robustness of PMU hardware and software, and the ability of a PDC to handle a concentrated cyber-attack like denial of service (DoS) or distributed DoS.

8.6. Operational & organizational issues

It is sometimes not clear inside an electric utility where the responsibility lies in maintaining and operating a Wide Area Monitoring System. The wide area infrastructure transcends all functional groups in utilities. For example, control center normally use the WAMS applications, the relaying department may have control of the phasor measurement units, and the communications department might have control of the communication infrastructure. It is necessary that the WAMS systems should have the support of the stakeholders inside a utility's organization.

9. CAPACITY BUILDING

Rrecruiting WAMS specialists is vital to achieving the benefits of WAMS implementation in daily operations, including

- Analytical skills to understand the information emerging from WAMS
- Information systems (IS) skills to support the 'end to end' process
- Specific skills: Power system Dynamic stability, IT critical infrastructure, data management, visualization development. 'End to End' project management. Interface engineering between WAMS and EMS

Applying a "WAMS-ready" approach and inclusion in engineering standards for wider substation new build or substation replacement works will provide network readiness once the technology is fully established.

The requirements of wide area monitoring systems can be categorized for the following ity: protection and control, enterprise, operations and customers.

Application	Rate Requirements	Latency Requirements	Data Accuracy (Time Tag & Value)
Control of System Oscillations	Moderately High (Tens of Milliseconds)	Tens of Milliseconds	Moderately High
Control of System Oscillations	Moderately High (Tens of Milliseconds)	Tens of Milliseconds	Moderately High
System Integrity Protection Schemes (SIPS)	High (milliseconds)	Milliseconds	High
System Protection (Out of Step)	High (milliseconds)	Milliseconds	High
System Protection (Voltage Stability)	Moderately High (tens of milliseconds)	Tens of Milliseconds	Moderately High
Thermal Protection of Transmission Line	Moderate (minutes)	Low (Seconds)	High

TABLE 2: PROTECTION AND CONTROL APPLICATIONS & REQUIREMENTS

Application	Rate Requirements	Latency Requirements	Data Accuracy (Time Tag & Value)
Metering	Medium (Sub second)	Sub second	High
Operational Costs	Low	Low	Moderately High
Play Back Capability	Medium (Sub second)	Low	High
Visualization	Moderately Medium	Moderately Medium	High

TABLE 3: ENTERPRISE APPLICATIONS & REQUIREMENTS.

Application	Rate Requirements	Latency Requirements	Data Accuracy (Time Tag & Value)
Dynamic Line Thermal Monitoring (Dynamic Line Rating)	Low (Minutes)	Low (Seconds)	High
Load Control	Low	Low	Low
Parameter Estimation / Model Validation	Off-Real-Time	Off-Real-Time	High
Post Mortem Analysis / Play Back Capability	Medium (Subsecond)	Low	High
Predictive Analysis / Look Ahead	Low	Low	Moderately High
State Estimation	Medium (Subsecond)	Subsecond	High
System Optimization	Low	Low	Moderately High
Visualization / Situational awareness / Alarming	Moderately Medium	Moderately Medium	High
Voltage Control	Low	Low	Moderately High
Voltage Security Monitoring	Low	Low	High

TABLE 4: OPERATIONS APPLICATIONS AND REQUIREMENTS

Application	Rate Requirements	Latency Requirements	Data Accuracy (Time Tag & Value)
Rates	Low	Low	Moderately High

TABLE 5: CUSTOMER APPLICATIONS AND REQUIREMENTS.

10. GAPS

The purpose of WAMS deployment is to provide accurate and timely data to a variety of applications involving system operation, protection and control, state estimation, etc. In order to meet the requirements of WAMS, the data accuracy, validity and latency issues must be addressed. Accuracy applies to the time tagging of the data as well as the numerical accuracy of the data. Accuracy requirement should particularly apply during transient conditions when phasor data might be used for controlling the disturbance. In a complex system like power grid, time synchronization is challenging if high accuracy is required. A related issue is the recovery of WAMS in case the accuracy is compromised, or one component fails. As an example, loss of GPS clock synchronization in a WAMS subsystem should not deteriorate the performance of the overall system. Availability of communication backbone, GPS visibility is the main constraints which need to be resolved for successful implementation of WAMS project.

11. OPTIMAL PMU PLACEMENT METHODOLOGY

Complex power systems need better observability and visualization capabilities to handle critical situations effectively. Synchro-phasor measurements provide intra second visibility to power system dynamics and enable faster control actions. Further, the phasors computed are time synchronized enabling power system state determination and analysis of dynamic phenomenon using the information. The wide area visibility based on remote measurements, and two-way communication makes this technology suitable for adaptive relaying, adaptive islanding etc. Since the implementation of this new technology is cost intensive, it is required to optimize on the number of PMUs while at the same time ensuring the observability of the power system.

This report addresses aspects of optimal phasor measurement unit (PMU) placement problem using a procedure for multistaging of PMU placement in a given time horizon using an integer linear programming (ILP) framework. It uses

algorithm of IIT Bombay used in GETCO. Additionally, algorithm used by shri Pentayya for ERLDC study is also applied.

In this approach total realistic cost for the installation of the PMUs at every node assumed to be equal. Also, it is assumed that PMUs have enough channels to record the bus voltage at its associated bus and current phasors along all the branches that are connected to this bus.

Phasor Measurement Unit (PMU) is significantly important device for better observability of complex power system. The objective of the PMU placement problem is to render an observable system by using a minimum number of PMUs. To minimize the cost of implementation it is necessary to optimize the number of PMUs. There are various techniques to optimize the number of PMUs. In the proposed model graph theory approach is used.

11.1. PMU Optimal Placement Problem Using IIT Bombay Method

Phasor Measurement Unit (PMU) is significantly important device for better observability of complex power system. The objective of the PMU placement problem is to render an observable system by using a minimum number of PMUs. To minimize the cost of implementation it is necessary to optimize the number of PMUs. There are various techniques to optimize the number of PMUs.

11.1.1. The IIT Bombay method proposes two main indices:

BOI: Bus Observability Index giving a measure of number of PMUs observing a given bus

SORI: System Observability Redundancy Index giving sum of all BOI for a system.

Consider the 14bus system as shown:

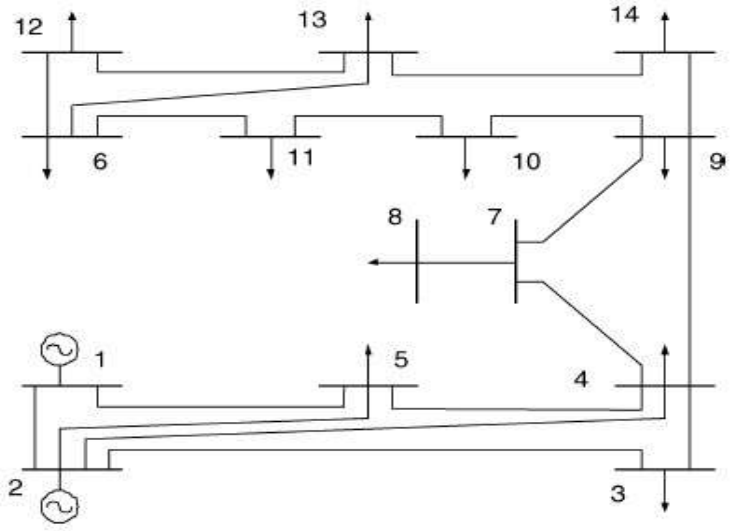


FIGURE 6: NETWORK FOR PMU PLACEMENT STUDY

Let Xi be a decision variable associated with bus I, then

Xi=1: PMU is installed at bus i

Xi=0: PMU is not installed at bus i

Then minimum PMU placement problem for IEEE-14 bus system can be formulated as follows:

$$\text{OPP}: \min x_1 + x_2 + \cdots + x_{14}$$

Subject to bus observability constraints defined as follows:

$$\begin{aligned}
&\text{Bus}-1: && x_1 + x_2 + x_5 \geq 1\\
&\text{Bus}-2: && x_1 + x_2 + x_3 + x_4 + x_5 \geq 1\\
&\text{Bus}-3: && x_2 + x_3 + x_4 \geq 1\\
&\text{Bus}-4: && x_2 + x_3 + x_4 + x_5 + x_7 + x_9 \geq 1\\
&\text{Bus}-5: && x_1 + x_2 + x_4 + x_5 \geq 1\\
&\text{Bus}-6: && x_6 + x_{11} + x_{12} + x_{13} \geq 1\\
&\text{Bus}-7: && x_4 + x_7 + x_8 + x_9 \geq 1\\
&\text{Bus}-8: && x_7 + x_8 \geq 1\\
&\text{Bus}-9: && x_4 + x_7 + x_9 + x_{10} + x_{14} \geq 1\\
&\text{Bus}-10: && x_9 + x_{10} + x_{11} \geq 1\\
&\text{Bus}-11: && x_6 + x_{10} + x_{11} \geq 1\\
&\text{Bus}-12: && x_6 + x_{12} + x_{13} \geq 1\\
&\text{Bus}-13: && x_6 + x_{12} + x_{13} + x_{14} \geq 1\\
&\text{Bus}-14: && x_9 + x_{13} + x_{14} \geq 1.
\end{aligned}$$

Solution of problem shows that for complete system observability, a minimum of four PMUs are required at busses 2, 6, 7, and 9.

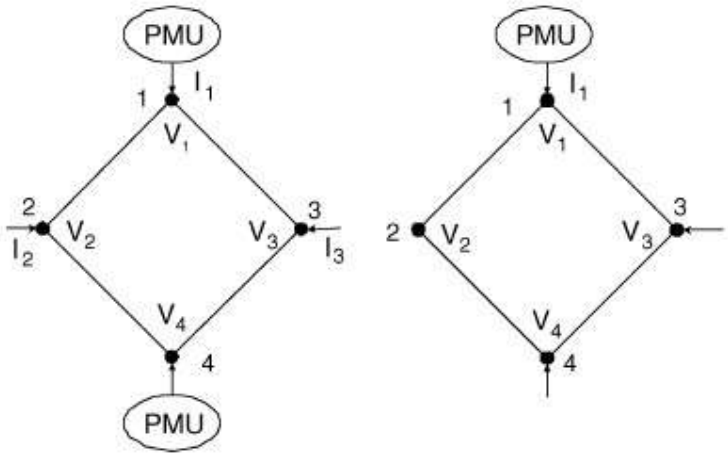
Beyond the number of PMUs required to make a system observable, a good PMU placement algorithm must also consider following additional issues:

1. Loss of a PMU or communication line;
2. Modelling of zero injection busses;

Zero injection bus

At zero injection busses, no current is injected into the system. If zero injection busses are also modeled in the PMU placement problem, the total number of PMUs can further be reduced. To understand this issue, consider a four bus example shown in Fig. Fig. (a) Ignores information about the zero injection busses while Fig. (b) Shows the bus 2 as a zero injection bus. For system in Fig. (a), it can easily be seen that a minimum of two PMUs are required to make the system completely observable. These can be placed on any two of the four busses.

For example, if a PMU is placed on bus 1, another PMU is required to make bus 4 observable. In contrast consider system in Fig (b). With a PMU at bus 1, current in branch 2–4 also becomes observable.



However, we impose following additional constraints.

1) Unobservable busses, if any, must belong to the cluster of zero injection busses and busses adjacent to zero injection busses.
2) For a zero injection bus Ai, let indicate the set of busses adjacent to bus-i . Let Bi=Ai U {i}. Then, number of unobservable busses in each cluster defined by set Bi (i.e., a zero injection bus-i and its adjacent busses) is at most one.

$$u_4 + u_7 + u_8 + u_9 \geq 3$$

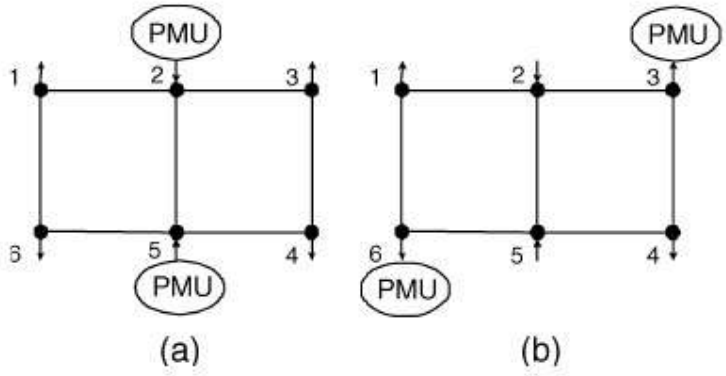
$$\begin{aligned}
&\text{Bus} - 1: && x_1 + x_2 + x_5 \geq 1\\
&\text{Bus} - 2: && x_1 + x_2 + x_3 + x_4 + x_5 \geq 1\\
&\text{Bus} - 3: && x_2 + x_3 + x_4 \geq 1\\
&\text{Bus} - 4: && x_2 + x_3 + x_4 + x_5 + x_7 + x_9 \geq u_4\\
&\text{Bus} - 5: && x_1 + x_2 + x_4 + x_5 \geq 1\\
&\text{Bus} - 6: && x_6 + x_{11} + x_{12} + x_{13} \geq 1\\
&\text{Bus} - 7: && x_4 + x_7 + x_8 + x_9 \geq u_7\\
&\text{Bus} - 8: && x_7 + x_8 \geq u_8\\
&\text{Bus} - 9: && x_4 + x_7 + x_9 + x_{10} + x_{14} \geq u_9\\
&\text{Bus} - 10: && x_9 + x_{10} + x_{11} \geq 1\\
&\text{Bus} - 11: && x_6 + x_{10} + x_{11} \geq 1\\
&\text{Bus} - 12: && x_6 + x_{12} + x_{13} \geq 1\\
&\text{Bus} - 13: && x_6 + x_{12} + x_{13} + x_{14} \geq 1\\
&\text{Bus} - 14: && x_9 + x_{13} + x_{14} \geq 1\\
&\text{Zero injection}: && u_4 + u_7 + u_8 + u_9 \geq 3.
\end{aligned}$$

Maximizing Redundancy Observability

If the minimum PMU placement problem defined by formulation- OPP has multiple number of optimal solutions, then the question of superiority of a particular solution vis-a-vis other Now we define SORI as the sum of bus observability for all the busses of a system.

$$\gamma = \sum_{i=1}^{n} \beta_i$$

Consider a six-bus system shown in Fig. It is seen that a minimum of two PMUs are required. To ascertain system observability. Consider two such optimal solutions shown in Fig. For the PMU placement as given in Fig. (a), BOI for busses 1 to 6 are 1, 2, 1, 1, 2, and 1, respectively. This makes SORI 8. Alternatively, for PMU placement in Fig. (b), BOI for busses 1 to 6 are unity, making SORI 6. Hence, the PMU placement with maximum SORI in Fig. (a) should be chosen for final placement. Optimal solution arises.

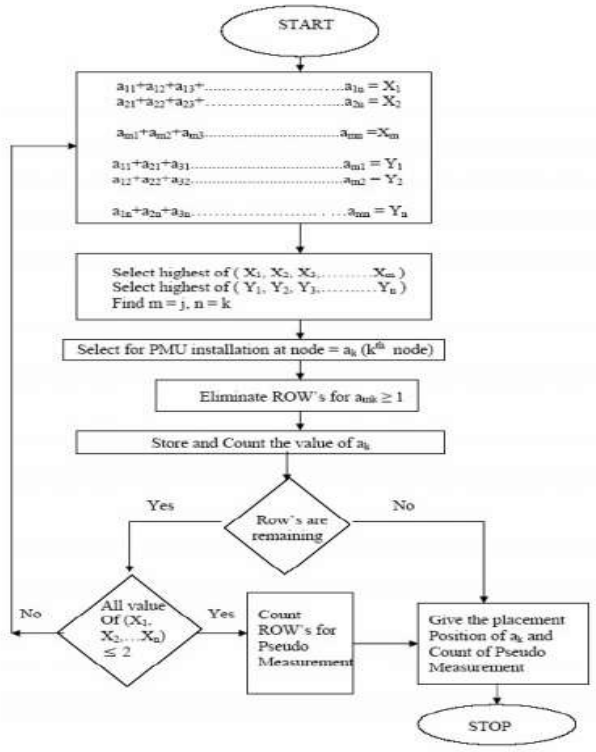


PMU Outage

To enhance the reliability of system monitoring, each bus should be observed by at least two PMUs. This ascertains that a PMU outage will not lead to loss of observability. In the ILP framework, this can be achieved with ease by multiplying the right-hand side of the inequalities in by 2.

$$x_1 + x_2 + x_5 \geq 2$$

11.2. PMU Optimal Placement Problem Using Pentayya et.al method



12. APPROACH AND RECOMMENDATION

The Approach adopted is to place PMUs on all the 400kV buses, 220kV buses (as 220kV substations are connected to other networks and availibillity of PMUs is not known on other networks like PGCIL, DVC, JUSCO, NTPC etc) and then optimize the placement of PMUs on 132kV buses with the help of the algorithm mentioned in Clause 11.

12.1. PMU Placement at JUNSL Grid

The Eastern Regional Grid comprises of West Bengal, Jharkhand, Orissa, Bihar and Sikkim. The EHV network of the region is highly meshed in nature and due to the connectivity with all the other four electrical regions, the power flow keeps on dynamically changing with season and time of the day.

For a case study, we have considered the transmission network of JUSNL above 132kV and optimized the PMU placement for 132kV buses along the transmission network. A total network of 54 substations is considered and availability of OPGW network is mentioned.

List of existing GSS substations

Sr. No	Name of GSS	Voltage Level	OPGW Network
1	PATRATU	400/220KV	Yes
2	HATIA-2	220/132 KV	Yes
3	MADANPUR DUMKA	220/132 KV	Yes
4	CHANDIL-1	220/132 KV	Yes
5	RAMCHANDRAPUR	220/132 KV	Yes
6	LALMATIA	220/132/33 KV	Yes
7	CHAIBASA-NEW	220/132/33 KV	Under Implementatio
8	PTPS	220/132/33 KV	Yes
9	GIRIDIH	220/132/33 KV	Yes
10	RATU (BURMU)	220/132/33 KV	Under Implementatio
11	JAINAMORE (BOKARO)	220/132/33 KV	Under Implementatio
12	GARHWA (BHAGODIH)	220/132 KV	Under Implementatio
13	GODDA	220/132/33 KV	Yes
14	JASIDIH	220/132/33 KV	Under Implementatio
15	GOVINDPUR	220/132/33 KV	Yes
16	NAMKUM	132/33 KV	Yes
17	KANKE	132/33 KV	Under Implementatio
18	MAHARO DUMKA	132/33 KV	Yes
19	DEOGHAR	132/33 KV	Under Implementatio
20	HATIA-1	132/33 KV	Yes
21	DALBHUMGARH	132/33 KV	Under Implementatio
22	JADUGODA	132/33 KV	Yes
23	KENDOPOSI	132/33 KV	Under Implementatio
24	NOAMUNDI	132/33 KV	Under Implementatio
25	DALTONGANJ	132/33 KV	Under Implementatio
26	MANIQUE	132/33 KV	Under Implementatio
27	ADITYAPUR-1	132/33 KV	Under Implementatio
28	ADITYAPUR-3	132/33 KV	Under Implementatio
29	GOLMURI	132/33 KV	Under Implementatio
30	JAMTARA	132/33 KV	Under Implementatio
31	GUMLA	132/33 KV	Under Implementatio
32	CHAIBASA-II	132/33 KV	Yes
33	CHITRA	132/33 KV	Under Implementatio
34	MADHUPUR	132/33 KV	Under Implementatio
35	MANOHARPUR	132/33 KV	Yes
36	SIMDEGA	132/33 KV	Yes
37	KAMDARA	132/33 KV	Under Implementatio
38	GOELKERA	132/33 KV	Under Implementatio
39	PAKUR	132/33 KV	Yes
40	SAHEBGANJ	132/33 KV	Yes
41	RAJMAHAL	132/33 KV	Yes
42	TAMAR	132/33 KV	Under Implementatio
43	JAPLA	132/33 KV	Under Implementatio

44	LOHARDHAGA	132/33 KV	Yes
45	MANGO	132/33 KV	Under Implementatio
46	RAJKHARSWAN	132/33 KV	Yes
47	CHAKDHARPUR	132/33 KV	Under Implementatio
48	GARHWA ROAD	132/33 KV	Under Implementatio
49	LATEHAR	132/33 KV	Yes
50	SHPS (JUUNL)	132/33 KV	Under Implementatio
51	JAMUA	132/33 KV	Yes
52	CHANDANKIYARI	132/33 KV	Under Implementatio
53	BAHRAGORA	132/33 KV	Under Implementatio
54	SARIA	132/33 KV	Yes

Recommendation:

The following tables show the list of buses where the PMU placement is considered to have required observability.

PMU placement at 400 KV Existing GSS substation

Sr. No	Name of GSS	Voltage Level	OPGW Network
1	PATRATU	400/220 KV	Yes

PMU placement at 220 KV Existing GSS substation

Sr. No	Name of GSS	Voltage Level	OPGW Network
1	HATIA-2	220/132 KV	Yes
2	MADANPUR DUMKA	220/132 KV	Yes
3	CHANDIL-1	220/132 KV	Yes
4	RAMCHANDRAPUR	220/132 KV	Yes
5	LALMATIA	220/132/33 KV	Yes
6	CHAIBASA-NEW	220/132/33 KV	Under Implementatio
7	PTPS	220/132/33 KV	Yes
8	GIRIDIH	220/132/33 KV	Yes
9	RATU (BURMU)	220/132/33 KV	Yes
10	JAINAMORE (BOKARO)	220/132/33 KV	Yes
11	GARHWA (BHAGODIH)	220/132 KV	Under Implementatio
12	GODDA	220/132/33 KV	Yes
13	JASIDIH	220/132/33 KV	Under Implementatio
14	GOVINDPUR	220/132/33 KV	Yes

PMU placement at 132 KV GSS substation using IIT Bombay method (ILP)

Sr. No	Name of GSS	Voltage Level	OPGW Network
1.	MAHARO DUMKA	132/33 KV	Yes
2.	DEOGHAR	132/33 KV	Under Implementatio
3.	HATIA-1	132/33 KV	Yes
4.	JADUGODA	132/33 KV	Yes
5.	KENDOPOSI	132/33 KV	Under Implementatio
6.	DALTONGANJ	132/33 KV	Under Implementatio
7.	GOLMURI	132/33 KV	NA
8.	GUMLA	132/33 KV	Under Implementatio
9.	MADHUPUR	132/33 KV	Under Implementatio
10.	SIMDEGA	132/33 KV	Yes
11.	KAMDARA	132/33 KV	Under Implementatio
12.	PAKUR	132/33 KV	Yes
13.	SAHEBGANJ	132/33 KV	Yes
14.	TAMAR	132/33 KV	Under Implementatio
15.	RAJKHARSWAN	132/33 KV	Yes
16.	GARHWA ROAD	132/33 KV	Under Implementatio
17.	LATEHAR	132/33 KV	Yes
18.	JAMUA	132/33 KV	Yes
19.	CHANDANKIYARI	132/33 KV	NA
20.	BAHRAGORA	132/33 KV	Under Implementatio
21.	SARIA	132/33 KV	Yes

PMU placement at 132 KV GSS substation using Pentayya et.al method

Sr. No	Name of GSS	Voltage Level	OPGW Network
1	KANKE	132/33 KV	Under Implementatio
2	HATIA-1	132/33 KV	
3	JADUGODA	132/33 KV	Yes
4	KENDOPSI	132/33KV	Under Implementatio
5	NOAMUNDI	132/33 KV	Under Implementatio
6	DALTONGANJ	132/33 KV	Under Implementatio
7	JAMTARA	132/33KV	Under

			Implementatio
8	GUMLA	132/33KV	Under Implementatio
9	CHITRA	132/33 KV	Under Implementatio
10	KAMDARA	132/33 KV	Under Implementatio
11	GOELKERA	132/33KV	Under Implementatio
12	SAHEBGANJ	132/33 KV	Yes
13	RAJMAHAL	132/33 KV	Yes
14	JAPLA	132/33 KV	Under Implementatio
15	RAJKSWAN	132/33KV	Yes
16	GARHWA ROAD	132/33 KV	Under Implementatio
17	JAMUA	132/33 KV	Yes
18	CHANDANKIYARI	132/33 KV	NA
19	BAHRAGORA	132/33 KV	Under Implementatio
20	SARIA	132/33 KV	Yes
21	SIMDEGA	132/33 KV	NA
22	TAMAR	132/33 KV	Under Implementatio
23	LATEHAR	132/33 KV	Yes

Based on above results, PMUs placement at 01 no. 400kV existing substation, 14 nos. 220kV existing substations and 21 nos. of 132kV Substations (Based on IIT Bombay method) is considered. Please refer Annesure 1 for details.

The process, infrastructure required and the application in near term is shown in following Figure.

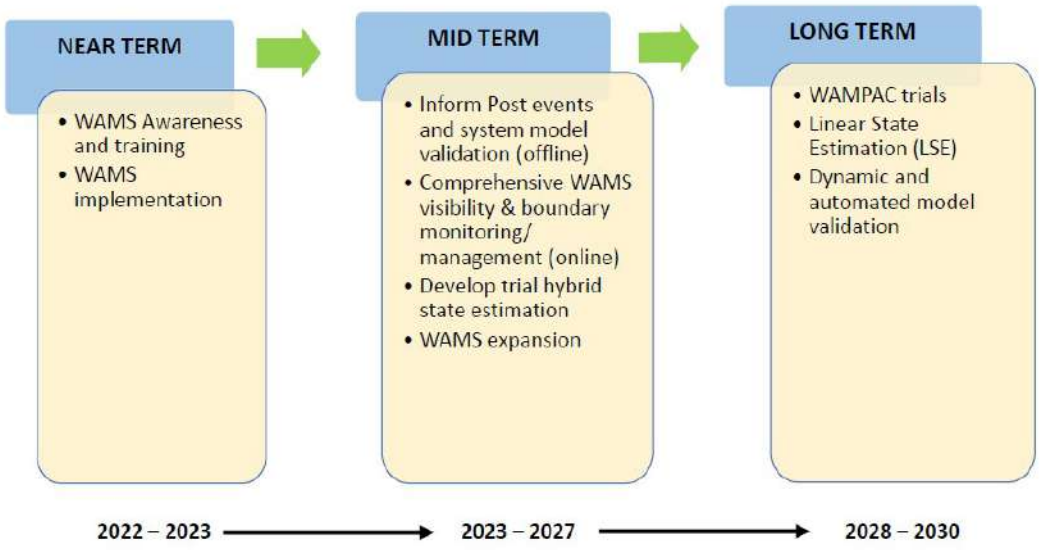


Figure – Timing of Investment windows and proposed WAMS implementation

a. Short term period (2022- 2023)

Training of WAMs will be starting point, WAMs task force, deployment strategy, applications, will be finalised in the Near-term period. The related infrastructure will be installed in the substations.

b. Mid term period (2023 to 2027)

The overall objectives for the mid term should centre on refining existing WAMS applications into daily business functions, deploying and trialling new applications. With the WAMS systems fully deployed and operation, studies should examine the benefits of:

- Upgrading the accuracy of substation measurement transducers
- Increasing the WAMS monitoring to full coverage as and when the substations get commissioned.
- Introduction WAMS visibility at strategic points within the networks,

c. Long term beyond 2028

The initial goal of the WAMS is to improve system awareness and provide oscillation monitoring system for the control room, however, it is important to consider potential future applications the additional requirements to facilitate these applications. For instance, if the long-term strategy incorporates system protection and control

functions, the requirements of the underlying infrastructure will extend beyond that of a monitoring-only system; where applications inform real-time system operations the infrastructure would be expected to require protection-class transducers, communication latency, and full redundancy.

The list below provides an indication of some potential and innovative future applications of WAMS; these are at various levels of maturity and many are far beyond the capability of the proposed WAMS, however, all could bring substantial benefits to the reliable and economic operation of the GB transmission system:

- **Frequency Response / Control**
  The concept of very-fast frequency control .

- **On-line Generator Compliance Monitoring**
  Real-time monitoring may allow compliance testing to be witnessed remotely

- **Linear State Estimator (LSE)**
  An LSE directly calculates the power system state without an iterative estimation procedure, as with sufficient PMU measurements estimating the system state becomes a linear problem. This requires full observability of the power system (PMUs at approximately 1/3 of all buses), which is not a realistic expectation at this time. Improvement in state estimator precision would result in improved energy balancing precision accordingly.

- **Volt-Var Control**
  Improved state estimation passed onto volt/var scheduling for loss optimisation, may reduce system losses by a small percentage each year equating to substantial savings.

- **System Integrity Protection Scheme (SIPS)**
  SIPS can be applied as an alternative to network reinforcement to help reduce the constraint cost rather than installing new lines or FACTS devices, and also offers increased flexibility during scheduled outages that may further reduce constraint. In addition, SIPS offer an additional line of system protection for major disturbances.

- **Improved Black-Start coordination**
  Islanding Operation, Reconnection & Restoration

- **Black out avoidance**

SIPS significantly reduce the risk of black out; avoiding or reducing an outage that may otherwise occur would represent significant financial and societal savings in the order of tens-to-hundreds of millions of pounds.

12.2. Summary of WAMS Cost:

Total Project costs are given in Table below. The detailed Bill of Materials (BOM) with cost break-up is tabulated in Annexure 2.

Description	Cost in Crores including GST
Implementation of WAMS	38.1

12.3. Reference

[1]. Vaishali Rampurkar, Polgani Pentayya, Harivittal A. Mangalvedekar, and Faruk Kazi, “Cascading Failure Analysis for Indian Power Grid”, IEEE Transactions on Smart Grid.

[2]. A.G. Phadke, J.S. Thorp, “Synchronized Phasor Measurements and Their Applications ”, Springer, January 2008

[3]. J. J. Romero, “Blackouts illuminate India’s power problems,” IEEE Spectrum, vol. 49, no. 10, pp. 11–12, Oct. 2012.

[4]. A. Gaikwad and S. C. Srivastava, “Indian blackouts-July 30, 31 2012 recommendations and further actions,” in Proc. CAMS/RRPA Panel Mitigation Prevent. Cascading Outages Methodol. Practical Appl. IEEE PES Gen. Meeting, Vancouver, BC, Canada, Jul. 2013, pp. 2–18.

[5]. (2012). Report of the Enquiry Committee on Grid Disturbance in Northern Region on 30 July 2012 and in Northern, Eastern and North-Eastern Region on 31 July 2012 New Delhi, India. [Online]. Available: http://powermin.nic.in/upload/pdf/GRID ENQ REP 16 8 12.pdf, accessed Aug. 20, 2012.

[6]. (Aug. 8, 2012). Report on the Grid Disturbance on 30th July 2012 and Grid Disturbance on 31st July 2012. [Online]. Available: http://www.cercind.gov.in/2012/orders/Final_Report_Grid_Disturbance.pdf,

[7]. J.E. Dagle , “Post-mortem analysis of power grid blackouts - The role of measurement systems”, IEEE Power and Energy Magazine, Volume: 4 Issue: 5.

[8]. ‘The wide world of Wide area- measurement’ IEEE power & energy magazine, September/October 2008.

[9]. AranyaChakrabortty and Pramod P. Khargonekar, 'Introduction to Wide-Area Control of Power Systems' 2013 American Control Conference (ACC) Washington, DC, USA, June 17-19, 2013

[10]. Vladimir Terzija, Gustavo Valverde, Deyu Cai, Pawel Regulski, Vahid Madani, John Fitch, SrdjanSkok, Miroslav M. Begovic, Arun Phadke, 'Wide-Area Monitoring, Protection, and Control of Future Electric Power Networks', Proceedings of the IEEE, Vol. 99, No. 1, January 2011

[11]. Distributed Energy Resources Issues and Challenges- editorial, journal of energy engineering asce / september 2007

[12]. M. Klein, G. Rogers and P. Kundur "A fundamental study of interarea oscillations in power systems", IEEE Trans. On Power Systems, vol. 6, no. 3, pp.914 -921 1991

[13]. K. Uhlen, L. Vanfretti, M.M. de Oliveira, A. B. Leirbukt, V. H. Aarstrand, and J.O. Gjerde, "Wide-Area Power Oscillation Damper Implementation and Testing in the Norwegian Transmission Network," IEEE PES General Meeting 2012, San Diego, CA, USA.

[14]. M. S. Almas and L. Vanfretti, "Implementation of Conventional and Phasor Based Power System Stabilizing Controls for Real-Time Simulation", 40th Annual Conference of IEEE Industrial Electronics Society (IECON), Dallas, USA, Oct 29-Nov 01, 2014

[15]. Phadke, A.G., Hlibka, T., and Ibrahim, M., "Fundamental basis for distance relaying with symmetrical components", IEEE Transactions on PAS. Vol. 96, No. 2, March/ April, 1977, pp 635–646.

[16]. Phadke, A.G., Thorp, J.S, and Adamiak,M.G., "A new measurement technique for tracking voltage phasors, local system frequency, and rate of change of frequency", IEEE Transactions on PAS. Vol. 102, No. 5, May 1983, pp 1025–1038.

[17]. "IEEE Standard for Synchrophasors for Power Systems", C37.118–2005, pp 56–57, IEEE 1344–1995, sponsored by the Power System Relaying Committee of the Power Engineering Society, pp 56–57.

[18]. "IEEE Standard for Synchrophasors for Power Systems", IEEE 1344-1995. Sponsored by the Power System Relaying Committee of the Power Engineering Society.

[19]. Depablos, J., Centeno, V., Phadke, A.G., and Ingram, M., "Comparative testing of synchronized phasor measurement units", Power Engineering Society General Meeting, 2004. IEEE, Vol. 1, 6–10 June 2004, pp 948–954.

[20]. IEEE Application Guide for IEEE Std 1547, IEEE Standard for Inter-connecting Distributed Resources with Electric Power Systems, IEEE Std 1547.2-2008, 2009.

[21]. R. Franco, C. Sena, G. N. Taranto, and A. Giusto, "Using synchro-phasors for controlled islanding - A prospective application for the Uruguayan power system", IEEE Trans. Power Systems, vol. 28, no. 2, pp. 2016-2024, May 2013.

13. TECHNICAL SPECIFICATION FOR PMU AND HARDWARES

PHASOR MEASUREMENT UNIT

1.0 GENERAL

The Bidders are encouraged to offer their standard products that meet or exceed the specification requirements. Although the bidder is encouraged to use as much standard hardware and software as possible, the proposal will be judged by its conformance to the Specification. The proposal shall clearly identify all deviations from the Specification to help EMPLOYER evaluate the degree of conformance of the Bidder's offering.

The substations /Generating stations normally are provided with CTs on each bay of the switchyard and CVTs in each transmission line bay and on each bus. Generally, CTs have one metering core and four protection cores. The CVTs are provided with three cores, one for metering and other two for protection. The PMUs to be supplied shall be connected to either of these CT and CVT cores.

The specification identifies some minimum requirements for each of the major component which are essentially required for measurement of complex quantities and transmitting the same to the PDC (Phasor Data Concentrator) at control centre. The delivered system is expected to provide meaningful measurement of the acquired data so that it is useful to the operators in assessing the current state of grid and can also be used for carrying out the post- facto analysis. The offered PMU must be in operation at least for one year as on date of bid opening.

1.1. Intent of Specification

The intent of this Specification is to describe the technical requirements for supply installation, testing, commissioning & integration of PMUs. The PMUs to be supplied under this Specification shall be installed at the Substations/Power stations and shall communicate to the Phasor Data Concentrator (PDC) at the Control Centre on IEEE C37.118 format.

1.2. Scope of Work

The scope of work shall include site survey, planning, design, engineering, testing, supply, integration, transportation & insurance, delivery at site, storage,

installation, training, commissioning, demonstration for acceptance and documentation of:

a) Phasor Measurement Units (PMUs) along with GPS

b) All cabling, wiring, terminations and interconnections to the equipment including necessary trench/surface conditioning to interconnect the PMUs to the installed or being installed communication equipment by the Owner.
c) Integration of supplied PMUs to PDC conforming to IEEE C37.118 standard. Support for IEC 60870-5-104 or ICCP connection to SCADA/EMS/DMS system.
d) Cable connection / interfacing with communication equipment.

e) In case of multiple PMU at a substation/power plant the Router with firewall shall be provided which shall interface PMUs on one side and communication equipment on the other side.

f) Any other work which is not identified in the specification but is required for completion of the work within intent of the specification shall also be in the scope of the Bidder.

g) On-site training of the Employer personnel.

h) Maintenance of the supplied equipment for 4 years after the one-year warranty period.

The list of substations/power plants where PMUs are to be installed are indicated at Table-6 and BOQ. The Data Requirement Sheet (DRS) to be submitted along with the Bid is attached at Part-I.

1.3. PMU Requirements

The offered PMUs shall be complete in all respect so that they can be installed at the substation/power plant and can communicate with Control centre having Phasor Data Concentrator (PDC). The necessary cable and connector and installation hardware shall also be supplied by the bidder. The PMUs shall normally be installed near to the control & relay panels and CT/CVT connections to the PMU shall be extended from the control & relay panels. The PMUs shall conform to IEEE C37.118 standard and shall be designed to meet the following requirements:

a) The PMUs shall be designed to measure the electrical parameters in the power system frequency band of 45-55 Hz.

b) The supplied PMU will be installed in standalone panel in the substation control rooms /relay panel room.

c) The auxiliary power supply to PMUs will be provided from the station DC which is used for control and protection of substation devices. Accordingly, the PMUs shall be suitable to operate on unearthed 220 V or 110V (+10%, -15%) DC power supply depending upon the station DC supply available.

d) The minimum offered configuration of PMUs shall have at least 9 analog input channel (1 set of 3-phase voltages, two set of 3-phase current) and 8 digital inputs. In case of substations & power plants where all the control & relay panels are installed in a single room, the Bidder may offer higher configuration to meet the requirement of multiple feeders and BOQ may be adjusted accordingly. Typical configuration diagram is shown in Part- II.

e) The PMUs shall be used to measure the following:

- 3 phase positive sequence voltages as magnitude and angle (polar form) quantities
- 3 phase positive sequence currents magnitude and angle (polar form) quantities

f) All the measurements shall be tagged with UTC (Coordinated Universal Time). The time tagging accuracy shall be at least one micro-second and comply to IEEE C37.118 standard.

g) The PMU output shall be in IEEE C37.118 format and shall communicate with the PDC in the same format. The accuracy of the measurements shall be as per the IEEE C37.118 standard level 1.

h) The PMUs shall be suitable for configuring the data sampling rate of 10, 25, 50 samples per second. Actual rate shall be user selectable.

i) The PMUs shall have continuous self-monitoring, diagnostic feature and capable to identify & communicate problems and shall generate alarm in case of any abnormality which shall be displayed locally as well as shall be transferred to the PDC.

j) The PMU design shall ensure that the impact of frequency fluctuation (45-55Hz) on accuracy is within permissible limit as per prevailing standards.

k) Testing & configuration accessories such as test switch, connector, software etc. which are not in-built to the PMUs but are required for testing and configuration changes, at least one set of such testing & configuration accessories shall be supplied complete with necessary hardware.

l) The PMUs shall communicate with PDC on Ethernet interface over the communication link provided by the employer. One communication port of 10/100/1000 Base Tx for TCP/IP for streaming data in IEEE C 37.118 format shall be provided in the PMU. Additional optical remote communication ports 10/100/1000 Base Tx for TCP/IP shall also be available for streaming data in IEEE C37.118 format.

m) There shall be provision for HMI (Human Machine Interface) in PMU to perform setting changes. In addition, HMI should display the measured quantities for ease during testing. The Operation indications and time tagged events shall be available by the Local HMI. Alternatively, Portable configuration device for PMUs at end can be provided for configuring the PMUs.

n) Remote configuration facility shall be provided in PMU and the supplier shall supply the software required for remote configuration of PMU.

o) Remote firmware upgrade feature shall be made available.

p) PMU shall be capable of sending data in Unicast and multicast both.

1.4. GPS based Time Facility

GPS based time facility to synchronize PMU clock with UTC source, shall be provided for each PMU. The time receiver shall include propagation delay compensation and shall also include an offset to permit correction to local time to achieve time accuracy of at least 1 microsecond. The time receiver shall detect the loss of signal from the UTC source and a loss-of-signal event shall be sent to the PMU which will be transferred to PDC and shall result in an alarm at PDC. Upon loss of signal, the PMU time facility shall revert to an internal time base. The internal time base shall have minimum stability of 1pps. Within five minutes of reacquisition of signal, the time shall return to within 1.5 micro-second of UTC. Proper correction of leap second shall be provided. Total Vector Error (TVE) should comply to IEEE C 37.118 standard.

1.5. Phasor Data Concentrator (PDC) Requirements

The PMU to be supplied shall communicate to the PDC. PDC to which PMUs to be integrated shall meet at least the following features.

- Shall support data streaming in IEEE C37.118 format.
- Shall be capable of receiving data in Unicast and Multicast.
- PDC shall be able to receive the loss of signal event of the time receiver from PMU and shall result in an alarm at PDC.
- PDC shall support Remote configuration of PMU.

1.6. Environmental Requirements

The PMU will be installed inside buildings without temperature or humidity control. The PMU shall be capable of operating in ambient temperatures from -10 deg C to +55 deg C and relative humidity up to 10-90% non-condensing.

1.7. PMU Panel Construction

a) The PMUs shall be installed in thee standalone panel.

b) Panels shall be free standing surface or flush type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of adequate thickness for weight bearing members of the panels such as base frame, front sheet and door frames, as well as for sides, door, top and bottom portions.

1.8. PMU Panels

The panel enclosures shall meet the following requirements:

a) The enclosures shall be finished inside and out. All cabinet metal shall be thoroughly cleaned and sanded, and welds chipped to obtain a clean, smooth finish. All surfaces shall be treated to resist rust and to form a bond between the metal and the paint. Enclosures (except for server racks) shall confirm to IP-31 degree of protection in accordance with IS-2147. All the louvers shall be provided with suitable wire mesh.

b) Enclosures shall be floor mounted with front and rear access to hardware and Wiring.

c) Moving assemblies within the enclosure, such as swing frames or extension slides, shall be designed such that full movement of the assembly is possible without bending or distortion of the enclosure or the moving assembly. Enclosures shall not require fastening to the floor to preclude tipping of the enclosure when the moving assembly is extended.

d) Cable entry shall be through the bottom. No cables shall be visible, all cables shall be properly clamped, and all entries shall be properly sealed to prevent access by rodents.

e) Cooling air shall be drawn from the conditioned air within the room. Ducted or directed cooling air to the enclosures will not be supplied by Employer.

f) All wiring shall use copper conductors. Conductors in multi core cables shall be individually colour coded.

g) Wiring within the enclosures shall be neatly arranged and securely fastened to the enclosure by non-conductive fasteners. Wiring between all stationary and moveable components, such as wiring across hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wire.

h) All materials used in the enclosures including cable insulation or sheathing, wire troughs, terminal blocks, and enclosure trim shall be made of flame-retardant material and shall not produce toxic gasses under fire conditions.

i) All enclosures shall be provided with suitable internal lighting lamp, 230 VAC 15/5A duplex type power socket & switch for maintenance purpose.

j) The finish colours of all enclosures/panels shall be finalized during detailed Engineering.

1.9. Earthing

a) All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25 X 6 sq.mm perforated copper with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc. for effective earthing provision shall be made for extending the earth bus bars to adjoining panels on either side.

b) Provision shall be made on each bus bar of the panels for connecting substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of Bidder.

c) Panels shall be connected to the substation control room earth system at least at two places separately.

d) All metallic cases of PMUs shall be connected to the earth bus by copper wires of size not less than 2X2.5 sq. mm. The Colour code of earthing wires shall be green.

e) Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. However, looping of earth connections between equipment to provide alternative paths to earth bus shall be provided.

f) Earthing and connecting it to electronic or general earth grid by suitable earth connection is in contractor's scope

1.10. Interconnections

The bidder shall be responsible for laying and termination of all cables at required under the project which includes interconnections among bidder supplied equipment and their interconnection with employer's panels. Testing and commissioning of these interconnections shall also be done by the bidder.

The signals cables for communication shall be shielded type to provide suitable protection against noise and electromagnetic interference. All the cables shall be suitably sized to meet the functional requirements. Shielded/Armoured cables shall be used for other requirements. These external cables (except communication cables) shall have the following characteristics:

- Minimum core cross-section of 2.5/4 mm2 (depending upon site requirements) for PT cables and 2x2.5 mm2 for CT cables, 2.5 mm2 for Power & Control outputs and 1.5 mm2 for Digital Status inputs shall be provided.

- Rated voltage of cables shall be Uo/U of 0.6/1.1KV.

The Communication cable shall be of shielded, twisted pairs and of minimum 0.22sq mm size as per IS 1554 Part- I.

1.11. Router

In case of multiple PMUs at a substation/power plants all the PMUs shall be connected to the communication equipment through router. The router shall interface PMUs on one side and communication equipment on the other side. Router shall be provided with following features.

S.No	Description of the Features	Minimum Quantity of the features
1.	Functions	High performance Routing for data, redundant control and redundant data plane
2.	Routing Capability	Static & Dynamic routing with layer 2 and layer 3 support
3.	Processing capacity	Minimum 2Mpps. 64Gbps throughput upgradable to 128 Gbps
4.	IPSec VPN tunnels	Minimum 10
5.	Features to support	QoS, IP/MPLS, Segment routing, Security, Broadband, Multiservice, Voice, IP to IP Gateway, point to point and point to multi point
6.	Routing protocols	EIGRP, IGRP, IS-IS, OSPF, BGP, ARP, IPCP, IP forwarding, VLAN & MPLS etc.
7.	Network protocols	TCP/IP, IPv4,IPv6 (BGP V6, OSPFV3), OSI, Telnet, UDP, DHCP
8.	Network management	Using SNMP Protocol v1/v2/v3, configuration support (netconf & YANG)
9.	Minimum inbuilt software firewall features required	a) Data encryption supported DES (56 BITS) 3des (168 bits) and hashing algorithm like MD5 and SHA-1 b) Filtering of packets based on Source address, Destination address, Protocol type, User, Port number, URL c) Filtering of Protocols such as FTP, SMTP, HTTP, SNMP, UDP, ICMP, RPC, DNS, DHCP, ARP d) Detailed system logging
10.	Speed configurability at each port	All ports shall be configurable from 64kbps to 2Mbps
11.	Interface ports	a) For connecting to communication equipment on 1Gbps Ethernet port or G.703 Port. b) 1Gbps Ethernet port for each PMU c) C37.94 support for tele protection applications
12.	Mounting	Rack mountable, temperature harden upto 65 deg
13.	Minimum no. of concurrent TCP sessions	10

The router along with respective linecards shall be supplied with timing protocol support such as 1588v2 (with boundary closck as well as ordinary clock (master and slave) and syncE).

Router shall have Cconsole port (USB/RJ45) and Managememt port.

Router shall have BITS and TOD ports.

1.12. Training

Training shall be conducted by contractors personal who are experienced instructor. All necessary training material shall be provided by the contractor. Each trainee shall receive individual copies of all technical manuals and all other documents used for training. The training courses, and their duration in each courses are identified in Table-1.

Table-1: Training Requirements

S.No	Training Course	Total No. of days	Participation
1	PMU– Technical internals	5	Persons responsible for Installation and commissioning

1.13. Spares

One spare PMU identical to PMU in Main items as a spare shall be supplied by the contractor, under the contract.

1.14. Maintenance

Contractor shall be responsible for providing "Maintenance on call" of the system under warranty including supply of spares for ensuring the successful operation of the system. The maintenance period shall be for 4 years after one year of warranty period. The maintenance period shall be extended for a further period of 3 years at the same price in the final offer of the vendor with same terms & conditions. During this period, the contractor shall have prime maintenance responsibility for the system. The response time for the maintenance shall be less than 24 hours excluding the journey period.

1.15. Documentation

Complete documentation is required to support PMU setup, operation and maintenance. The documentation shall include following:

a) Procedures for PMU setup and use with regards to all features.
b) Documentation of procedures regarding routine maintenance including use of system diagnostics.
c) Detailed connection diagrams showing how the PMUs are installed at site.
d) A complete copy of PMUs functional design
e) Details of PMU database.
f) Details of hardware/software and as built system

All documentation shall be delivered in both electronic format (e.g. PDF, MS WORD, Hypertext, etc.) on CDs/DVDs/USB drive, and in hardcopy format. Sufficient on-line, documentation, such as help screens, user guidance messages, context-sensitive help information links etc., shall be included with the system to minimize the need for users to consult the hardcopy documentation.

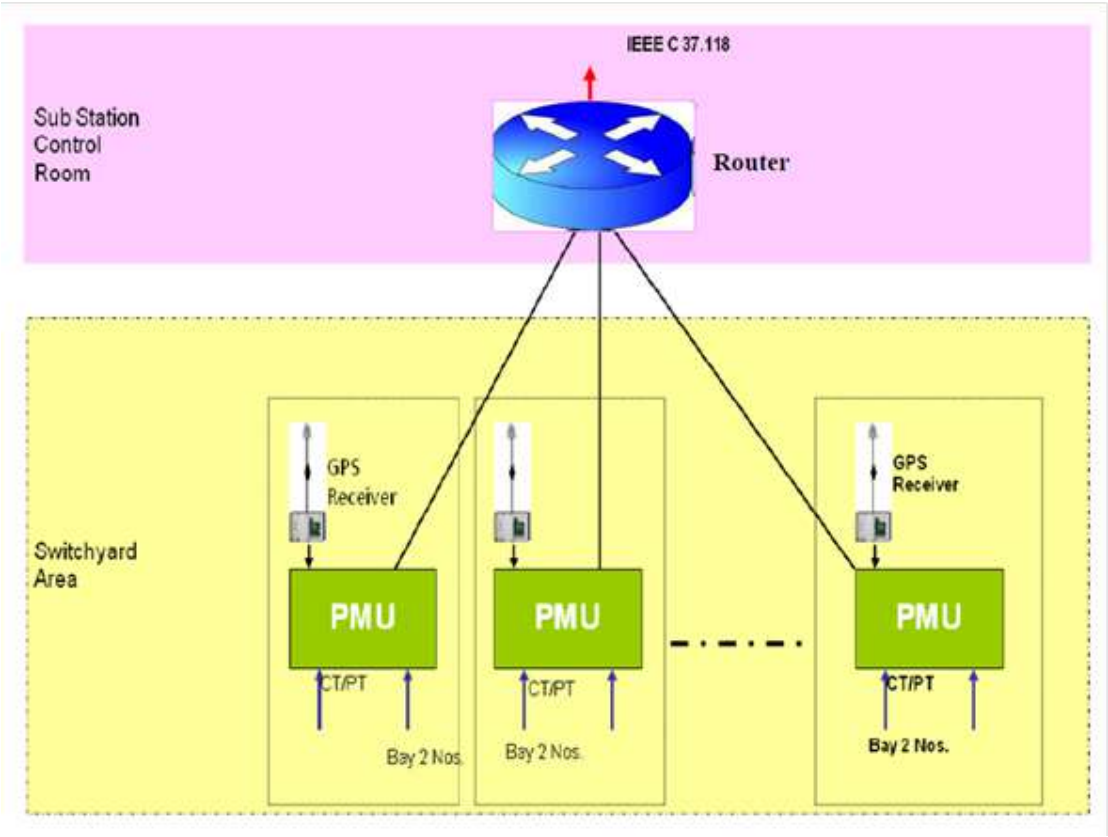
1.16. Testing of PMUs

The offered PMUs shall conform to the type tests as per applicable standard and the bidder shall supply type tested PMU. The bidder shall submit PMU type test reports along with the bid for the offered make and model. The type test report shall include at least these tests indicated as follows:

a) Level-1 accuracy test as per IEEE C37.118 standard
b) Electromagnetic compatibility (EMC), Immunity conforming to the requirements of IEC-60255/IEC 61000.
c) Emission test conforming to the requirements of EN 55011
d) Insulation Test per IEC 60255-5
e) Environmental Test as per IEC 60068-2-2

In case the type tests are conducted after placement of order, the Bidder shall get the Type Test procedure approved by the Employer/Owner and then these tests shall be conducted at bidder's own cost in presence of owner representative. The Bidder shall offer the PMUs for inspection & Factory acceptance Tests (FAT). During FAT the supplier shall demonstrate all the functions of PMU. The compatibility to integrate with PDC in accordance to IEEE C37.118 shall also be demonstrated. These functionalities shall also be demonstrated at site at the time of commission of PMUs at site. The procedure for all the testing shall be agreed between the supplier and purchaser before proceeding for the testing.

TYPICAL HARDWARE CONFIGURATION DIAGRAM FOR MULTIPLE PMUS



PHASOR DATA CONCENTRATOR (PDC)

2.0 GENERAL

The Bidders are encouraged to offer their standard products that meet or exceed the specification requirements. These products may be provided from their in-house baseline offerings or may be provided from the others manufacturer and established third-party software suppliers. Although the bidder is encouraged to use as much standard hardware and software as possible, the proposal will be judged by its conformance to the Specification. The operating system, firewalls, routers offered in the bid should have Evaluation Assurance level, preferably EAL4+ as specified by the Common Requirements defined International Standard (ISO/IEC15408) for computer security certification. The proposal shall clearly identify all deviations from the Specification to help JUSNL evaluate the degree of conformance of the Bidder's offering.

2.1. Access control

2.1.1 Users

Users may access the PDC from several locations. The PDC should allow access from multiple locations over LAN/WAN. All system access will be validated by username and password.

2.1.2 Administrator

The PDC's administrator shall be provided with tools to configure the system, such as:

- Connection of PMUs
- Data output streams
- User profiles
- Alarm thresholds

2.2. Functional Requirements

PDCs of shall provide the following functionalities:

- Real-time streamed PMU data handling functions including PMU data receiving, PMU data time –alignment and PMU data repacking
- Data Storage Management functions
- PMU configuration information exchanging and condition monitoring.
- Interfacing to other PDC for streaming synchro phasor data exchange.

The functional requirements for these functionalities are described in the following subsections.

2.2.1 Real-time PMU Steamed Data Handling

PDC shall provide the following functions for handling the receiving, processing, time alignment and repacking of PMU streaming data.

2.2.2.1 PMU Data Receiving

a) PDC shall be as a minimum capable of receiving real-time synchrophasor measurement data stream for PMUs in all substation that are in compliance to latest version of IEEE C37.118 data frame protocol at user selected phasor data reporting rates.

b) PDC shall as a minimum, support receiving PMU data in compliance to latest version of IEEE C37.118 data frame protocol using the following UDP-TCP operating mode:

- Receiving the streaming data from a PMU using UDP-TCP operating mode
- Receiving the streaming data from a PMU using UDP/IP protocol (the data from PMU could have either a unicast or multicast destination IP address).
- Other massaging communications between PDC and PMU use a separate TCP/IP connection.

c) PDC shall be able to receive PMU data in the above UDP-TCP mode from PMUs in all substations simultaneously. PDC shall be able to receive multiple multicast real time data (with different IP addresses) through UDP/IP connection.

d) PDC shall provide a function to allow users to set a maximum waiting time for PMU data arrival for each output data stream. Only PMU data arriving before the waiting time shall be included in the output data stream.

e) PDC shall be expandable and upgradable to support receiving real- time data in other data frame protocols and/or other operating modes.

2.2.2.2 PMU data processing

PDC shall provide, as a minimum the following data processing capabilities.

a) Data quality check and flagging,
b) Data format conversion
c) Data scaling change
d) Re-sampling of a received data stream. (The re-sampling is defined as changing the data rate of a PMU data stream from one rate to another rate)
(e.g.: 30 phasor per sec to 15 phasor per second, or 30 fps to 60 fps).

2.2.2.3 PMU data time-alignment

a) PDC shall align PMU data according to their time tags, not their arriving order of arriving time.
b) PDC time alignment function shall be able to preserve time quality and UTC sync indication and add other data quality information of aligned data on individual PMU basis to be included in the output data frames.

2.2.2.4 PMU data repacking

a) PDC shall as a minimum be able to generate latest version of IEEE C37.118 compliant output data streams with a user configurable data repacking configuration for each stream. It shall be possible to generate an output data stream with any number of input data points included of a user selected data rate.
b) When generating an latest version of IEEE C37.118 compliant output data stream with all input data, PDC shall support to repack the data to maintain individual PMU data configurations
c) PDC shall be expandable and upgradable to support repacking real- time data in other data frame protocols.

2.2.2.5 Phasor Data Gateway Function

PDC shall also support a phasor data gateway (PDG) function in which it relays data and message received from one network to the other network without making any changes. PDCs supporting this function shall have physically separate network ports for connecting to different networks. PDC shall provide the minimum PDG function of data and message relaying function as described below.

a) Receiving data in UDP/IP (with either unicast or multicast destination IP address) and exchanging other messages with source devices (PMUs/PDCs) in TCP/IP
b) Resending data in UDP/IP (to either unicast or multicast destination IP address) and exchanging other messages in TCP/IP with other PDCs.
c) The multicast destination IP address, when data is relayed to a multicast destination IP address, should be user configurable.
d) Data and message shall be sent without any changes.

The PDG function should be an additional function to normal PDC functions, which can be run in parallel with the normal PDC data alignment functions.

2.3. Storage Management

PDC shall provide data storage for all received PMU data, the processed data and repacked data. PDC shall provide two types of data storages:

a) The online data storage for storing data for a period of time that is configurable by users
b) Long term data storage for data of selected events (events achieve historian). PDC shall provide the following data management functions.

2.3.1 Online Data Storage Management

a) The storing period for online data storage shall always end with the current time. The minimum length of the storing period for online data storage shall meet the sizing and performance requirement of this specification. The data older than the storing period may be discarded or overwritten.
b) PDC's online data storage shall be able to output the stored data upon receiving a data retrieval request. The stored data shall, as a minimum, be able to be retrieved at the granularity of an individual PMU and any single time point within the stored period.
c) PDC's online data storage shall, as a minimum, support output retrieved data in latest version of IEEE C37.118 data frame format.
d) PDC's online data storage shall be upgradable to support output (or export) stored data in latest version of IEEE C37.111 COMTRADE file format for synchro phasors .
e) PDC's online data storage shall be expandable and upgradable to support outputting stored data in other data protocols and file formats.

2.3.2 Event Data Archive Storage Management

For event data archive historian, PDC shall include an event detection application with user configurable event detection criteria for detecting various events (disturbances, abnormal system conditions, etc.) occurred in the system. The data of the detected events then shall be moved to event data archive historian with all relevant information (e.g. PMU status, event detection settings, etc.)

PDC shall provide, as a minimum the following types of event detection functions:

a) Real- Time Event Detection Functions

These event detection functions will be executed in real-time to detect system events. These functions shall be executed each time a new frame of data is received.

The real-time event detection functions shall, as a minimum, support the detection of the following events:

- System frequency out of specified range (f> and f<)
- The rate of change of the system frequency exceeding the specified threshold (df/dt>)
- Combined system frequency and the rate of change of the system frequency exceeding specified thresholds (f+ df/dt > and f+df/dt<)
- Bus voltage phasor magnitude out of specified range
- The rate of change of the bus voltage phasor magnitude exceeding the specified threshold
- Combined bus voltage phasor magnitude and the rate of change of the bus voltage phasor magnitude exceeding specified threshold
- Phase angle difference of two bus voltage phasors exceeding specified
- The rate of change of the phase angle difference of two bus voltage phasor exceeding the specified threshold
- Combined the phase angle difference of two bus voltage
- phasors and the rate of change of the phase angle difference exceeding specified threshold
- Symmetric fault occurrence indicated by protective relay
- operation status and breaker operation status included in the
- PMU data packet
- Asymmetric permanent fault occurrence indicated by protective relay operation status and breaker operation status indicated in the PMU data packet.
- Pole-slipping condition indicated by pole-slipping protective
- relay operation status.

b) Non-Real-Time Event Detection Functions

These event detection functions will be executed in real-time to detect system events. These event detection functions could be executed at a user-configurable period using data stored in the online data storage or event detection functions own data buffer.

PDC's event data archive historian shall be able to output the stored event data upon receiving an event data retrieval request. The stored data shall, as a minimum, be able to be retrieved at the granularity of an individual event within a user specified time period.

2.4. PDC Interfaces with Other PDCs

PDC shall provide proper interfaces for facilitate necessary communications with other PDCs. PDC of other types at SLDCs/NLDC control centers.

PDC shall provide proper interface to facilitate necessary connection to SCADA/EMS/DMS system with IEC 60870-5-104 or ICCP protocol

2.4.1 Operating mode

It is assumed that other PDCs shall support at least one these operating modes:

- Exchange all data and messages through a dedicated TCP/IP connection
- Exchange real-time streaming data in UDP/1P while messages in a separate TCP/IP connection.

PDC shall as a minimum support both operating modes when interfacing with other PDCs.

2.4.2 Exchange real-time streaming data

It is assumed that other PDCs support, as minimum exchange real-time streaming data in latest version of IEEE C37.118 data frame format:

- PDC shall, as minimum be capable of exchanging streaming data with other PDCs in latest version of IEEE C37.118 data frame format.
- PDC shall be expandable and upgradable to support receiving streaming input data from other PDCs in other data protocols.

2.4.3 Messaging with other PDCs.

It is assumed that other PDCs support as minimum exchanging the configuration frames messages in latest version of IEEE C37.118 messaging protocol.

- PDC shall as a minimum be capable of exchanging configuration frames with other PDCs in latest version of IEEE C37.118 messaging protocol.
- PDC shall support as a minimum exchanging configuration frames with other PDCs through a dedicated TCP/IP connection.

2.5. Network Interfaces

a) PDC shall support multiple physical Ethernet ports simultaneously.
b) PDC shall provide both optical and metallic physical port options for each port.
c) PDC shall provide an isolated networking option, in which PDC's physical input ports are connected to internal JUSNL LANs where PMUs are connected through its internal JUSNL WAN, while some or all PDC's physical output ports may be connected to physically separate external LANs/ WANs such as external WAN connections to other PDCs.

2.6. Communication Protocols

PDC, as a minimum shall support the following communication protocols.

2.6.1 Latest version of IEEE C37.118 Communication Protocol

a) PDC shall, as a minimum fully support latest version of IEEE C37.118 communication protocol for PDC to PMU data receiving and messaging related communications.
b) PDC shall as a minimum fully support latest version of IEEE C37.118
c) communication protocol for PDC to other PDC data receiving and messaging related communications.

PDC shall as a minimum support extend messaging communication protocol based on latest version of IEEE C37.118 messaging communication protocol for additional PDC-PDC messaging related communications.

2.6.2 IPv4 and IPv6

PDC shall support both IPv4 and IPv6 Internet protocols.

2.6.3 IP Multicast

PDC shall support send output data steam as multicast IP data packet. The destination multicast IP address shall be user configurable.

2.7. HMI/GUI

PDC shall provide adequate Human-Machine Interface (HMI) as is commonly available to a JUSNL control Centre system. PDC shall as a minimum include Graphical User Interface (GUI) for PDC configuration, test and diagnose purpose.

2.8. Security

PDC shall provide functions and means to enable a WAMS to meet all physical cyber security requirements of the owner for its control centre control system (Supplier shall make formal request for the detailed security requirements). These shall include but not limited to, PDC access control, data encryption/decryption, interfaces to common security services, etc.

2.9. System Sizing, Performance, Configurability, and Availability Requirements

2.9.1 System Sizing

The system sizing for PDC is only specified for initial sizing. The delivered system shall be expandable as the input and output requirements grow. Suppliers are required to describe their system's expandability in detail in their response and to fully demonstrate their system's expandability in FAT.

2.9.2 Input

PDC shall be able to receive real-time data streams at the highest reporting rate from up to 100 PMUs with an average of 10 phasors per PMU initially.

2.9.3 Online Data Storage

PDC shall provide online storage for storing as a minimum 30 days of a full record of all received processed and outputted data.

2.9.4 Event Archive Data Storage Historian

PDC event archive data storage historian shall provide, as a minimum a data storage that is capable of storing 5 years of event data assuming event data will not exceed 20% of the total volume of a full record.

2.10. System Time

PDC system time shall meet the following specifications.

2.10.1 Sync to UTC

The system clock of PDC shall be synced to UTC within 1 microsecond.

2.10.2 Timing resolution

PDC system clock shall have a time resolution of better than 1 microsecond.

2.10.3 Time and data format

PDC's HMI/GUI shall be able to display UTC time and date in compliance to ISO 8601 format. PDC's HMI/GUI shall be able to display UTC time and date in local time and date display format. PDC shall record all time as UTC time and date in compliance to ISO 8601 format.

2.11. Data Handling Performance Requirements

PDC shall meet the following performance requirements for data processing data alignment and data repacking. Filtering and data down-sampling processing functions of PDC for each output reporting rate shall not introduce additional TVE more than 0.1%.

2.11.1 Performance requirements

PDC shall be able to complete all data receiving data processing data alignment, and data repacking for all inputs and outputs within 5 ms excluding the waiting time for data arrival. This performance requirement shall be met under the maximum number of input PMU data steams and maximum number of output data steams with the maximum number of phasor as specified for the delivered as-build or expanded system.

2.12. Configurable Parameters

PDC shall, as a minimum, enable users to perform the following configurations for desired operations.

2.12.1 Configure output data streams

- It shall be possible to enable and disable each output data stream independently.
- It shall be possible to configure each output data stream independently. The configuration of each data stream shall include, as a minimum, assigning a data stream ID, selecting data elements included for output, data frame structure, waiting times for data arrival (normal and late data arrival), output data rate, and the number of data frames to be transmitted in one IP data packet.

2.12.2 Wait time settings

PDC shall enable users to set two groups of waiting time settings:

- Normal data arrival wait time settings
- Maximum wait time settings

The normal data arrival waiting time is the waiting time used for each output data stream to wait for all data arrival before performing the data processing, alignment, and repacking. The maximum waiting time is for determining if a data packet of a data stream has been lost during the transmission.

Normal data arrival wait time shall be configurable independently for each data stream. Data arrived after the wait time will not be included in the output data stream and shall be marked as “data not received in time”.

Normal data arrival wait time shall be configurable from 0 to 120 seconds with a step of 1 ms. There shall be only one maximum system wait time setting for each PDC. The maximum system wait time shall be configurable from 0.1 second to 1,000 seconds at a step of 0.1 second. Data received after the maximum system wait time will be discarded and shall be marked as “data not received”.

2.12.3 Alarm settings

User shall be able to enable and disable alarms individually. PDC shall generate an alarm whenever “data not received” occurs for one or more times for one or more PMU input data streams. The number of times and the number of streams having the problem shall be user configurable. The number of times that “data not received” occurs shall be configurable from 1 to 1,000 with a step of 1. The number of input data streams that has the problem shall be configurable from 1 to

the maximum number of the input data streams that PDC receives. The alarm shall indicate which data stream has the problem.

PDC shall generate an alarm when “data not received in time” occurred to a PMU data stream for more than a preset number of times during a specified period. The number of times that “data not received in time” occurs shall be configurable from 1 to 1,000 with a step of 1.

2.12.4 Online storage time period configuration

PDC shall enable users to configure the online data storage period. The period shall be configurable from a minimum of 15 days to the maximum number of days that the system supports at a step of one day.

2.12.5 Event detection criteria configuration

PDC shall enable users to configure event detection criteria for each event detection function as specified below.

2.12.5.1 System frequency related event detection criteria

PDC shall enable users to configure the followings:

- System frequency range of min and f max, as well as the time period that the frequency stays out of the range. fmin shall be from 0 Hz to nominal system frequency with a step of 0.01 Hz. fmax shall be from nominal system frequency to 2 times the nominal system frequency with a step of 0.01 Hz. The time period that the frequency stays out of the range shall be configurable from 0 to 10 seconds with a step of 1 ms. The rate of change of the system frequency |df/dt| detection threshold shall be from 0 to 25 Hz/s for 50 Hz system.

- The thresholds for combined system frequency and the rate of change of the system frequency shall be configurable as follows:
  ¾ f + a*df/dt >: “a” shall be configurable from 0 to 10 seconds with a step of 1 ms; and the threshold shall be from nominal system frequency to 2 times the nominal system frequency with a step of 0.01 Hz

  ¾ f + b*df/dt <: “b” shall be configurable from 0 to 10 seconds with a step of 1 ms; and the threshold shall be from 0 Hz to nominal system frequency with a step of 0.01 Hz All frequency related detection criteria shall be global criteria.

2.12.5.2 Voltage magnitude related event detection criteria

PDC shall enable users to configure the followings:

- Bus voltage phasor magnitude range: Vmin from 0 pu to 1.0 pu with a step of 0.01 pu.Vmax from 1.0 pu to 2.0 pu with a step of 0.01 pu. A time period that voltage stays out of the range shall be configurable from 0 to 10 seconds with a step of 1 ms.

- The threshold for rate of change of the bus voltage phasor magnitude |dV/dt| shall be configurable from 0 to 1.0 pu/s with a step of 0.01 pu/s. A time period that |dV/dt| stays above the threshold shall be configurable from 0 to 10 seconds with a step of 1 ms.

- The thresholds for combined bus voltage phasor magnitude and the rate of change of the bus voltage phasor magnitude shall be configured as follows:

¾ V + a*dV/dt >: “a” shall be configurable from 0 to 10 seconds with a step of 1 ms; and the threshold shall be from 1.0 pu to 2.0 pu with a step of 0.01 pu

¾ V + b*dV/dt <: “b” shall be configurable from 0 to 10 seconds with a step of 1 ms; and the threshold shall be from 0 pu to 1.0 pu with a step of 0.01 pu

All voltage magnitude related event detection criteria shall be configurable on an individual bus voltage basis. An option shall be provided to configure global default criteria for voltage magnitude related event detection.

2.12.5.3 Voltage phase angle difference related event detection criteria

PDC shall enable users to configure the followings:

- The threshold for phase angle difference of two bus voltage phasors shall be configurable from 0 to 180 degree with a step of 0.1 degree.

- The threshold for rate of change of the phase angle difference of two bus voltage phasors shall be configurable from 0 to 100 degree/ms with a step of 0.1 degree/ms.

- The threshold for combined phase angle difference of two bus voltage phasors and the rate of change of the phase angle difference shall be configurable from 0 to 180 degree with a step of 0.1 degree.

All phase angle difference related event detection criteria shall be configurable on an individual phase angle difference basis. An option shall be provided to configure global default criteria for phase angle difference related event detection.

2.12.5.4 Other real-time event detection criteria

PDC shall enable users to configure the followings:

- Detection logic for symmetric fault occurrence indicated by AND and/or OR protective relay operation status and breaker operation status included in the PMU data packet.
- Detection logic for asymmetric permanent fault occurrence indicated by AND and/or OR protective relay operation status and breaker operation status included in the PMU data packet
- Detection logic for pole-slipping condition indicated by pole- slipping protective relay operation status

2.12.6 Communication mode configuration

PDC shall enable users to select and configure data input and output communication modes. User shall be able to select between TCP/IP and UDP/IP for data receiving for each data input stream or each output data stream.

For each input stream received in UDP/IP, user shall be able to configure whether the data will be received with a unicast or multicast IP address.

For each UDP/IP output stream, user shall be able to select between sending the data to a unicast or multicast IP address. User shall be able to configure the destination IP address in both cases. PDC shall allow users to configure the number of frames of output data frames contained in each IP packets. The number shall be between 1 to the maximum number of frames that an output IP packet allows.

2.13. Availability Requirements

System components shall meet the following availability requirements.

2.13.1 System components

Individual system components, such as server hardware, storage devices, shall each exhibit an availability of better than 98%.

2.13.2 Performance monitoring and reporting

PDC shall include system performance monitoring functions to continuously monitor the following system performance:

- Data Handling Performances
- PMU input data performance, such as interruptions, excessive delay, Data error rate, etc.

Performance shall be logged, and performance fail to meet the specified requirements reported.

2.14. PDC Software Requirements

PDC shall meet the following software requirements.

2.14.1 **Upgradability**

The complete real-time software kernel/OS and application programs of a PDC shall be fully upgradable through firmware upgrade and/or other software upgrade methods. The firmware/software upgrade may include

- General software upgrade such as kernel/OS upgrade
- Adding new features and functionalities, such as supporting new data format and communication protocols
- Fixing bugs and deficiencies

The Supplier shall keep Procurement Entity informed of the latest software updates or revisions available after the system is shipped.

Users shall be able to perform the necessary software upgrade in the field.

2.14.2 Self-monitoring and alarming

PDC shall provide self-monitoring functions to monitor the operating conditions and the performance of the PDC. Any detected problems shall be reported through local display, built-in event logging and to remote control centers when remote reporting is enabled.

Severe problems, such as loss of communication, shall generate alarms

both locally and remotely.

2.14.3 Local and remote configuration

The configuration software shall support both local and remote configuration of the PDC.

Local and remote configuration functions shall meet all security requirements and procedures.

2.14.4 Software security requirements at delivery

Software at delivery shall meet following requirements in accordance with general software security assurance practices.

2.14.4.1 Security Tested and Configured

The executive and all associated application software modules shall be the most secure version of the software available at the time of start of the Factory Acceptance Test. The delivered software shall be tested to ensure the followings:

a) Free of computer viruses, worms, Trojan horses, and other software contaminants
b) Unused services are disabled/removed, these include
   - Device drivers for devices not included in the hardware
   - Unused networking protocols
   - Unused administrative utilities, diagnostics, network management, or system management functions
   - Administrative utilities, diagnostics, network management, or system management functions or workstations unused by administrators
   - Backups of files, databases, and programs, used during system installation/upgrade but not needed in the operational system
c) Accounts that are not End-User Administrator created shall be removed, this include
   - Any guest accounts (with and without passwords) or default administrator or maintenance accounts other than the initial system administrator account for Procurement Entity
   - Any guest accounts or default administrator or maintenance accounts for any third party software

2.14.5 Maximum Initial Security Settings

The PDC software shall be shipped with all security settings at their maximum setting. All software shall be delivered with all the latest relevant security patches installed.

All security-related parameters and options shall be placed at their most restrictive settings at the delivery, i.e., affording the access and execution privileges to the smallest class of users consistent with meeting the functional specifications, and restricting their rights to the narrowest range of privileges.

2.14.6 No Automatic Downloading and Execution of Executable Code

It shall not be possible to download any executable code into the PDC and execute the downloaded software code automatically without system administrator's approval. All software shall be removed that would otherwise make it possible to execute a scripting language (such as ActiveX, Java, Java scripts, etc.), including software in the browser and e- mail processor, where applicable.

2.14.7 File Access Control

The PDC software shall support controlled access privileges for files, including at least access, read, write, execute, and combinations of these. The

access privileges for each user can only be assigned by system administrator of PDC and shall be assigned on an individual user account basis.

The default access privileges for each new user account shall be no access to any file on the system at all. No user, including system administrator, shall be given the privilege of modifying operating system files and other files that are never supposed to change while the system is running.

2.14.8 Free of "Electronic Self-Help" Enabled Software

It shall be strictly prohibited for delivered software to contain embedded faults or back-door mechanisms that allow the software manufacturer to remotely disable some or all of the functions of the software, or affect their performance, or in any way degrade its operation (so- called "electronic self-help" in the terms of the Uniform Computer Information Transactions Act). The software shall not contain any mechanism that automatically disables some of all of its functions or degrades their operation on a certain date or upon the occurrence of a specific event.

2.15. Logging

The PDC shall provide automatic logging of events & alarms. The purpose of these logs is both to support the users of the PDC in their day to day activities, and also to support troubleshooting activities in the event of problems. All PDCs events shall be logged in a global log, as follows:

- Each log entry shall be time stamped
- Each log entry shall contain details including the applicable thresholds violated
- The user shall be able to filter and sort the alarm log on specific criteria, e.g.: Category of alarm (frequency deviation, angle difference, etc.), Classification by level of alarm (normal, alert, alarm), Location of alarms in the power system, Type of signal(s) producing alarm.
- The PDC should have Facility for archival of different categories of Log for reporting to be provided.

2.16. Data analysis and reporting application

Provision of tailor-made / customized application suitable for query-based retrieval of archived data and presentation of the same in various graphical and tabular forms required for conducting basic power system study and event analysis. This should include necessary OS platform, application, Multi user licensing along with implementation & customization.

2.17. Data exchange with EMS applications

JUSNL is planning to upgrade their SCADA/EMS system and would require the phasor data output for improvement of the results of State Estimator. The data

output from the phasor data concentrator would be transferred to EMS applications every Minute. The data exchange format would be as per IEC 60870-5-104 format.

2.18. Data exchange with other applications

The PDC system should have facility for exchanging the data with other PDC , System Protection System applications or any other applications developed by owner for system operation on ICCP or any other data format as mutually agreed.

2.19. System Redundancy

The PDC & Historian servers shall be configured on hot-standby mode to provide adequate system redundancy. Automatic detection of any system function failure and switching to available resource shall be provided. User shall be able to access the stored data from both the servers at any time period and also if any system failure happened.

2.20. Visualization Displays /Alarm Generation

The user interface application software is required to visualize & analyse the online and stored phasor data. User interface shall be provided for the configuration, monitoring and analysis of multiple synchronized phasor data on single and multiple displays. PDC real time data and displays shall be displayed on the consoles using internet browsers such as Internet explorer, fire fox etc. The no of consoles shall be as per BOQ.

2.20.1 Real Time Display

The Visualization Software should directly communicate with the PDC to display the data in real time. Provision to display Phasor magnitude, angle, frequency, df/dt, MW, MVAR should be provided. The time window (in the order of hours) of the real time display should be configurable along with the provision to visualize multiple displays.

2.20.2 Archived/Stored Data Display

The Visualization Software should be able to access and display the archived data. Provision to display Phasor magnitude, angle, frequency, df/dt, MW, MVAR shall be provided. The window of the real time display should be configurable along with the provision to visualize multiple displays. To visualize the data over a period of a month/year, provision to average the data should be available.

It shall be possible for a user to define, modify and verify alarm conditions on-line. It shall be possible to trigger alarms & trigger storage of data on the following:

- Deviation of frequency from nominal
- Rate-of-change of frequency exceeding a set value
- Voltage magnitude outside upper or lower boundaries
- Active or reactive power exceeding limits
- Voltage angle difference between selected points exceeding limits

For each quantity triggering alarms, it shall be possible to define three states such as Normal, Alert and Alarm state. Alarm should be inhibited on detection of an invalid signal from a PMU, such as out of range voltage or frequency. Alarm displays shall have the identification of the source (station/PMU etc) where alarm is raised, type of violation and recent history of alarms.

All the events shall be logged in global alarm log so that each log entry is time stamped and shall contain the details of defining applicable threshold. The user shall be able to filter and sort of the alarm log on specific criterion such as category of alarm: freq, angle deviation, by level of alarm: normal, alert, location, time etc.

The time window for display or analysis of historic data should be user selectable. It should be possible to select data for output via ASCII/Binary files/IEEE format.

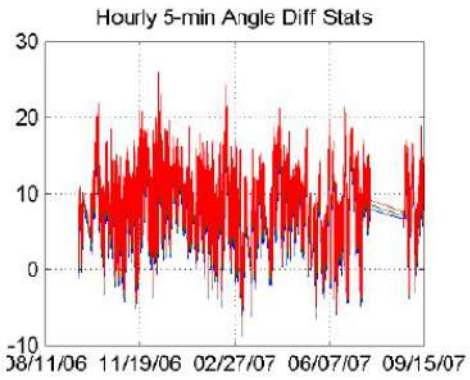
Visualization displays shall be provided to rapidly detect abnormal direction of power flow or sudden change in power across the line. Bidder is required to supply UI tool and create displays for use by JUSNL operator. Display should be user configurable by using various symbols etc.

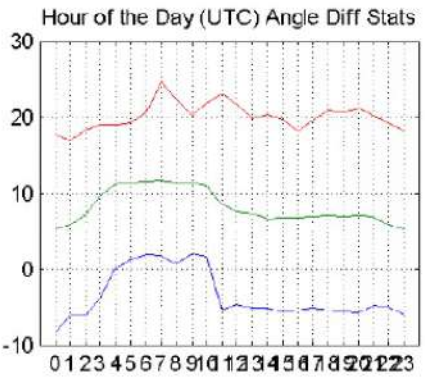
The visualization shall include;

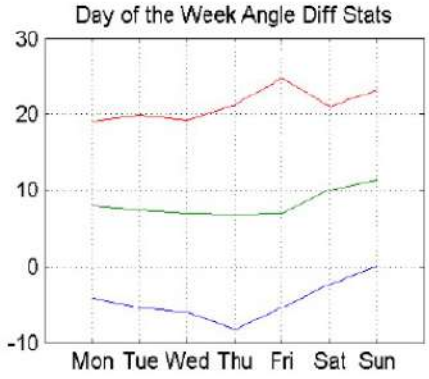
- Phase angle difference between selected voltage measurement locations
- Topological phasor display for voltages
- Polar diagrams
- Strip charts (Voltage / Frequency / Active & Reactive Power)
- Total Vector Error display

Some typical desirable visualization displays are provided in Figure-1, Figure-2 & Figure 3.

Figure-1


Hourly 5-min Angle Diff Stats
30
20
10
0
-10
08/11/06 11/19/06 02/27/07 06/07/07 09/15/07


Hour of the Day (UTC) Angle Diff Stats
30
20
10
0
-10


Day of the Week Angle Diff Stats
30
20
10
0
-10
Mon Tue Wed Thu Fri Sat Sun

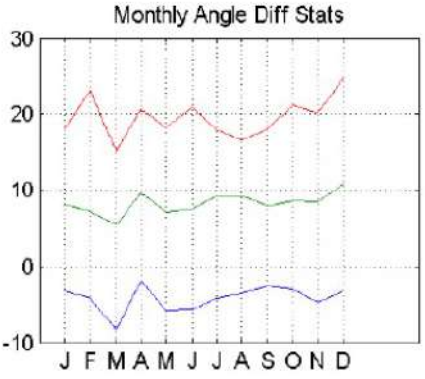

Monthly Angle Diff Stats
30
20
10
0
-10
J F M A M J J A S O N D

Figure -2

USER INTERFACE DISPLAYS

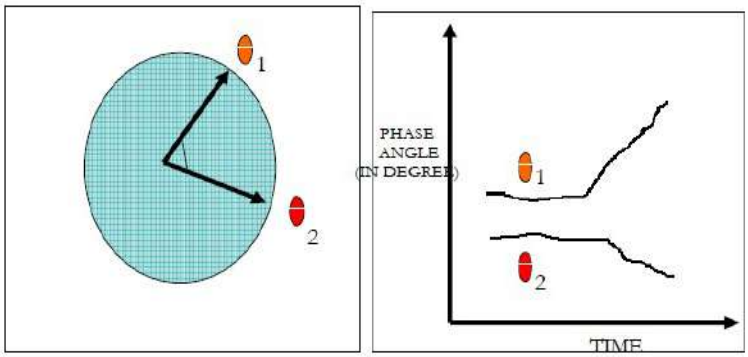
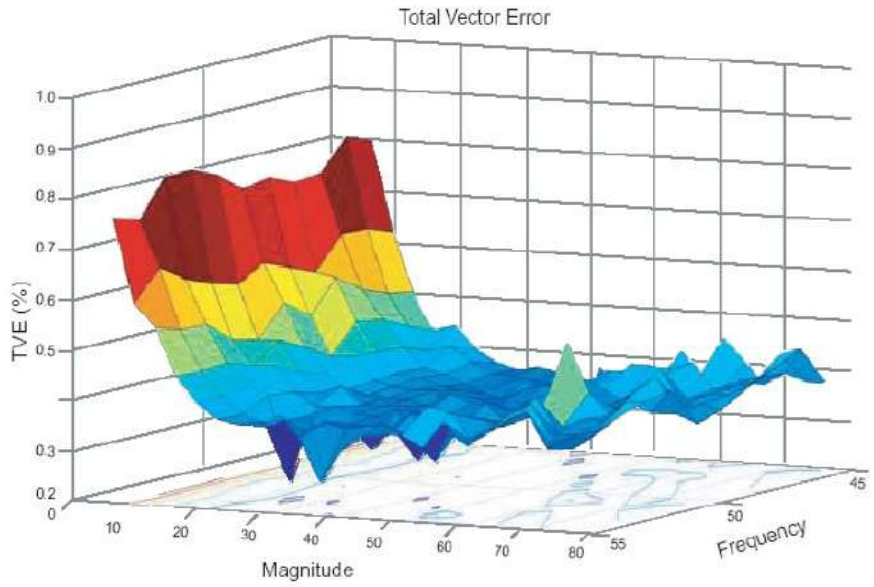


Figure-3



Angle & Frequency variations

HARDWARE REQUIREMENTS

3.1. LOCAL AREA NETWORK (LAN) SWITCHES

Server and peripheral devices are connected to each other on a local area network (LAN), which allows sharing of resources without requiring any physical disconnections & reconnections of communication cable. LAN shall have the following characteristics:

- Conform to the ISO 8802 or IEEE 802 series standards.
- Allow reconfiguration of the LAN and the attached devices without disrupting operations
- Have minimum of twenty four (24) ports of 10/100/1000Mbps in LAN switch.

3.2. OPERATOR/WORKSTATION CONSOLES

Operator /Workstation are to be provided at JUSNL for visualization. All the workstation shall be equipped with software, applications, user license and database for user displays, data Analysis and reporting output as well as user administration at all locations with user access as defined in the specification.

The minimum hardware configuration of workstation shall be:

- 2 GB Main memory
- 72 GB Auxiliary memory
- DVD-RW drive
- 21 inch TFT dual colour monitors
- Keyboard
- Mouse
- Speakers for audible alarms
- 10/100/1000Mbps dual Ethernet ports

3.3. REMOTE CONSOLES AT SLDC/RPC/CTUS

The Remote console with client software provided at SLDC/ERPC/STUs. All remote consoles shall be equipped with software, applications, user license and database for user displays, data Analysis. The minimum hardware configuration of remote console shall be as Workstation consoles hardware.

3.4. ROUTERS

Routers shall be capable for data exchange between PDC & PMU over communication media. Each router shall have the following features:

- Support the TCP/IP protocols
- Support dynamic discovery of routes
- Support 10/100/1000 Mbps LAN interface
- have inbuilt software firewall

For normal operation, router shall use all channels and in the event of any channel failures, traffic shall be re-routed to the remaining healthy channels with an attempt to generally balance the load. Connectivity of the PMUs installed at various sites with PDC at JUSNL is envisaged to be distributed in two routers to increase probability of availability of partial data in case of any hardware failure.

3.5. FIREWALL

Suitable Hardware Firewall for intrusion detection & prevention and anti-virus / anti- spyware protection to be installed and configured for enhanced security.

Firewall shall be hardware box Firewall system with following features.

- Firewall throughput >400 Mbps
- Firewall 3DES throughput >120 Mbps
- Data encryption supported DES (56 BITS) 3des (168 bits) and hashing algorithm like MD5 and SHA-1.
- Encryption to offload the main CPU
- Minimum 8 Ethernet 10/100/1000 Mbps ports.
- Support NAT and PAT
- Filtering of packets based on Source address, Destination address, Protocol type, User, Port number, URL
- Filtering of Protocols such as FTP, SMTP, HTTP, SNMP, UDP, ICMP, RPC, DNS, DHCP, ARP
- Denial of service prevention
- DNS guard features
- JAVA and ActiveX blocking content filtering services
- Antivirus, anti-worm and anti-spyware protection
- Stateful packet inspection
- Detailed system logging and accounting feature
- tight integration with the NIPS provided
- 500 No. of concurrent TCP Session
- Capability of working in Active/Active mode
- Capability of load balancing among interfaces for WAN links
- Radius Integration
- Assigning zones to virtual and physical interfaces
- Assigning firewall policies between zones, physical interfaces and virtual interfaces
- Web based management interface
- Remote/online/Auto update for virus definition.
- Firewall shall also support OT protocols used in WAMS

3.6. COLOUR LASER JET PRINTER

Colour Laser printer shall be used to take coloured hardcopy printout and shall be interfaced with Ethernet LAN either directly or through individual print server. Except for output capabilities unique to any printer type (such as extended character sets or graphic print capabilities), there shall be no limitations on the use of any printer to perform the functions of any other printer. The features colour laser jet printer is defined below:

- Shall be suitable for printing on A4 & A3 size normal paper. Printer shall support Dual LAN interface, Different types of paper - weight (75 GSM to 200 GSM) the printout shall match to object/content to be printed in colour & size.
- Shall have resolution of at least 1200 X 1200 dots per inch.
- print time shall be less than 30 seconds per page for a coloured printout in normal mode
- Print speed of 20 colour pages per minute
- Automatic Duplex printing
- Duty cycle of at least 100000 per month
- shall have input trays of 400 sheets & output trays
- shall have landscape and portrait print orientation

3.7. HISTORICAL SERVER AND STORAGE

Data Historian server with storage as per given in table 3.3 shall be provided on Windows based system which shall be used for storing time-stamped PMU data for future use in standard format e.g. Spread sheet tables. Data Historian shall be provided with full data storage of the PMU data at least for 12 months. Retrieval of data from the historian should be possible by querying with SQL-99 compliant SQL query language. It shall also be possible to get streaming data from Data historian in Microsoft Excel spreadsheet.

3.8. SYSTEM DESIGN PARAMETERS

The Computer hardware and software for PDC System shall be designed as per the Technical parameters defined in the Part-II.

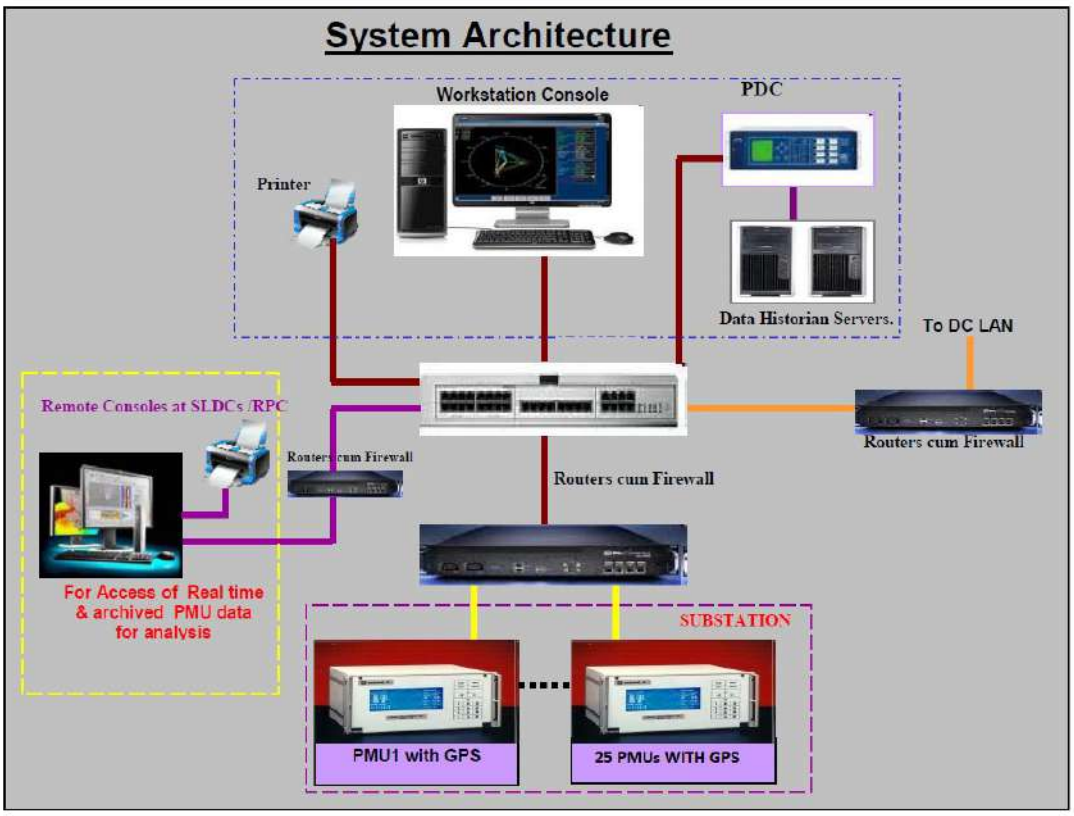

System Architecture
Workstation Console
PDC
Printer
Data Historian Servers.
To DC LAN
Remote Consoles at SLDCs /RPC
Routers cum Firewall
Routers cum Firewall
Routers cum Firewall
For Access of Real time & archived PMU data for analysis
SUBSTATION
PMU1 with GPS
25 PMUs WITH GPS

Table 3.1 PMU to PDC data

S.No	Description	Quantity
1	3 phase Positive sequence Current magnitude	2
2	3 phase Positive sequence Voltage magnitude	1
3	Phase angle of current and voltage	9
4	frequency	1
5	Rate of change of frequency	1
6.	Active Power	1
7.	Reactive Power	1

The PMU shall be expendable for another 2 sets of similar inputs of one 3 phase voltage and two 3 phase current without addition of any additional hardware.

Table 3.2 Substation to PMU interface

S.No	Description	Quantity
1	Voltage input from PT	3 phase V
2	Current input from CT	3 phase I
3	Status Indicator	8

Table 3.3 Capacity Storage Sizing parameters

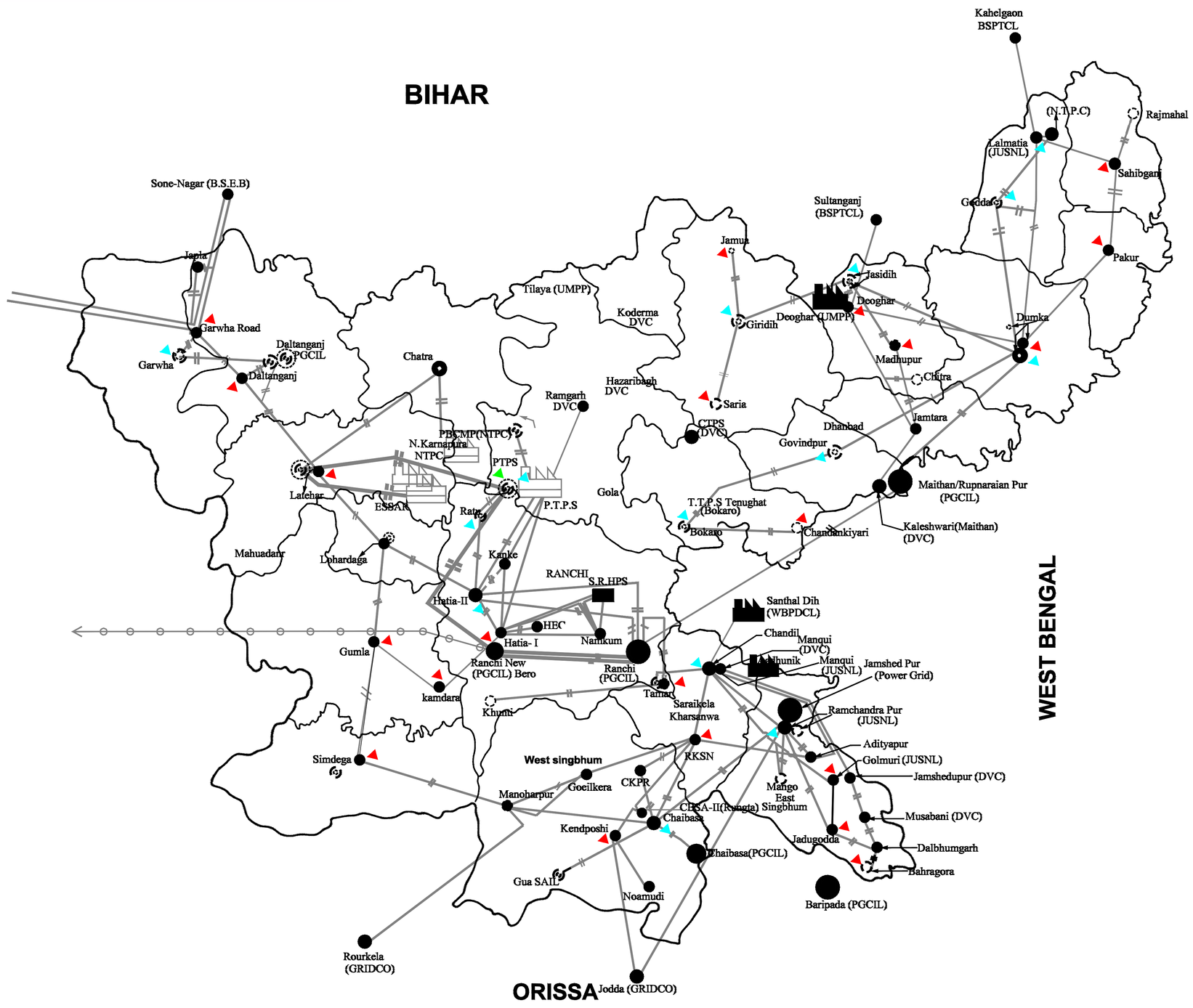
S.No	Description	Quantity
1	Number of PMUs	72
2	Sampling Rate	50 samples/sec
3	Values per PMU	As per table 3.1 above
4	Triggered data storage capability	15 days
5	On line archiving of data	1 month

The systems to be designed for 100% expansion capacity without any addition of software or Hardware.

ANNEXURE 1 - PMU LOCATION MAP

DWG NO: ANNEXURE – 1

TITLE: PMU LOCATIONS AT EXISTING 400/220/132/33kV SUBSTATIONS



LEGENDS:-

- PROPOSED PMU AT 400/220kV GSS SUBSTATION
- PROPOSED PMU AT 220/132kV GSS SUBSTATION
- PROPOSED PMU AT 132/33kV GSS SUBSTATION

DO NOT SCALE

JUSNL SMART GRID PROJECT
WAMS DPR

PMU LOCATIONS AT EXISTING 400/220/132/33kV SUBSTATIONS

TATA CONSULTING ENGINEERS LIMITED
MUMBAI

FILE NAME : PMP_LOC

"P" (PRELIMINARY) ISSUES ARE NOT TO BE USED FOR CONSTRUCTION / FABRICATION BUT ARE ISSUED FOR LIMITED PURPOSES ONLY AS INDICATED IN THE SMALL BLOCK AT THE TOP RIGHT HAND CORNER OF THE TITLE BLOCK.

CONSTRUCTION / FABRICATION WORK IS PERMITTED ON 'R' (RELEASED) ISSUES ONLY.

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DEL.CENTRE-DISC: EL	MP
DRN: AS	
CHD:	DWG NO ANNEXURE – 1

DATE (RO ISSUE)
DATE (CURRENT ISSUE) 23-09-2022
ISSUE P2
SIZE-A1

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MECH		

ISSUE	REVISIONS	DRN	CLEARED					APPD	DATE
			CIVIL	ELEC	I&C	MECH			

ISSUE	REVISIONS	DRN	CLEARED					APPD	DATE
			CIVIL	ELEC	I&C	MECH			

FILE NAME: F-041-Rev-R5.dwg

ANNEXURE 2 - COSTING DETAILS FOR WIDE AREA MONITORING SYSTEM (WAMS)

	Employer	**JHARKHAND URJA SANCHARAN NIGAM LIMITED (JUSNL)**							Annexure - 2		
	Consultant	**TATA CONSULTING ENGINEERS LIMITED**									
	Project	**Implementation of Smart Grid Technologies for JUSNL**									
	Schedule	**SUMMARY OF WAMS SYSTEM**									
Sr. No	**Description of Works**	**Total Price in Rs.**	**Supply GST in Rs.**	**Freight & Insurance**	**Freight & Insurance GST**	**Sub Total (Supply)**	**Installation & Service Charges**	**Service GST in Rs.**	**Sub Total (Installation)**	**Total cost in INR (Without GST)**	**Total cost in INR (With GST)**
1	Phasor Measurement Unit and its hardware at GSS	140,921,964	25,365,954	5,636,879	1,014,638	172,939,434	1,620,000	291,600	1,911,600	148,178,843	174,851,034
2	PDC & Application Cost (including Hardwares, softwares) at SLDC	159,061,403	28,631,053	1,482,456	266,842	189,441,754	14,166,667	2,550,000	16,716,667	173,228,070	206,158,421
	TOTAL	**299,983,367**	**53,997,006**	**7,119,335**	**1,281,480**	**362,381,188**	**15,786,667**	**2,841,600**	**18,628,267**	**321,406,913**	**381,009,455**
	GRAND TOTAL									**321,406,913**	**381,009,455**

Cost break-up for 01 no Substation (2 nos. of PMU & its hardware per substation)					
Sr No	**Description**	**Unit**	**QTY**	**Unit Price (INR)**	**Total Price (INR)**
	Phasor Measurement Unit & Hardware				
1	Phasor Masurement Unit	Nos.	2	550,000	1,100,000
2	WAMS Hardware				
2.1	Time System (GPS receiver)	Nos.	1	250,000	250,000
2.2	Router with Firewall (Substation Garde Layer-3 LAN switches with minimum 4x10/100Mbps Ethernet Ports and 2x1 Gbps Ethernet Ports)	Nos.	1	746,076	746,076
2.3	Miscellaneous - Armoured FO cable, associate terminations, for connecting PMU panels located different control room of a station	Set	2	145,000	290,000
2.4	Tributory Interface - E1 Interface with (Minumum 16 Nos)	Nos.	1	325,566	325,566
2.5	Ethernet Interface 10/100 Base with Layer-2 Switching (Min 8 interfacec per card)	Nos.	1	111,191	111,191
2.6	VOIP Telephone Instrument with one common switch (Min 8 Ports)	Nos.	1	1,091,666	1,091,666
	PMU & Hardware Total Cost				**39,14,499**
3	Installation, testing and commissioning Cost for PMU's and its hardware	Nos.	9	5,000	45,000

COST BREAK-UP OF WAMS EQUIPMENTS														
Project	**Implementation of Wide Area Monitoring System (WAMS) at JUSNL**										Annexure – 2			
											Amount in INR			
				SUPPLY COST						**SERVICES COST**				
Sr. No	**Description of the equipment**	**Unit**	**Qty**	**Rate in INR**	**Total Cost**	**Supply GST**	**Freight & Insurance**	**Freight & Insurance GST**	**Sub Total (Supply)**	**Installation per Unit**	**Installation Cost**	**Services GST**	**Sub Total (Services)**	**Total cost in INR**
			A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Part - A	**400kV Substations**				A x B	18%	4%	18%	C + D + E+ F		(A x H)	18%	(I + J)	(G + K)
1	**400/220 kV Patratu GSS**													
1.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
Part - B	**220kV Substations**													
1	**220/132 kV HATIA-2 GSS**													
1.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
2	**220/132/33 kV CHAIBASA-NEW GSS**													
2.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
3	**220/132/33 kV PTPS GSS**													
3.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
4	**220/132/33 kV RATU (BURMU) GSS**													
4.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
5	**220/132/33 kV GOVINDPUR GSS**													
5.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
6	**220/132 kV MADANPUR DUMKA GSS**													
6.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
7	**220/132 kV CHANDIL-1 GSS**													
7.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
8	**220/132 kV RAMCHANDRAPUR GSS**													
8.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
9	**220/132/33 kV LALMATIA GSS**													
9.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
10	**220/132/33 kV GARHWA (BHAGODIH) GSS**													
10.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
11	**220/132 kV GODDA GSS**													
11.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
12	**220/132/33 kV JASIDIH GSS**													
12.1	Phasor Measurement Unit and its hardware(Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973

13	**220/132/33 KV JAINAMORE (BOKARO) GSS**													
13.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
14	**220/132/33 kV GIRIDIH GSS**													
14.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
Part - C	**132kV Substations**													
1	**132/33 kV MAHARO DUMKA**													
1.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
2	**132/33 kV DEOGHAR**													
2.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
3	**132/33 kV HATIA-1**													
3.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
4	**132/33 kV JADUGODA**													
4.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
5	**132/33 kV KENDOPOSI**													
5.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
6	**132/33 kV DALTONGANJ**													
6.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
7	**132/33 kV GOLMURI**													
7.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
8	**132/33 kV GUMLA**													
8.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
9	**132/33 kV MADHUPUR**													
9.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
10	**132/33 kV SIMDEGA**													
10.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
11	**132/33 kV KAMDARA**													
11.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
12	**132/33 kV PAKUR**													
12.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
13	**132/33 kV SAHEBGANJ**													
13.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
14	**132/33 Kv TAMAR**													
14.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973

15	**132/33 kV RAJKHARSWAN**													
15.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
16	**132/33 kV GARHWA ROAD**													
16.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
17	**132/33 kV LATEHAR**													
17.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
18	**132/33 kV JAMUA**													
18.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
19	**132/33 kV CHANDANKIYARI**													
19.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
20	**132/33 kV BAHRAGORA**													
20.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
21	**132/33 kV SARIA**													
21.1	Phasor Measurement Unit and its hardware (Phasor Measurement Unit= 2Nos.)	Set	1	3914499	3,914,499	704,610	156,580	28,184	4,803,873	45,000	45,000	8,100	53,100	4,856,973
	TOTAL				**140,921,964**	**25,365,954**	**5,636,879**	**1,014,638**	**172,939,434**		**1,620,000**	**291,600**	**1,911,600**	**174,851,034**

COST BREAK-UP OF WAMS EQUIPMENTS														
Project	**Implementation of Wide Area Monitoring System (WAMS) at JUSNL**										Annexure - 2			
											Amount in INR			
				SUPPLY COST							**SERVICES COST**			
Sr. No	**Description of the equipment**	**Unit**	**Qty**	**Rate in INR**	**Total Cost**	**Supply GST**	**Freight & Insurance**	**Freight & Insurance GST**	**Sub Total (Supply)**	**Installation per Unit**	**Installation Cost**	**Services GST**	**Sub Total (Services)**	**Total cost in INR**
			A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
	WAMS at SLDC Ranchi				A x B	18%	4%	18%	C + D + E + F	5%	(A x G)	18%	(I + J)	(G + K)
1	**Hardware**													
1.1	PDC	Nos.	2	20,00,000	40,00,000	7,20,000	1,60,000	28,800	49,08,800	1,41,66,667	1,41,66,667	25,50,000	1,67,16,667	2,16,25,467
1.2	PDC hardware & Network Accessories	Set	1	3,30,61,403	3,30,61,403	59,51,053	13,22,456	2,38,042	4,05,72,954	-	-	-	-	4,05,72,954
2	**Software**													
2.1	PDC Software with Analytics	Set	1	12,20,00,000	12,20,00,000	2,19,60,000	-	-	14,39,60,000	-	-	-	-	14,39,60,000
	TOTAL				**15,90,61,403**	**2,86,31,053**	**14,82,456**	**2,66,842**	**18,94,41,754**		**1,41,66,667**	**25,50,000**	**1,67,16,667**	**20,61,58,421**

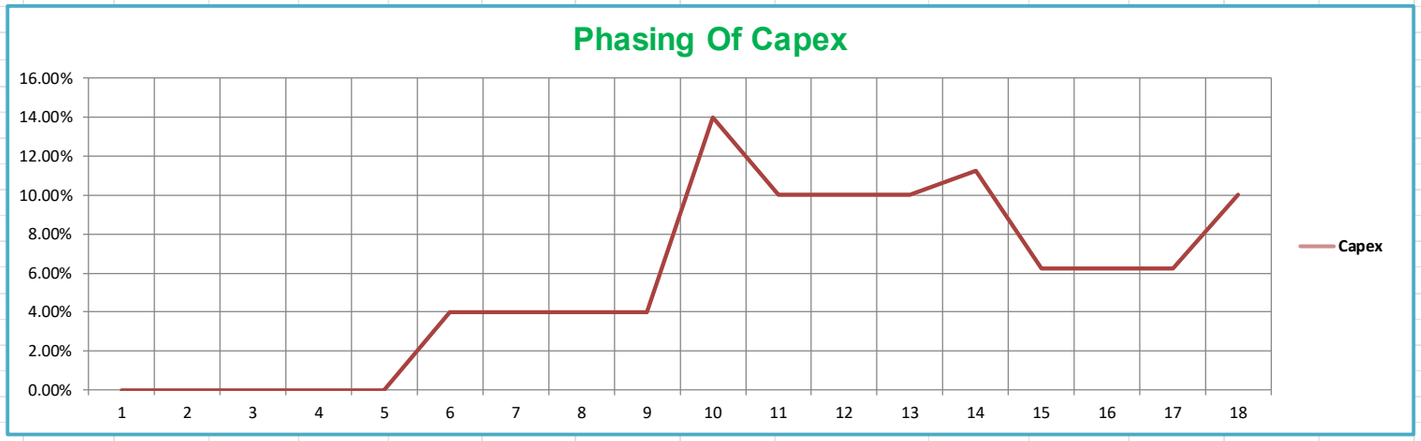
ANNEXURE 3 – CAPITAL EXPENDITURE SCHEDULE

SMART GRID IN JUSNL CAPEX SCHEDULE

		Equity (Rs. Crores)	10.74	Note:	Equity	30%
		Debt (Rs. Crores)	25.05		Debt	70%

TOTAL PROJECT COST (Rs. Crores) WITHOUT CONTINGENCY	**35.79**	**Crores**
WIDE AREA MONITORING SYSTEM (WAMS) AT JUSNL	**35.79**	**Crores**
TOTAL PROJECT COST (%)	**100.00%**	

Activity	Progress
Detailed Design	20.00%
Supply including Factory Acceptance Test - FAT	50.00%
Installation of Equipments	5.00%
Site Testing & Commissioning	5.00%
Site Acceptance Test - SAT	5.00%
Testing & Commissioning	5.00%
Trial operation and Taking Over	10.00%



MONTHLY PROJECT PROGRESS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
WIDE AREA MONITORING SYSTEM (WAMS) AT JUSNL																		
Bidding period																		
Detailed Design						20%	20%	20%	20%	20%								
Supply including Factory Acceptance Test - FAT										20%	20%	20%	20%	20%				
Installation of Equipments														25%	25%	25%	25%	
Site Testing & Commissioning															50%	25%	25%	
Site Acceptance Test - SAT															25%	50%	25%	
Testing & Commissioning															25%	25%	50%	
Trial operation and Taking Over																		100%
PHASING OF CAPEX (%)	0.00%	0.00%	0.00%	0.00%	0.00%	4.00%	4.00%	4.00%	4.00%	14.00%	10.00%	10.00%	10.00%	11.25%	6.25%	6.25%	6.25%	10.00%
Capex required in Rs. Crores	0.0	0.0	0.0	0.0	0.0	1.4	1.4	1.4	1.4	5.0	3.6	3.6	3.6	4.0	2.2	2.2	2.2	3.6
Equity Available distributed equally (%)						2.31%	2.31%	2.31%	2.31%	2.31%	2.31%	2.31%	2.31%	2.31%	2.31%	2.31%	2.31%	2.31%
Equity Available distributed equally (Rs. Crores)	0.00	0.00	0.00	0.00	0.00	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Debt or Loan Required (Rs. Crores)	0.00	0.00	0.00	0.00	0.00	0.61	0.61	0.61	0.61	4.18	2.75	2.75	2.75	3.20	1.41	1.41	1.41	2.75
Debt Opening Balance (Rs. Crores)	0.00	0.00	0.00	0.00	0.00	0.00	0.61	1.21	1.82	2.42	6.61	9.36	12.12	14.87	18.07	19.48	20.89	22.30
Debt Addition (Rs. Crores)	0.00	0.00	0.00	0.00	0.00	0.61	0.61	0.61	0.61	4.18	2.75	2.75	2.75	3.20	1.41	1.41	1.41	2.75
Debt Closing Balance (Rs. Crores)	0.00	0.00	0.00	0.00	0.00	0.61	1.21	1.82	2.42	6.61	9.36	12.12	14.87	18.07	19.48	20.89	22.30	25.06
Interest Rate (Monthly) (%) Annual 8%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%	0.667%
IDC Calculated on monthly basis(Rs. Crores)	0.000	0.000	0.000	0.000	0.000	0.004	0.008	0.012	0.016	0.044	0.062	0.081	0.099	0.120	0.130	0.139	0.149	0.167

Total IDC (Rs. Crores)	**1.03**

ANNEXURE 4 – PHYSICAL AND FINANCIAL MILESTONES

"Annexure 4"

Physical and Financial Milestones activities for WAMS

		Q1			Q2			Q3			Q4			Q5			Q6		
		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18
A	**Pre-Bid activities, bid process & Award of work**																		
1	Project Approval																		
2	Bid Preparation & Floating																		
3	Bidding Period																		
4	Bid Evaluation & Award of Contract																		
B	**Execution of work**																		
1	issue of LOA from JUSNL to EPC contractor in 6 months																		
	1st Disbursement - 10% of Total Approved Amount on mobilization						10%												
2	Resource Mobilization & Establishment of project office																		
	2nd Disbursement - 10% of Drawing submission and approval							10%											
3	Report / Drawing submissions and approval																		
4	Manufacturing Clearance																		
5	Material Dispatch Clearance Certificate for WAMS equipments																		
	3rd Disbursement - 50% of Total Approved Amount on supply of WAMS equipments										50%								
6	Supply of WAMS equipments																		
	4th Disbursement -20% of Total Approved Amount on commissioning of WAMS system														20%				
7	Installation, testing and Commissioning of WAMS equipments																		
8	Communication establishment with Server center																		
9	Data integration with SLDC Control Centre																		
10	Process upgradation/ Implementation																		
11	Training & Capacity Building																		
	5th Disbursement - 10% of Total Approved Amount on submission of Project Completion Report																		10%
12	Report Submission for Project Completion and handover																		

Physical Milestones	
Financial Milestones	

Annexure B 1.2

POWER SYSTEM OPERATION CORPORATION LIMITED
National Load Despatch Centre
(Designated as Nodal Agency in accordance with Regulation 5 of CERC (PSDF) Regulations, 2014)
(PSDF-Secretariat)

Office Address: B-9, 1st Floor, Qutub Institutional Area, Katwaria Sarai, New Delhi -16
Tel: 011-26524521, 26536959 Fax: 011-26524525, 26536901
Website: https://psdfindia.in/. Email psdf@posoco.in ; nldc.psdf2020@gmail.com

Ref: NLDC-PSDF/TESG-56th meeting/2021-22/ Dated: 22nd September, 2021

To,

General Manager (Contracts & Material)
Jharkhand Urja Sancharan Nigam Ltd
JUSNL Building, Kusai Colony, Ranchi-834002
Email: cetjusnl@gmail.com, cetrans@jusnl.in

Subject: Observation of 56th meeting of TESG held on 07.07.2021

Proposal Name: Implementation of Smart grid Technologies, Wide Area Monitoring System (WAMS) at JUSNL. (Proposal No: 293).

Sir,

The subject proposal of M/S JUSNL and the inputs furnished by them were discussed in the 56th TESG meeting held on 07.07.2021. The relevant extracts of deliberations and observations recorded during the meeting are as per the attached Annexure-I.

It is requested to kindly provide the inputs for the observations as per the Annexure-I at the earliest.

Thanking you,

Yours faithfully

Suhas Dambhare
Convener of Techno Economic Subgroup
General Manager
NLDC-POSOCO

Copy to:

1. CE(NPC), CEA
2. ED, NLDC-POSOCO

Annexure: 1

1. Proposal No 293: JUSNL

1.1. **Implementation of Smart grid Technologies, Wide Area Monitoring System (WAMS) at JUSNL. Estimated Cost: ₹51.80 crore**

1.2. The proposal was examined by the TESG in its 53rd Meeting held on 21.08.2020 and following observations were communicated to the entity;

(i) A5 and A6 format are to be provided by the entity.

(ii) Schedule completion time of the project was mentioned 12 months and 24 months at two different places in the DPR. Entity may confirm the Schedule completion time period of the project.

(iii) Physical and Financial Milestones are to be provided by the entity.

(iv) Entity had considered both existing and under construction Substations. PSDF funding allowed only for existing substations. Entity may exclude under construction substations from the cost estimates of this DPR.

(v) Visibility of placement of PMUs on map is very poor. Entity may provide a map with good Visibility of PMU location.

(vi) Entity used an algorithm for choosing the location of PMUs. Justification of same is to be provided by entity.

(vii) PGCIL-URSTDM scheme (Installation of PMUs) is also funded from PSDF. Entity may confirm that the substation covered in the Jharkhand schemes should not be same as in the PGCIL scheme.

(viii) Entity has to clarify about the communication scheme/system to be used for WAMS as the communication system is the key component for successful implementation of the WAMS.

(ix) Entity may provide the specifications of PMUs and PDC (hardware and Software).

(x) It is suggested that the scheme may be discussed in the ERPC to confirm the locations of PMUs, quantity as per optimal placement method and MoM of the same may be provided to TESG.

(xi) Entity may provide the study report for optimum requirement of PMUs for observability as done in case of GETCO by IIT Bombay.

(xii) Application Utilization of project is to be specified, i.e. specification of development of analytics etc.

1.3. In response to the above observations, SLDC, JUSNL vide letter ref. Letter No 196/CE(T)/JUSNL/GM, C&M/Trans./1731/2018-19, dated 01.03.2021 submitted inputs and the revised DPR cost comes to ₹41.59 crores. These inputs were discussed in the meeting held on 07.07.2021. TESG further sought the following clarifications from entity:

(i) Appraisal Report is to be provided.

(ii) Approval of JUSNL Board seeking grant from PSDF is required.

(iii) Total 70 nos PMUs are identified (14 nos in 220 kV network & 21 nos in 132 kV network). In original DPR 400kV ss were also covered but in revised DPR 400kV SS has been excluded. Entity may justify it.

(iv) As per decisions of Joint meeting of all the regional standing committee on Power System Planning held on 5th March, 2012 for firming up the URTDSM Scheme as part of Smart Transmission Grid development following PMU placement philosophy was decided:

a. All 400 kV stations in State and ISTS grids.
b. All generating stations at 220 kV and above
c. HVDC terminals and inter-regional and inter-national tie lines
d. Both ends of all the transmission lines at 400kV and above: State and ISTS sector

JUSNL to revise the placement of PMUs as above and submit the revised DPR.

(v) POWERGRID has also installed PMU with analytical software under the funding from PSDF. Entity may confirm that the PMUs and analytical software proposed by them is not the duplicity of the work already undertaken by POWERGRID. Entity may submit an undertaking for the same.

(vi) Network topography/map of JUSNL, depicting the existing PMUs/ installed PMUs (by POWERGRID under URTDSM scheme) or any other scheme and proposed PMUs (to be installed by JUSNL) in this DPR is to be provided with different colour marking.

(vii) Cost justification needs to be provided. Documents supporting Basis of cost estimates need to be provided.

(viii) The tentative completion schedule of under construction OPGW network where PMUs are proposed to be installed is to be provided.

(ix) Entity needs to provide list of total no of existing 400 kV/220 kV/132 kV substations under JUSNL along with list of substations where PMU is proposed by JUSNL.

(x) Physical & Financial Milestones as per format is to be provided.

(xi) Information regarding availability of WAMS system at 400kV and above in JUSNL network has not been provided.

1.4. In addition to above clarification, TESG asked the entity to submit the approval from Standing Committee on Power communication for the subject work. Entity shall ensure that there should not be repetition of PMUs.

1.5. **TESG decided to further examine the proposal after submission of the above inputs by Entity.**

Annexure B 1.3

Details of important 132KV GSS with respect to WAMS implementation.				
Sl. No.	GSS	Max load	Important 132KV & 33KV load	Details of importance (Govt. building/ Hospital/Railway/Critical load etc.
1	132KV Hatia -I	15 MW	132KV Hatia-I to Railway	Railway
		16 MW	132KV Hatia-I to HEC	Govt. Building-HEC, Jharkhand Secretariate & JUVNL Headquarter.
		17 MW	33KV Rajbhawan	Govt. Building-Rajbhawan
		08 MW	33KV Vidhansabha	Govt. Building-Vidhansabha & High Court
		19 MW	33KV Kanke	Govt. Building-IIM
		10 MW	33KV R&D Sail	Govt. Building SAIL
2	132KV Gumla	30 MW	33 KV Supply load	Administrative Govt. Building, Sadar Hospital
3	132KV Simdega	09 MW	33 KV Simdega	Administrative Govt. Building, Sadar Hospital
4	132KV Tamar	18 MW	132 KV Khunti	District Administrative building, Hospoital, Police Station
		18 MW	33 KV Bundu	Subdivision office, Police Station, Hospital
		10 MW	33 KV Rahe	Block office and Police Station
		03 MW	33 KV Arki	Block office
5	132KV Kamdara	28 MW	132 KV Railway Feeder I & II Bano & Bakaspur	Railway Feeder I & II Bano & Bakaspur
6	132KV Maharo	120	132 KV Jarmundi Ckt-I	Basukinath Temple, Hospital
			132 KV Jarmundi Ckt-II	
			33 KV Dumka	Hospital, Colleges, Secretariate, Railway
			33 KV Saraiyahat	Hospital, School, College
			33 KV Basukinath	Basukinath Temple, Hospital
			33 KV Sri Amra	University, School
			33 KV Amrapara	School, Hospital
			33 KV Palojori	School, Hospital
			33 KV Masalia	School, Hospital
			33 KV Madanpur I	Aux. supply to GSS Madanpur
			33 KV Madanpur II	
7	132KV Deoghar	55 MW	132 KV Shankarpur Railway (Max load 18MW)	Shankarpur Railway load
			33KV Jasidih/ AIIMS feeder (Max load 2.5MW)	AIIMS Devipur (Deoghar)
			33KV College Feeder (Max load 15MW)	Baba Mandir and DC office
			33KV Rohini Feeder (Max load 08MW)	Deoghar Cirruit House PHED and Deoghar Airport
			33KV Deoghar-I Feeder (Max load 12MW)	Deoghar Court PHED Block office and Marker area
			33KV Baidyanathpur Feeder (Max load 18MW)	Deoghar sadar hospital
8	132KV Pakur	125	132 KV Rajmahal ckt-I	School, College, Hospital, Railway
			132 KV Rajmahal ckt-II	
			132 KV TSS Railway	Rialway
			33 KV Pakur	School, College, Hospital, Railway
			33 KV Patharia	School, College, Plants
			33 KV Hiranpur	School, College, Plants
			33 KV Amrapara	School, Hospital
			33 KV Maheshpur	School, Hospital
			33 KV Ballavpur	School, Hospital
			33 KV Dubrajpur	School, College, Plants
9	132KV Sahebganj	60 MW	132 KV Karamtola	Railway
			33 KV Sahebganj	School, College, Collectroerate, Hospital
			33 KV Talijhari	Hospital
			33 KV Borio	School, College, Hospital
			33 KV Mandro	Hospital
			33 KV Port	Port
10	132KV Madhupur	30 MW	33KV Patwabad Feeder (Max load 12MW)	Civil SDO office, Hospital and Railway colony, Govt. Polytechinc college and madhupur market area.
			33KV Kano Feeder (Max load 08MW)	PHED
			33KV Gadiya Feeder (Max load 08MW)	PHED

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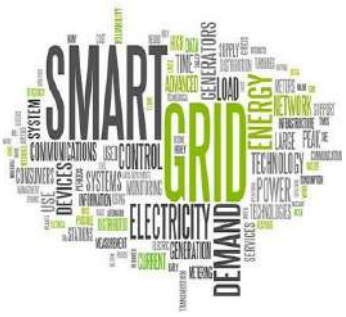
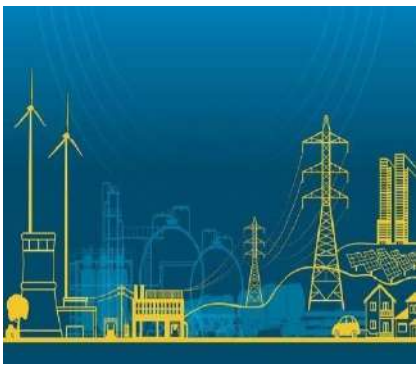
Sl. No.	GSS	Max load	Important 132KV & 33KV load	Details of importance (Govt. building/ Hospital/Railway/Critical load etc.
11	132KV Jamua	45 MW	33KV Rajdhanwar I & II Feeder (Max load 15MW)	Block office , SDO office, Hospital
			33KV Karodih Feeder (Max load 15MW)	Jamua Block Hospital
			33KV Ranidih Feeder (Max load 15MW)	Tisri, Gawan, Deori Block office and hospital
12	132KV Jadugoda	05 MW	33 KV UCIL-01	Plant,Mines, Administrative buildings and residential buildings of UCIL (Uranium Corparation of India Limited), Jadugada
		04 MW	34 KV UCIL-02	
		12 MW	33 KV Narwa	Mines of UCIL Narwa
		10MW	33 KV Turamdih	Plant and Mines of UCIL, Turamdih
		01 MW	33KV HCL	Hindustan Copper Limited, Kendadih
13	132KV Kendposi	47 KV	132KV RTSS - 25	Railway
			132KV NMD - 28	
			33KV Jhikhpani (Chaibasa -II) -10 MW	ACC Plant, Engineering College, NVC School , Hostiptal
			33KV Hatgamhari (Chaibasa-I)-03MW	Police Station, Block, Hospital
			33KV Kumardungi -05MW	Kastruba School , Police Station
			33KV Jagganathpur -05MW	SDM office, Block, Inter College Civil Court
			33 KV DPS -0.7 MW	Railway Workshop/ Railway Colony
14	132KV Golmuri	15 MW	33KV Jugsalai Feeder	1) PHED Water supply 2) Sadar Hospital 3) Municipality Office
		16 MW	33KV Karandih Feeder	1) Atomic Research Center 2) Tata Nagar Railway Station 3) Sadar Hospital 4) Block Office 5) Veterinary Hospital
		14 MW	33KV Sarjamda Feeder	1) Rapid Action Force (RAF) Comp
		01 MW	33KV PHED Feeder	1) PHED Water supply
15	132KV RKSN	124 MW	132KV RTSS Ckt 01&02 Rly-25 MW	Railway
			132KV CKP 01 Rly-15 MW	Railway
			132 KV CKP Ckt- 02-12 MW	Chakradharpur Town
			132KV KENDPOSY-40 MW	KNPS GSS & Chaibasa GSS (Sikursai)
			132KV Shree Cement Plant -12 MW	Cement Plant
			33KV Amda+Sini Rly-11 MW	Railway/Supply
			33KV Seraikela -09	Seraikela Town
16	132KV Bahragora	15 MW	33KV Load (Bharagora feeder)	Govt. Building/Hospital/etc.
17	132KV Latehar	37 MW	1) 33KV Latehar Feeder 2) 33KV Bariatu Khalsa Feeder	1) 33KV Latehar Feeder All District HQ offices & sadar Hospital 2) 33KV Bariatu Khalsa Feeder - Community Health Center at Chandwa
18	132KV Daltanganj	78 MW	1) 33KV Reedma Feeder 2) 33KV Sudna Feeder	1) 33 KV Sudna -All District HQ Office & Sadar Hospial
19	132KV Garhwa Road	60 MW	1) 132KV Railway 2) 132KV ABCIL 3)132KV Garhwa -I 4) 132KV Garhwa -II 5)132KV Chhatarpur	1) 132KV Railway Tolra 2) 33KV Garhwa -I All District HQ offices & sadar Hospital 3) 33KV Garhwa-II PHED (Drinking Water & Saintation, Garhwa)
20	132KV Saria	28 MW	132 KV Gididih-Sariya Ckt-I 14 MW 132 KV Gridih-Sariya Ckt II- 14 MW 33 KV Birni-7MW 33 KV Sariya- 10 MW 33 KV Ambadih- 04 MW 33 KV Khambrah-06 MW 33 KV Chandanadih-04MW	All the 33 KV feeders have Govt. building/Hospitals/Railways lighting load consist of maximum demand of that feeder.
21	132 Chandankyari		Under commissioning	

12-09-23

Annexure B 2.1





TITLE

DETAILED PROJECT REPORT

FOR

RECONDUCTORING OF EXISTING 132KV LINE BY HTLS CONDUCTOR FOR RELIEVING CONGESTION

OWNER:

JHARKHAND URJA SANCHARAN NIGAM LIMITED

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TABLE OF CONTENTS

DISCLAIMER

This report has been prepared exclusively for the benefit of JUSNL. TATA Power Delhi Distribution Ltd and TATA Consulting Engineers Limited (TCE) will not be liable to any other persons or organization and assumes no responsibility to any other person or organization for or in relation to any matter dealt with or conclusions expressed in this note, or for any loss or damage suffered by anyother persons or organizations arising from matters dealt with or conclusions expressed in this note. In preparing this note TATA Power DDL and TCE has relied on information gathered from system study report by PRDC and the site visit undertaken by TATA Power DDL and TCE personnel. Any projections are at best estimates only and may not be realized in the future. No blame or responsibility should be attached to any of these sources for any factual errors or misinterpretation of data in the note.

ABBREVIATIONS

The following abbreviations are used in this Inception Report:

Abbreviation	Full Name
AC	Alternating Current
CEA	Central Electricity Authority
CTU	Central Transmission Utility
CPP	Captive Power Plant
DPR	Detail Project Report
EHV	Extra High Voltage
ERLDC	Eastern Region Load Dispatch Centre
FOTE	Fiber Optic Terminal Equipment
GOI	Government of India
GOJ	Government of Jharkhand
GSS	Grid Substation
Hz	Hertz
HV	High Voltage (as per Indian Electricity Rules)
ICAO	International Civil Aviation Organization
IEC	International Electro technical Commission
IEEE	Institution of Electrical and Electronic Engineers
IEGC	Indian Electricity Grid Code
IIOT	Industrial Internet of Things
IS	Indian Standard
ISO	International Standards Organization
JSEB	Jharkhand State Electricity Board
JUSNL	Jharkhand Urja Sancharan Nigam Limited
JPSIP	Jharkhand Power System Improvement Project
KV	Kilo Volt
KW	Kilo Watt
MVA	Mega Volt Ampere
O&M	Operation and Maintenance
OPGW	Optical Ground Wire
PSDF	Power System Development Fund
TCE	Tata Consulting Engineers Ltd.
TPDDL	Tata Power Delhi Distribution limited

SUMMARY OF PROPOSAL

Format A1
Page 1 of 2

For Official Use - To be filled by the Nodal Agency	
Project Proposal Number: 304	Date of Receipt : _____

To be filled by the Requesting Organization / Project Entity	
1. Name of the requesting Organization / Utility :	Jharkhand Urja Sancharan Nigam Limited (JUSNL)
2. Short Summary of Project / Scheme / Activity	
a. Name and location of the Project / Scheme / Activity :	Reconductoring of existing 132kV line by HTLS conductor for relieving congestion at JUSNL in Jharkhand state
b. Objective of the Project / Scheme / Activity:	Replacement of existing 132kV ACSR conductors by HTLS conductor and polymer insulators for relieving congestion at JUSNL network in Jharkhand state
c. Authorized Person For this Project / Scheme / Activity	Name : Shri Arun Kumar E-mail ID : sldcranchi@gmail.com Land line No : _____ Mobile No. : 7070816390 Fax No : _____
d. Nature of the Project / Scheme / Activity: Inter – State / Intra – State (Please Specify)	Intra State
e. Identified Beneficiaries	The state of Jharkhand in particular JUSNL, JBVNL and Consumers connected to JUSNL Grid
f. Merits of the scheme	• Overall improvement in redundancy and reliability of the transmission system • Faster implementation • No requirement of separate right of way or land acquisition • Increased revenue • Reduced capital cost • Reduction in lines losses
g. Limitations, if any	No limitation envisaged. Only partial shutdown is required to replace one circuit keeping the other circuit of the double circuit line live. This can be managed judiciously.

h. Time frame for Implementation	The scheme is scheduled to be completed within 24 months progressively from the date of receipt of sanction of the fund/grant from PSDF
i. Estimated Cost of Project / Scheme / Activity	Rs. 170.55 Crores/- (Rupees Seventy Crores and Fifty lakhs Only) including GST. (As per the DPR prepared by M/s. TPDDL/TCE the estimate cost is Rs.170.55 Crores based on JUSNL network status as on June, 2023.
j. Category under which the project is classified (Please refer Para 5.1 of the Guidelines/Procedure)	Project is classified as per clause 5.1(d) of the PSDF Guidelines for disbursements of Funds from PSDF – *"Renovation and* Modernization (R&M) of Transmission and Distribution systems for relieving *congestion".*

Date: _____

Signature:_____

Name: Arun Kumar_____

(Authorized Representative)

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DETAILED PROPOSAL (DP)

1. Details of the Requesting Organization / Project Entity

1.1 Details of Organization / Entity

Name of Organization / Entity	Jharkhand Urja Sancharan Nigam Limited
Acronym or Abbreviation (if applicable)	JUSNL

1.2 Details of Head of the Organization

Name (Mr / Ms / Mrs)	Mr. K K Verma
Designation	Managing Director
E-mail Address	md@jusnl.in, mdjusnl@gmail.com
Landline No.	
Fax No.	
Address	JUSNL Building, Kusai Colony
City	Ranchi
Postal Code	834002

1.3 Details of Project Incharge / Project Manager (Authorized Person) for this project/ scheme/ activity (Not below the rank of Dy. General Manager / Superintending Engineer)

Name (Mr / Ms / Mrs)	Mr. Arun Kumar
Designation	General Manager, SLDC
E-mail Address	sldcranchi@gmail.com
Landline No.	
Mobile No.	7070816390
Fax No.	
Address	JUSNL Building, Kusai Colony
City	Ranchi
Postal Code	834002

Any Change in above mentioned details may be notified to the Nodal Agency of PSDF immediately.

Signature:_____

Name: Arun Kumar_____

(Authorized Representative)

2. Justification of the proposal

As per the transmission line studies conducted by JUSNL for the period of 2025-26 few the 132kV lines are observed with loading higher than 100% of its rated capacity during N-1 Condition. In order to increase the overall reliability of the JUSNL network and relieve congestion, renovation of those lines is necessary. This can be achieved through installation of new transmission lines or increasing the power transmission capacity through use of higher capacity conductor. Construction of new transmission lines lead to high capital costs, long lead times and involve difficulties due to land acquisition, forest clearances, right-of-way issues, etc. Whereas, re-conductoring of existing lines with higher capacity conductor (HTLS) has multiple benefits:

- Can transfer up to twice the power carried by conventional conductor
- Lesser transmission losses
- Uses the existing towers
- Lower sag than the conventional conductor at the higher operating temperatures
- Uses existing line corridor, so, no additional clearances are required (forest, land acquisition, etc)
- Faster implementation

All the above factors make it suitable for such transmission capacity enhancement application

The central transmission utility PGCIL; different state transmission utilities like UPPTCL, MSETCL, WBSETCL, OPTCL; private utilities like Tata Power, CESC, Torrent Power have already used HTLS conductors for replacing existing overloaded line conductors and performance is satisfactory.

In view of the above HTLS (ACCC type Panther equivalent) conductor is proposed to strengthen the congested 132kV lines along with necessary polymer insulators, hardware and accessories.

2.1 Analysis of the object

As per the old system study report (2021-22) & DPR submitted to PSDF, there are 02 Nos of Lines are considered. one is existing 132kV D/C line from Ramchandrapur (220/132/33kV substation) to Adityapur (132/33kV substation) is loaded upto 85.2 % of its rated capacity. Also, second one is existing 132kV D/C line from Golmuri (132/33 kV substation) to Chandil (220/132 kV substation) with one circuit LILO at Mango (132/33 kV substation) is loaded up to 90.9% of its rated capacity. But as per the recommendation of New system study report (2025-26) & Addendum report done by third party agency that is PRDC, there are 07 Lines in which Element outage causes over loading & during N-1 contingency. Following are the Existing lines with W.R.T. future loading and N-1 contingency which are considered for HTLS reconductoring.

1) 132kV D/C line from Ramchandrapur (220/132/33kV substation) to Adityapur (132/33kV substation) is loaded up to 110.1 % of its rated capacity.
2) 132kV S/C line from Sikdri (132/33 kV substation) to Namkum (132/33 kV substation) is loaded up to 125.4 % of its rated capacity.
3) 132kV D/C line from Hatia New (220/132/33 kV substation) to Hatia old (132/33 kV substation) is loaded up to 135.9 % of its rated capacity.
4) 132kV D/C line from Dumka Madanpur (220/132/33 kV substation) to Dumka Maraho (132/33 kV substation) is loaded up to 191.7 % of its rated capacity.
5) 132kV S/C line from Adityapur (132/33 kV substation) to Rajkharsawa (132/33 kV substation) is loaded up to 107.8 % of its rated capacity.
6) 132kV S/C line from chandil (220/132/33kV substation) to Rajkharsawa (132/33 kV substation) is loaded up to 112.2 % of its rated capacity.
7) 132kV D/C line from Ramchandrapur (220/132/33kV substation) to Jadugoda (132/33kV substation) is loaded up to 130.2 % of its rated capacity.

All lines are congested and outage of any one circuit will overload the other circuit as per the system study report (2025-26) & Addendum Report Outage of transmission lines causes overloading in the system .So there are some recommendation to manage the overloading and solution for critical cases are mentioned in System Study report (Table 6.7) . Reconductoring of this D/C and S/C line with higher capacity HTLS conductor is required as proposed in the *"New* system study*"*.

2.2 Target beneficiaries

The beneficiaries of the project are State of Jharkhand in particular JUSNL, JBVNL and

Consumers connected to JUSNL Grid.

With implementation of the scheme, the JUSNL grid, part and person of one grid, will run more efficiently and more effectively. So, reliability of the grid can be achieved.

2.3 Identified source of funding

75% of the total project cost is to be funded through grant from PSDF. Balance amount will be contributed from internal resources.

2.4 Details of Activities for Project/Scheme/Activity

After getting approval of the DPR towards funding, the following activities will be carried out for successful implementation of HTLS reconductoring.

All the technical specifications required for the execution works and material procurement works will be prepared as per the guidelines in applicable International, Indian standards and CEA recommendations.

JUSNL will invite open tenders on e-procurement platform.

After award of contract on L1 basis the work will be supervised and monitored at site till successful implementation.

2.5 Executing Agency

The project will be implemented through the Contractor selected based on open tendering process.

JUSNL which functions as the State Transmission Utility, has appointed Tata Power DDL and TCE as consultant for preparation of DPR, Tender document and providing support to JUSNL in implementation of the project.

All the work involved will be implemented in close association of JUSNL Engineering and O&M teams at various zones.

2.6 Time Line for Implementation of Project/Scheme/Activity

Time line for implementing this project is given below considering zero/start date as receipt of PSDF grant approval.

Timeline of the Project / Scheme / Activity	
Duration of Project (in Months)	24 Months
Likely Start Date	June, 2023
Likely Completion Date	April, 2025

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S.No.	Description	Year	2023-24 & 2024-25																							
		Month	M 1	M 2	M 3	M 4	M 5	M 6	M 7	M 8	M 9	M 10	M 11	M 12	M 13	M 14	M 15	M 16	M 17	M 18	M 19	M 20	M 21	M 22	M 23	M 24
1	Project Approval																									
2	Bid Preparation (1 Month)																									
3	Bidding Period(1Month)																									
4	Evaluation& Approval (3 Months)																									
5	Contract Award and Mobilization (2 Months)																									
6	Check Status of the lines and substations (1 month)																									
7	Supplies (6 Months)																									
8	First Disbursement (1 Month)																									
9	Erection &Commissioning (8 Months)																									
10	Second Disbursement (1 Month)																									
11	Project Status Report (2 Months)																									
12	Third Disbursement (2 Months)																									
13	Project Status Report (3 Months)																									
14	Completion of balance works (3 Months)																									
15	Taking over of Project (1 month)																									
16	Financial closure (1 month)																									
17	Fourth Disbursement (1 Month)																									
18	Project Status Report (1 Month)																									

Date:

Signature: _____

Name: Arun Kumar_____

(Authorized Representative)

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Summary of Detailed Project Report (DPR)

A Detailed Project Report (DPR) is attached which include Background, Project Objectives, Benefits and beneficiaries, Technologies, cost estimates and BOQ.

Summary of DPR given – Yes

Copy of the DPR attached. – Yes

Date:

Signature: _____

Name: Arun Kumar_____

(Authorized Representative)

Financial Implication of the Scheme

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Page 1 of 1

1. Summary

S.No.	Item	Amount in Rs.
1.	Total Cost Estimate	Rs.170.55 Crores/- (including GST)
2.	Funding Proposed from PSDF	75%
3.	Contribution from Internal Sources	25%
4.	External Borrowings	NIL

2. Details

2.1 Cost Estimate

The cost estimate for all equipment/material in the project is based on the DPR prepared by TPDDL/TCE in respect of HTLS reconductoring for the existing lines. Summary is given below. Details of cost estimate is given in attached Annexures. Costs are based on market rate and sameare verified with vendors.

Sr. No	Technology	Cost in Crores (Excluding GST) INR	Cost in Crores (Including GST) INR	Annexures Reference
1	RECONDUCTORING WITH HTLS CONDUCTOR & POLYMER INSULATOR ASSEMBLY	143.45	170.55	Annexure I
	TOTAL ESTIMATED COST	**143.45**	**170.55**	

3. Funding

3.1 Funding Proposed from PSDF as grant

75% grant from PSDF is requested for successful implementation of the project in a time bound manner.
JUSNL is already establishing 60 new substations and associated lines of 400kV, 220kV and 132kV under various mode i.e. State funded, World Bank funded and PPP. There is already lot offinancial burden on JUSNL due to existing commitments towards 24x7 power supply. As such JUSNL is not in position to take more financial burden.

3.2 Contribution from Internal Sources

Balance amount will be contributed from internal sources.

3.3 External Borrowings

No external borrowings will be necessary.

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Page 1 of 3

Brief Details of the Project Appraisal by CTU / STU / RPC

The applicant utility shall submit project appraisal by CTU / STU / RPC In the given format and a copy of the Appraisal Report should be attached at Annexure

Item	Details to be filled by Applicant Utility	
Appraisal By	**CTU**	**STU** JUSNL **RPC**
Date of Submission to CTU / STU / RPC for approval	Proposal submitted on ……..	
Name of the Scheme	Project on "RECONDUCTRING OF EXISTING 132KV LINE BY HTLS CONDUCTOR FOR RELIVING CONGESTION AT JUSNL" in Jharkhand State.	
Details of the Appraisal Report by CTU / STU / RPC (Attached to Annexure)	Refer to Detailed Project report.	
Summary of observations from CTU/STU/RPC Appraisal Report	Summary of Proposal Appraised	Jharkhand Urja Sancharan Nigam Ltd (JUSNL), the State Transmission Utility (STU) of Jharkhand owns and operates intra-statetransmission system of Jharkhand and is responsible for transmission of electricity to the Distribution entity of Jharkhand from the Generating Plants of the State as well as from Central Generating Utilities and the power contracted from other sources. At present, JUSNL has 14 nos. of 220kV GSS and 39 nos. of 132kV GSS having transformation capacity of appx 6500 MVA and appx 4000 CKM of transmission line of different voltage level to cater power supplyin Jharkhand state. Power system in the state is expanding very fast and with increased number of interconnections between Regions, many new technologies are being implemented. In addition, Grid is characterized by wide variation of Power flow due to variation in demand/generation during day/seasons. Further, consumer aspiration for quality and reliable power supply is increasing. In view of existing Line Loading higher than 80 % in network has to

		replace by proposing HTLS Conductor so that preventive action can be taken for Load Management and avoid cascaded tripping and black out. Hence JUSNL requests funding from PSDF for reconductoring of existing 132KV line by HTLS Conductor for reliving congestion at JUSNL with necessary hardware in Jharkhand State.
Summary of observations from CTU/STU/RPC Appraisal Report	Technical Observations	Some areas future load growth may cause conventional transmission line to exceed its rated capacity creating congestion and overloading. New transmission lines/ higher transmission capacity is necessary in these areas. Construction of new transmission lines involve high capital costs, long lead times and difficulties in land acquisition due to right-of-way issues. Therefore, re-conductoring of existing lines with higher capacity conductor, that is, refurbishment and improvement of the existing lines, is a preferred solution and can be considered under transmission capacity building. High temperature low sag (HTLS) conductors have the capacity to carry higher power with lesser transmission losses. It can transfer up to twice the power using the existing towers and line corridor, lower sag than the conventional conductor at the higher operating temperatures and a faster implementation makes it suitable for such transmission capacity enhancement application. Whereas, re-conductoring of existing lines with higher capacity conductor (HTLS) has multiple benefits: • Can transfer up to twice the power carried by conventional conductor • Lesser transmission losses • Uses the existing towers • Lower sag than the conventional conductor at the higher operating temperatures • Uses existing line corridor, so, no additional clearances are required (forest, land acquisition, etc) • Faster implementation All the above factors make it suitable for such transmission capacity enhancement application

		Implementation of scheme involves the following activities. It is proposed to install HTLS (ACCC type Panther equivalent) conductor is proposed to strengthen the congested 132kV lines along with necessary polymer insulators, hardware and accessories with replacing of conventional ACSR panther conductor.
	Financial Observations	**i)** Total cost of the scheme works out to **Rs. 170.55 Crores.** ii) 75% grant is expected from PSDF. ***75% grant is required for as there is financial burden on JUSNL due to various projects undergoing for expansion of network to meet load growth.***
	Compliance of Grid Standards/ Codes by the Applicant	JUSNL is government owned state utility of Jharkhand State and follows the guidelines and regulations issued from time to time by relevant authorities like CEA, CERC, JERC, ERPC, MoP of Govt. of India Ltd.
	Limitations/ Shortcomings pointed out by CTU/ STU/ RPC if any	Implementation of the scheme, if is to be taken up by JUSNL with its internal financial resources will take substantially longer time of around 3 to 5 years and will always be lagging behind the up to date requirements of future improvements. Hence grant from PSDF is essentially required to provide HTLS conductor, the JUSNL grid, part and person of one grid, will run more efficiently and more effectively. So, reliability of the grid can be achieved to meet the present/Future load forecasting requirements of grid operations, load management and smooth and unhindered operation of power systemin the state of Jharkhand.
	Recommendations of CTU/STU/PRC	JUSNL recommended and firmly believes that the proposed scheme is qualified for grant from PSDF.

Date:_ Signature:___

Name:_Mr. Arun Kumar

(Authorized Representative)

Format A6
Page 1 of 1

UNDERTAKING

I, Mr. Arun Kumar , resident of Ranchi working as General Manager, SLDC in JUSNL here by undertake to comply with the following terms and conditions with regard to funding of the **"RECONDUCTORING OF EXISTING 132KV LINE BY HTLS CONDUCTOR TO RELIEVE CONGESTION"** with
Disbursement from PSDF:

- No tariff shall be claimed for the portion of the scheme funded from PSDF.
- Amount of grant shall be refunded in case of transfer/disposal of the facility being created under this proposal to any other scheme for funding.
- Shall specifically mention if for the scheme under the proposal, the grant from any other agency is being taken / proposed to be taken.
- The grant shall be refunded back to PSDF in case of non-utilization of the grant within one year of release of instalment.

Date:

Signature: _____

Name: Arun Kumar_____

(Authorized Representative)

DETAILED PROJECT REPORT

1. RECONDUCTORING OF TRANSMISSION LINE WITH HTLS CONDUCTOR

1.1 Project Objectives

JUSNL and most of the other transmission utilities in India predominantly use conventional Aluminum Conductor Steel-Reinforced (ACSR) Panther conductors for 132kV transmission lines. However, in some areas future load growth may cause conventional transmission line to exceed its rated capacity creating congestion and overloading. New transmission lines/ higher transmission capacity is necessary in these areas. Construction of new transmission lines involve high capital costs, long lead times and difficulties in land acquisition due to right-of-way issues. Therefore, re-conducting of existing lines with higher capacity conductor, that is, refurbishment and improvement of the existing lines, is a preferred solution and can be considered under transmission capacity building.

High temperature low sag (HTLS) conductors have the capacity to carry higher power with lesser transmission losses. It can transfer up to twice the power using the existing towers and line corridor, lower sag than the conventional conductor at the higher operating temperatures and a faster implementation makes it suitable for such transmission capacity enhancement application.

1.2 Background

The PRDC system study report for JUSNL network (2025-26) shows that most of the 132kV lines are loaded less than 80% during normal operating condition. However, few of the lines are observed to be loaded higher than 100% of its rated capacity during N-1 condition. But as per the recommendation of New system study report (2025-26) & Addendum Report done by third party agency that is PRDC, there are 07 Lines in which Element outage causes over loading & during N-1 contingency. Following are the Existing lines with W.R.T. future loading and N-1 contingency which are considered for HTLS reconductoring.

1) 132kV D/C line from Ramchandrapur (220/132/33kV substation) to Adityapur (132/33kV substation) is loaded up to 110.1 % of its rated capacity.
2) 132kV S/C line from Sikdri (132/33 kV substation) to Namkum (132/33 kV substation) is loaded up to 125.4 % of its rated capacity.
3) 132kV D/C line from Hatia New (220/132/33 kV substation) to Hatia old (132/33 kV substation) is loaded up to 135.9 % of its rated capacity.
4) 132kV D/C line from Dumka Madanpur (220/132/33 kV substation) to Dumka Maraho (132/33 kV substation) is loaded up to 191.7 % of its rated capacity.

5) 132kV S/C line from Adityapur (132/33 kV substation) to Rajkharsawa (132/33 kV substation) is loaded up to 107.8 % of its rated capacity.
6) 132kV S/C line from chandil (220/132/33kV substation) to Rajkharsawa (132/33 kV substation) is loaded up to 112.2 % of its rated capacity.
7) 132kV D/C line from Ramchandrapur (220/132/33kV substation) to Jadugoda (132/33kV substation) is loaded up to 130.2 % of its rated capacity.

All lines are congested and outage of any one circuit will overload the other circuit as per the system study report (2025-26) Outage of transmission lines causes overloading in the system .So there are some recommendation to manage the overloading and solution for critical cases are mentioned in System Study report (Table 6.7) & Addendum Report . Reconductoring of this D/C and S/C line with higher capacity HTLS conductor is required as proposed in the *"New* system study*"*.

Details of the existing transmission lines are given below:

A. 132kV D/C Adityapur – Ramchandrapur Transmission Line		
a.1	Route length	
	- Circuit# 1	8.3 km
	- Circuit# 2	8.3 km
a.2	Conductor	ACSR Panther
a.3	Total Number of Towers	36
	- Suspension type	12
	- Angle/Tension type	24
	- Monopoles	0
a.4	Railway crossings	2
a.5	Power Line crossings	1
B. 132kV S/C Namkum – Sikdri Transmission Line		
b.1	Route length	
	- Circuit# 1	34 km
b.2	Conductor	ACSR Panther
b.3	Total Number of Towers	146
	- Suspension type	50
	- Angle/Tension type	96
	- Monopoles	0
b.4	Railway crossings	1
b.5	Power Line crossings	11
C. 132kV D/C Hatia old – Hatia New Transmission Line		

c.1	Route length	
	- Circuit# 1	0.6 km
	- Circuit# 2	0.6 km
c.2	Conductor	ACSR Panther
c.3	Total Number of Towers	6
	- Suspension type	0
	- Angle/Tension type	6
	- Monopoles	0
c.4	Railway crossings	0
c.5	Power Line crossings	3
D. 132kV D/C Dumka Madanpur – Dumka Maraho Transmission Line		
d.1	Route length	
	- Circuit# 1	1.8 km
	- Circuit# 2	1.8 km
d.2	Conductor	ACSR Panther
d.3	Total Number of Towers	8
	- Suspension type	1
	- Angle/Tension type	7
	- Monopoles	0
d.4	Railway crossings	1
d.5	Power Line crossings	0
E. 132kV S/C Adityapur - Rajkharsawa Transmission Line		
e.1	Route length	
	- Circuit# 1	36 km
e.2	Conductor	ACSR Panther
e.3	Total Number of Towers	112
	- Suspension type	84
	- Angle/Tension type	28
	- Monopoles	0
e.4	Railway crossings	3
e.5	Power Line crossings	8
F. 132kV S/C Rajkharsawa - Chandil line via kandra Transmission Line		
e.1	Route length	
	- Circuit# 1	35 km
e.2	Conductor	ACSR Panther
e.3	Total Number of Towers	118
	- Suspension type	94
	- Angle/Tension type	24
	- Monopoles	0
e.4	Railway crossings	1

e.5	Power Line crossings	2
G. 132kV D/C Jadugoda - Ramchandrapur LILOed at Sundarnagar Transmission Line		
d.1	Route length	
	- Circuit# 1	46.8 km
	- Circuit# 2	46.8 km
d.2	Conductor	ACSR Panther
d.3	Total Number of Towers	183
	- Suspension type	71
	- Angle/Tension type	112
	- Monopoles	0
d.4	Railway crossings	2
d.5	Power Line crossings	9

1.3 Technologies

A brief description of the major type of High-Performance Conductors presently available are given in following sections.

1.3.1 (Z)TACSR

(Z) TACSR conductor has the same construction as conventional ACSR conductor, with galvanized steel wires for the core and TAL (thermal-resistant aluminum alloy) wires or ZTAL (thermal resistant aluminum alloy wires with zirconium added) wires as envelope. TAL and ZTAL aluminum strands have the same conductivity and tensile strength as ordinary electrical conductor grade aluminum strand but can operate continuously at temperatures up to 150deg C and 210deg C, respectively, without any loss of tensile strength over time. (Z)TACSR is not, by design, a low-sag conductor. It has the same thermal elongation

Behavior as ACSR. The main advantage of (Z) TACSR is that its aluminum alloy wires do not anneal at temperatures up to 150deg C for TAL and 210deg C for ZTAL. (Z)TACSR can be used to uprate existing lines where some additional clearance is available.

1.3.2 (Z)TACIR / STACIR (INVAR core)

As with (Z) TACSR, (Z) TACIR/STACIR has a conventional stranded construction identical to ACSR, making use of material innovations to give properties allowing the conductor to be operated at high temperatures. In place of the steel strands of (Z) TACSR, it has galvanized or aluminum-clad invar alloy steel wires for the core and (Z) TAL wires surrounding them. Invar is an iron-nickel alloy (Fe- 36%Ni) with a very small coefficient of thermal expansion. Geometrically identical to conventional ACSR, with the only differences being a slightly reduced conductivity and a much increased maximum allowable temperature as the aluminum alloy wires do not lose strength at high temperature.

(Z) TACIR/SATCIR has a maximum continuous operating temperature of 210deg C and can have twice the current capacity of ACSR conductor. The coefficient of thermal expansion of invar wire is around one-third that of galvanized or aluminum-clad steel wire.

However, tensile strength of invar wire (1080 MPa) is lower than galvanized steel wire. Tensile strength of the conductor is about 8% lower than normal ACSR conductor. (Z)TACIR/SATCIR Conductor has equivalent sag-tension properties to conventional ACSR. The installation methods and accessories for the conductor are similar to those used for conventional ACSR. A slight lengthening of compression type accessories is required onlyto satisfy increased current carrying requirements. Pre-stressing can effectively lower the temperature of the knee-point. Cladding may be done to improve conductivity.

1.3.3 G (Z) TACSR (GAP Conductor)

G (Z) TACSR i.e. gap type conductor uses a galvanized steel core surrounded by a thermo-resistant aluminum alloy. The wires of the innermost layer of aluminum are always of trapezoidal shape, and sized such that the inside diameter of the resulting tube is slightly larger than the external diameter of the core so as to maintain slight gap in between. The radial gap between the core and the envelope allows independent movement between the two. The gap is filled with heat-resistant grease (filler) to reduce friction between the steel core and the aluminum layer and to prevent water penetration & corrosion. The outer layers can be made trapezoidal also to maintain compact stranding and to minimize electrical resistance and increase the effective cross-sectional area on aluminum strands.

Gap-type conductor exhibits the same properties (corrosion, electrical, etc.) as a TACSR and its low sag behavior will allow it to be operated at much higher temperatures than ACSR. Knee point of the conductor is at erection temperature which means sag of the conductor is fully dependent on sag of steel core allowing to maximize use of low sag properties at very high temperature. However, if sections are erected at different temperatures (on different days) then their sag/temperature behavior will be different in the different sections. The expansion coefficient of the conductor above the knee-point temperature will be that of the steel core (11.5 x10-6/°C).

The installation of this conductor is more complex and labor intensive than ACSR. During erection, the conductor has to be stripped bare and hanged from the steel for 8-12 hours during stringing. Although this special erection technique is different from that employed with conductors of standard construction (i.e., ACSR), the compression splices and bolted suspension clamps are similar albeit suitable for elevated temperature.

Grease used in the gap type conductor should have elevated drop point (at least 300deg C) and oil separation point to prevent migration of the grease to the outer surface; should retain its properties over a specified temperature range and under varied environmental conditions; and should comply with the requirements of relevant standards. Trapezoidal wires (TW) may be used for outer layer of the conductor for snow bound areas, as these are less sensitive to snow accretion.

1.3.4 Aluminum Conductor Steel Supported (ACSS and ACSS/TW)

ACSS conductor consists of fully annealed strands of aluminum around a stranded steel core. In appearance, ACSS conductors are essentially identical to standard ACSR conductors. ACSS is typically available in "Standard Round Strand" construction or "Trapezoidal Aluminum Wire" construction with equal area or equal diameter to conventional round wire construction. The steel core may be of High Strength (HS), Extra High Strength (EHS), Ultra High Strength (UHS) steel, mischmetal or aluminum Clad Steel core. Annealed aluminum (61.8% IACS) has higher conductivity than hard-drawn aluminumwires (61% IACS) used in ACSR thereby increasing the existing current capacity of the line. However, the tensile strength of fully annealed aluminum is lower than hard drawn aluminum. This may be mitigated by using high strength steel core or higher steel core areaor both. Since the tension in the annealed aluminum wires is low, the thermal elongation is essentially that of the steel core alone thereby providing reduced sag up to 250° C. Also, due to low tension in the aluminum strands, it does not creep under everyday tension loading.

Galvanizing is prone to degradation above 200° C, however, aluminum-clad or mischmetal (Al-Zinc alloy) clad cores are more robust against heat degradation. The Mischmetal Coating on the steel core may also be used which can withstand up to 250° C temperature for continuous operation. Mechanical and physical properties of Mischmetal steel wire are similar to that of the galvanized steel wires. Corrosion resistance of Mischmetal steel wires are better than that of galvanized steel wires. The reduced strength of the annealed aluminum wires results in a relatively low knee-point for the conductor. It can be significantlyreduced by pre-stressing the conductor, which has the effect of imparting a permanent plasticdeformation to the aluminum wires, such that an even greater proportion of stress is carried by the steel core. This helps to reduce or prevent vibration fatigue damage in challenging installations such as river crossings.

Although the splicing, installation, and termination is no more complicated than for ACSR conductors, however, the annealed strands, being very soft, should be handled with care and should not be dragged across the bare ground, over rocks, or fences etc. Parallel jaw grips should be closely sized to the conductor diameter and the clamp surface needs to be clean to minimize strand distortion. Also because of the annealed aluminum strands, the two-stage compression splice is somewhat longer than those designed for an ACSR conductor. They require no special suspension clamp design, and tension-stringing installation is straightforward. High temperature tolerant suspension clamps must be used to allow the maximum operating temperature that these HTLS conductors are capable of reaching.

1.3.5 Metal-Matrix Composite (MMC) core (ACCR)

These conductors are made of Metal Matrix Composite (MMC) Core with envelope of thermal-resistant aluminum alloys. The core is made of wires composed of alumina fibers in an aluminum matrix, forming a composite material. The core wire looks physically similar to steel core, but it is eight times stronger than aluminum and about the same stiffness as the steel core. Each core wire contains thousands of small-diameter and ultra-high-strength aluminum oxide fibers. These fibers are continuously oriented in the direction of the wire, and fully embedded within high-purity aluminum. Both the composite core and the outer strands contribute to the overall conductor strength and conductivity. The composite core material provides a substantially lower coefficient of thermal expansion above its knee-point in comparison to steel core, thereby significantly reducing the expansion coefficient of the conductor as a whole. The core material is significantly lighter than steel, resulting in a lower weight, while at the same time being both stronger and having a higher elastic modulus. Conductivity is also significantly greater than steel. These conductors can be operated continuously at temperatures up to 210° C and emergency up to 240° C with AT3 alloy

Wires. The conductor is essentially all-aluminum, and the lack of a steel core removes the possibility of galvanic corrosion. It also exhibits very little creep. It has no undesirable magnetic properties unlike conductors with a ferrous core which experience increase in resistance due to magnetic effects. This magnetic effect is eliminated in MMC core with thermal resistant aluminum alloys.

The compression-type hardware for the dead-end assembly of these conductors uses a modified two-part approach, as in the ACSR conductor. One part grips the core, and then an outer sleeve grips the aluminum strands. This approach prevents notching of the core wires. The gripping method ensures that the core remains straight to evenly load the wires, and also ensures that the outer aluminum strands suffer no lag in loading relative to the core. The composite materials are highly anisotropic, i.e., they have good tensile strength but lower shear, transverse & torsional strength and have a more limited ability to conform to a low bend radius than conventional engineering metals and alloys, such as steel & aluminum. Thus composite materials require careful handling and care needs to be taken in choosing the correct diameter sheaves (i.e. travelers), bull wheel sizes, pulling tension and conductor reels sizes, to prevent excessive bending radius during installation.

1.3.6 Polymer-matrix Composite Core (ACCC, CFCC, HVCRC, ACFR)

The core is made of a polymer matrix composite (PMC), usually carbon fibers in a resin or epoxy resin matrix, with annealed aluminum or thermal resistant aluminum alloy envelope. The polymer matrix can be made with thermoplastic or thermosetting compounds. The core is protected against galvanic corrosion by either an annular sleeve made up of glass fibers, all in the same resin matrix, or protected by an aluminum alloy welded tube or other methods while the envelope can be round, trapezoidal or Z-shaped. PMC cores have higher tensile strength compared to steel and compensate for the lower strength of fully annealed aluminum wires. While the aluminum strands are fully annealed, offering the highest degree of conductivity for any aluminum available today, the composite core offers a very low coefficient of thermal expansion than steel core which allows for less sag at high temperatureoperation. Less sag and low weight can be utilized to have increased spans on fewer/shorterstructures along with reduced line losses. Generally, the composite core used is a solid, single-piece rod with no interstices. However, stranded configuration does also exist.

As the core has a smooth surface and it bears the overall tensile strength of the conductor, the dead-end assembly has been designed to create a stronger crimp compared to that of ACSR conductor that forms a very solid aluminum press that fits around the composite core. The core resists degradation from vibration, corrosion, ultraviolet radiation, corona, chemical and thermal oxidation and, most importantly, cyclic load fatigue. However, the core made of

Multiple strands may be more susceptible to thermal oxidation. Although CCC has significantly less thermal sag than other High Performance Conductor designs, its core is quite elastic and sags more than other designs under ice load. For ice loading condition, corewith higher modulus has to be designed. For very heavy ice loading regions, extra high strength composite core should be used to improve Sag values.

This conductor requires special fittings, such as splice and dead-end connections which are patented. The composite materials are highly anisotropic, i.e., they have good tensile strength but lower shear, transverse & torsional strength and have a more limited ability to conform to a low bend radius than conventional engineering metals and alloys, such as steel& aluminum. Thus composite materials require careful handling and care needs to be taken in choosing the correct diameter sheaves (i.e. travelers), bull wheel sizes, pulling tension andconductor reels sizes, to prevent excessive bending radius during installation. The manufacturer's recommendations/procedures should be adhered to during installation so as to avoid any damage to the core of the CCC conductor which may lead to snapping of conductor.

1.4 Comparison of Conductor Parameters

Typical values of weight, diameter, Ampacity and Resistance at various temperatures for ACSR Panther and Equivalent AAAC, Al59 & High-Performance Conductors are shown in the table next.

S. No.	Conductor	Dia (mm)	Resistance at 20◦ C (Ohm/km)	Weight (Kg/km)	Parameter	Operating Temperature								
						75°C	85°C	95°C	125°C	150°C	180°C	200°C	210°C	250°C
1.	ACSR Panther	21	0.139	974	Ampacity (A)	374	465							
					R_{ac}(Ohm/km)	0.1703	0.17588							
2.	AAAC	21	0.114	720	Ampacity (A)	416	518	600						
					R_{ac}(Ohm/km)	0.13752	0.14163	0.1457						
3.	Al59	21	0.1143	720	Ampacity (A)	413	514	595						
					R_{ac}(Ohm/km)	0.1394	0.1438	0.1483						
4.	TACSR	21	0.1386	973	Ampacity (A)	375	466	539	703	807				
					R_{ac}(Ohm/km)	0.1698	0.1754	0.1809	0.1975	0.2115				
5.	ACCC	20.5	0.1024	834	Ampacity (A)	434	539	623	813	931	1049			
					R_{ac}(Ohm/km)	0.1258	0.1299	0.134	0.146	0.1565	0.1689			
6.	STACIR	20.7	0.1408	966	Ampacity (A)	370	460	532	694	796	896	955	982	
					R_{ac}(Ohm/km)	0.1725	0.1782	0.1835	0.2001	0.2149	0.2319	0.2432	0.2488	
7.	GZTACSR (Gap)	20.6	0.1224	974	Ampacity (A)	397	493	570	743	852	959	1022	1051	
					R_{ac}(Ohm/km)	0.1501	0.155	0.1599	0.1745	0.1867	0.2014	0.2112	0.2161	
8.	ACSS	20.5	0.1355	925	Ampacity (A)	377	469	542	707	810	896	972	1000	1103
					R_{ac}(Ohm/km)	0.166	0.17144	0.1768	0.1931	0.2067	0.2203	0.2339	0.2393	0.2611

1.5 Selection of Conductor

JUSNL and most of the other transmission utilities in India predominantly use conventional Aluminum Conductor Steel-Reinforced (ACSR) Panther conductors for 132kV transmission lines. However, in some areas future load growth may cause conventional transmission line to exceed its rated capacity creating congestion and overloading. New transmission lines/ higher transmission capacity is necessary in these areas. Construction of new transmission lines involve high capital costs, long lead times and difficulties in land acquisition due to right-of-way issues. Therefore, re-conductoring of existing lines with higher capacity conductor, that is, refurbishment and improvement of the existing lines, is a preferred solution and can be considered under transmission capacity building.

High temperature low sag (HTLS) conductors have the capacity to carry higher power with lesser transmission losses. It can transfer up to twice the power using the existing towers and line corridor, lower sag than the conventional conductor at the higher operating temperatures and a faster implementation makes it suitable for such transmission capacity enhancement application

The ordinary ACSR starts annealing and losing its strength at 93° C and therefore not suitable for use at higher temperature. HTLS conductors have effectively same conductivity and tensile strength but are designed to operate continuously at temperature of 150° C or higher. This allows higher power flow over the transmission lines than conventional ACSR conductors.

The central transmission utility PGCIL; different state transmission utilities like UPPTCL, MSETCL, WBSETCL, OPTCL; private utilities like Tata Power, CESC, Torrent Power have already used HTLS conductors for replacing existing overloaded line conductors. It is seen that most of the utilities adopted ACCC type conductors for the 132kV level and performance is satisfactory. JUSNL also recently replaced 2 existing 132kV lines with ACCC type conductor and that is performing satisfactorily.

In view of the above ACCC type Panther equivalent conductor is proposed to strengthen the congested Adityapur-Ramchandrapur , Namkum–Sikdri , Hatia old–Hatia New , Dumka Madanpur–Dumka Maraho , Adityapur – Rajkharsawa , Rajkharsawa - Chandil line via kandra and Jadugoda - Ramchandrapur LILOed at Sundarnagar lines along with necessary insulators, hardware and accessories.

S. No	Description	Unit	Values
1	Name		ACCC HTLS
2	Nominal Diameter		As per ASTM B 857 / EN50540,
3	UTS of Conductor	kN	85.7
4	Maximum permissible conductor temperature	Deg C	180
5	Steady state conductor temperature at conductor current of min 1050A at 50 deg ambient condition & Still wind	Deg C	175
6	Sag & Tension at 32 Deg C & No wind	Meters & kg	5.28 & 2026
7	Tension at 32 Deg C & Full wind	kg	2919.5
8	Sag & Tension at 180 Deg C & No wind	Meters & kg	6.04 & 1773
9	Linear Mass of Conductor	Kg/km	834.4
10	Standard Length	Km	2.5

1.6 Summary of Cost

Total Project costs are given in Table below. The detailed Bill of Materials (BOM) with cost break-up is tabulated in Annexure I.

Description	Cost in Crores including GST
Upgrading the existing Seven (7) Tr. Lineswith HTLS ACCC conductors	170.55

1.7 References:

a) PRDC final report on Load flow and short circuit study for year 2021-22 to 2025-26 (Document reference No: PRDC\DWG. NO: LFA\2025-26\132kV) & Addendum report Nov-2022 on JUSNL system perspective transmission plan for horizon year 2025-26.

b) For Rate Referencing Schedule of Rates F.Y 2022-2023 of JUSNL is considered.

c) SLD of Switchyard with equipment ratings.

d) CEA guidelines for rationalized use of high-performance conductors.

e) CTC manual on engineering transmission lines with high capacity low sag ACCC conductors

ANNEXURE I - COSTING DETAILS FOR RECONDUCTORING WITH HTLS CONDUCTOR

	Employer	**JHARKHAND URJA SANCHARAN NIGAM LIMITED (JUSNL)**					Annexure - I
	Consultant	**TATA CONSULTING ENGINEERS LIMITED**					
	Project	**IMPLEMENTATION OF SMART GRID PROJECT FOR JUSNL**					
	Schedule	**SUMMARY OF HTLS RECONDUCTORING & POLYMER INSULATOR**					
Sr. No	**Description of Works**	**Sub Total exclucing GST(Supply)**	**Sub Total includingGST (Supply)**	**Installation & Service Charges**	**Sub Total includingGST (Installation)**	**Total cost inINR (Without GST)**	**Total cost in INR (With GST)**
1	Re-conductoring of 132 KV D/C Adityapur -Ramchandrapur Transmission line with HTLS conductor and polymer insulator	113,512,318.70	134,900,524.55	7,212,161.33	8,510,350.37	120,724,480.03	143,410,874.92
2	Re-conductoring of 132 KV S/C Namkum-sikidri Transmission line with HTLS conductor and polymer insulator	228,663,229.99	271,780,006.34	17,307,904.00	20,423,326.72	245,971,133.99	292,203,333.06
3	Re-conductoring of 132 KV D/C Hatai old - Hatai new Transmission line with HTLS conductor and polymer insulator	16,660,128.58	19,729,410.14	521,361.06	615,206.05	17,181,489.64	20,344,616.19
4	Re-conductoring of 132 KV D/C Dumka madanpur -Dumka Maharo Transmission line with HTLS conductor and polymer insulator	28,841,289.86	34,240,087.78	1,564,083.18	1,845,618.15	30,405,373.04	36,085,705.93
5	Re-conductoring of 132 KV S/C Adityapur- Rajkharsawa Transmission line with HTLS conductor and polymer insulator	181,101,009.24	215,765,987.64	19,860,429.60	23,435,306.93	200,961,438.84	239,201,294.57

6	Re-conductoring of 132 KV S/C Rajkharsawa - Chandil line via kandra Transmission line with HTLS conductor and polymer insulator	173,361,818.25	206,576,546.58	19,308,751.00	22,784,326.18	192,670,569.25	229,360,872.76
7	Re-conductoring of 132 KV D/C Jadugoda - Ramchandrapur LILOed at Sundarnagar Transmission line with HTLS conductor and polymer insulator	586,001,079.53	696,863,695.00	40,666,162.68	47,986,071.96	626,667,242.21	744,849,766.97
	GRAND TOTAL	**1,328,140,874.14**	**1,579,856,258.04**	**106,440,852.85**	**125,600,206.36**	**1,434,581,726.99**	**1,705,456,464.40**

Supply cost of Re-conductoring of 132 kV D/C Adityapur-Ramchandrapur transmission line with HTLS conductor and Polymer insulator

SI.NO.	DESCRIPTION OF ITEMS	UNIT	QTY	Unit Rate (Rs.)	Unit Rate(Freight & Insurance) (@4%of supply rate)	Total Price w/o GST (Rs.)	Total Price with GST (Rs)
A	*B*	*C*	*D*	*E*	*F=4% of E*	*G=D*(E+F)*	*H=1.18*G*
1	ACCC HTLS Conductor of Capacity 1050A	KM	52	1,130,191.70	45,207.67	61,120,767.14	72,122,505.22
2	Silicon Composite type Polymer Insulator						
	(a) Suspension type	Nos.	96	4,918.00	196.72	4,91,013.12	5,79,395.48
	(b) Tension Type	Nos.	348	5,276.00	211.04	19,09,489.92	22,53,198.11
	HARDWARE FITTINGS & ACCESSORIES						
3	Suspension Clamp with String Hardware	Set	72	15,170.00	606.80	11,35,929.60	13,40,396.93
4	Single Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	252	1,22,474.00	4,898.96	3,20,97,985.92	3,78,75,623.39
5	Double Suspension clamp set with String Hardware	Set	12	38,252.00	1,530.08	4,77,384.96	5,63,314.25
6	Double Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	48	1,45,393.00	5,815.72	72,58,018.56	85,64,461.90
7	Vibration Damper & Armor Rods for conductors	Nos.	660	15,301.00	612.04	1,05,02,606.40	1,23,93,075.55
8	Repair Sleeves	Nos.	38	16,912.00	676.48	6,68,362.24	7,88,667.44
9	M.S. Joint	Nos.	25	1,21,608.00	4,864.32	31,61,808.00	37,30,933.44
10	T- Clamp	Nos.	0	5,680.00	227.20	-	-
11	**(Less) SCRAP value of dismantled ACSR PANTHER conductor,Tension & Suspension Hardware etc.**	Lot	1	(53,11,047)	-	(53,11,047)	(53,11,047)
TOTAL						**113,512,318.70**	**134,900,524.55**

Erection cost of Re-conductoring of 132 kV D/C Adityapur-Ramchandrapur transmission line with HTLS conductor and Polymer insulator						
SI.No.	**DESCRIPTION OF WORK**	**UNIT**	**QTY.**	**Unit Rate (Rs.)**	**Total Price w/o GST (Rs.)**	**Total Price with 18% GST (Rs)**
A	*B*	*C*	*D*	*E*	*F=(D*E)*	*G=1.18*F*
1	De-stringing of existing 132 KV D/C Transmission line with 6 phase ACSR Panther conductor with hardware fittings, insulators …etc	CKM	8.3	165660	1374978	1622474.04
2	Stringing of 132 KV D/C Transmission line with 6 phase ACCC HTLS conductor with hardware fittings, insulators and accessories… etc. all complete work in 132 kv transmission Lines including all necessary tools and plants, skilled labours, site transportations, ROW etc.	CKM	8.3	703275.1	5837183.33	6887876.329
TOTAL					**72,12,161.33**	**85,10,350.37**

Supply cost of Re-conductoring of 132 KV S/C Namkum-sikidri transmission line with HTLS conductor and Polymer insulator

SI.NO.	DESCRIPTION OF ITEMS	UNIT	QTY	Unit Rate (Rs.)	Unit Rate(Freight & Insurance) (@4%of supply rate)	Total Price w/o GST (Rs.)	Total Price with GST (Rs)
A	*B*	*C*	*D*	*E*	*F=4% of E*	*G=D*(E+F)*	*H=1.18*G*
1	ACCC HTLS Conductor of Capacity 1050A	KM	105.06	1,130,191.70	45,207.67	123,487,457.60	145,715,199.97
2	Silicon Composite type Polymer Insulator						
	(a) Suspension type	Nos.	150	4,918.00	196.72	7,67,208.00	9,05,305.44
	(b) Tension Type	Nos.	762	5,276.00	211.04	41,81,124.48	49,33,726.89
	HARDWARE FITTINGS & ACCESSORIES						
3	Suspension Clamp with String Hardware	Set	150	15,170.00	606.80	23,66,520.00	27,92,493.60
4	Single Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	402	1,22,474.00	4,898.96	5,12,03,929.92	6,04,20,637.31
5	Double Suspension clamp set with String Hardware	Set	0	38,252.00	1,530.08	-	-
6	Double Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	180	1,45,393.00	5,815.72	2,72,17,569.60	3,21,16,732.13
7	Vibration Damper & Armor Rods for conductors	Nos.	1344	15,301.00	612.04	2,13,87,125.76	2,52,36,808.40
8	Repair Sleeves	Nos.	148	16,912.00	676.48	26,03,095.04	30,71,652.15
9	M.S. Joint	Nos.	50	1,21,608.00	4,864.32	63,23,616.00	74,61,866.88
10	T- Clamp	Nos.	0	5,680.00	227.20	-	-
11	**(Less) SCRAP value of dismantled ACSR PANTHER conductor,Tension & Suspension Hardware etc.**	Lot	1	(1,08,74,416)	-	(1,08,74,416)	(1,08,74,416)
TOTAL						**228,663,229.99**	**271,780,006.34**

Erection cost of Re-conductoring of 132 KV S/C Namkum-sikidri transmission line with HTLS conductor and Polymer insulator						
SI.No.	**DESCRIPTION OF WORK**	**UNIT**	**QTY.**	**Unit Rate (Rs.)**	**Total Price w/o GST (Rs.)**	**Total Price with 18% GST (Rs)**
A	*B*	*C*	*D*	*E*	*F=(D*E)*	*G=1.18*F*
1	De-stringing of existing 132 KV S/C Transmission line with 3 phase ACSR Panther conductor with hardware fittings, insulators …etc	CKM	34	82830	2816220	3323139.6
2	Stringing of 132 KV S/C Transmission line with 3 phase ACCC HTLS conductor with hardware fittings, insulators and accessories… etc. all complete work in 132 kv transmission Lines including all necessary tools and plants, skilled labours, site transportations, ROW etc.	CKM	34	426226	14491684	17100187.12
TOTAL					**1,73,07,904.00**	**2,04,23,326.72**

Supply cost of Re-conductoring of 132 KV D/C Hatai old - Hatai new transmission line with HTLS conductor and Polymer insulator

SI.NO.	DESCRIPTION OF ITEMS	UNIT	QTY	Unit Rate (Rs.)	Unit Rate(Freight & Insurance) (@4%of supply rate)	Total Price w/o GST (Rs.)	Total Price with GST (Rs)
A	*B*	*C*	*D*	*E*	*F=4% of E*	*G=D*(E+F)*	*H=1.18*G*
1	ACCC HTLS Conductor of Capacity 1050A	KM	3.708	1,130,191.70	45,207.67	4,358,380.86	5,142,889.41
2	Silicon Composite type Polymer Insulator						
	(a) Suspension type	Nos.	26	4,918.00	196.72	1,32,982.72	1,56,919.61
	(b) Tension Type	Nos.	78	5,276.00	211.04	4,27,989.12	5,05,027.16
	HARDWARE FITTINGS & ACCESSORIES						
3	Suspension Clamp with String Hardware	Set	26	15,170.00	606.80	4,10,196.80	4,84,032.22
4	Single Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	54	1,22,474.00	4,898.96	68,78,139.84	81,16,205.01
5	Double Suspension clamp set with String Hardware	Set	0	38,252.00	1,530.08	-	-
6	Double Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	12	1,45,393.00	5,815.72	18,14,504.64	21,41,115.48
7	Vibration Damper & Armor Rods for conductors	Nos.	144	15,301.00	612.04	22,91,477.76	27,03,943.76
8	Repair Sleeves	Nos.	6	16,912.00	676.48	1,05,530.88	1,24,526.44
9	M.S. Joint	Nos.	5	1,21,608.00	4,864.32	6,32,361.60	7,46,186.69
10	T- Clamp	Nos.	0	5,680.00	227.20	-	-
11	**(Less) SCRAP value of dismantled ACSR PANTHER conductor,Tension & Suspension Hardware etc.**	Lot	1	(3,91,436)	-	(3,91,436)	(3,91,436)
TOTAL						**16,660,128.58**	**19,729,410.14**

Erection cost of Re-conductoring of 132 KV D/C Hatai old - Hatai new transmission line with HTLS conductor and Polymer insulator						
SI.No.	**DESCRIPTION OF WORK**	**UNIT**	**QTY.**	**Unit Rate (Rs.)**	**Total Price w/o GST (Rs.)**	**Total Price with 18% GST (Rs)**
A	*B*	*C*	*D*	*E*	*F=(D*E)*	*G=1.18*F*
1	De-stringing of existing 132 KV D/C Transmission line with 6 phase ACSR Panther conductor with hardware fittings, insulators …etc	CKM	0.6	165660	99396	117287.28
2	Stringing of 132 KV D/C Transmission line with 6 phase ACCC HTLS conductor with hardware fittings, insulators and accessories… etc. all complete work in 132 kv transmission Lines including all necessary tools and plants, skilled labours, site transportations, ROW etc.	CKM	0.6	703275.1	421965.06	497918.7708
TOTAL					**5,21,361.06**	**6,15,206.05**

Supply cost of Re-conductoring of 132 KV D/C Dumka madanpur -Dumka Maharo transmission line with HTLS conductor and Polymer insulator

SI.NO.	DESCRIPTION OF ITEMS	UNIT	QTY	Unit Rate (Rs.)	Unit Rate(Freight & Insurance) (@4%of supply rate)	Total Price w/o GST (Rs.)	Total Price with GST (Rs)
A	*B*	*C*	*D*	*E*	*F=4% of E*	*G=D*(E+F)*	*H=1.18*G*
1	ACCC HTLS Conductor of Capacity 1050A	KM	11.124	1,130,191.70	45,207.67	13,075,142.57	15,428,668.23
2	Silicon Composite type Polymer Insulator						
	(a) Suspension type	Nos.	12	4,918.00	196.72	61,376.64	72,424.44
	(b) Tension Type	Nos.	96	5,276.00	211.04	5,26,755.84	6,21,571.89
	HARDWARE FITTINGS & ACCESSORIES						
3	Suspension Clamp with String Hardware	Set	0	15,170.00	606.80	-	-
4	Single Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	96	1,22,474.00	4,898.96	1,22,27,804.16	1,44,28,808.91
5	Double Suspension clamp set with String Hardware	Set	6	38,252.00	1,530.08	2,38,692.48	2,81,657.13
6	Double Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	0	1,45,393.00	5,815.72	-	-
7	Vibration Damper & Armor Rods for conductors	Nos.	192	15,301.00	612.04	30,55,303.68	36,05,258.34
8	Repair Sleeves	Nos.	10	16,912.00	676.48	1,75,884.80	2,07,544.06
9	M.S. Joint	Nos.	5	1,21,608.00	4,864.32	6,32,361.60	7,46,186.69
10	T- Clamp	Nos.	0	5,680.00	227.20	-	-
11	**(Less) SCRAP value of dismantled ACSR PANTHER conductor,Tension & Suspension Hardware etc.**	Lot	1	(11,52,032)	-	(11,52,032)	(11,52,032)
TOTAL						**28,841,289.86**	**34,240,087.78**

Erection cost of Re-conductoring of 132 KV D/C Dumka madanpur -Dumka Maharo transmission line with HTLS conductor and Polymer insulator						
SI.No.	**DESCRIPTION OF WORK**	**UNIT**	**QTY.**	**Unit Rate (Rs.)**	**Total Price w/o GST (Rs.)**	**Total Price with 18% GST (Rs)**
A	*B*	*C*	*D*	*E*	*F=(D*E)*	*G=1.18*F*
1	De-stringing of existing 132 KV D/C Transmission line with 6 phase ACSR Panther conductor with hardware fittings, insulators …etc	CKM	1.8	165660	298188	351861.84
2	Stringing of 132 KV D/C Transmission line with 6 phase ACCC HTLS conductor with hardware fittings, insulators and accessories… etc. all complete work in 132 kv transmission Lines including all necessary tools and plants, skilled labours, site transportations, ROW etc.	CKM	1.8	703275.1	1265895.18	1493756.312
TOTAL					**15,64,083.18**	**18,45,618.15**

Supply cost of Re-conductoring of 132 KV S/C Adityapur- Rajkharsawa transmission line with HTLS conductor and Polymer insulator

SI.NO.	DESCRIPTION OF ITEMS	UNIT	QTY	Unit Rate (Rs.)	Unit Rate(Freight & Insurance) (@4%of supply rate)	Total Price w/o GST (Rs.)	Total Price with GST (Rs)
A	*B*	*C*	*D*	*E*	*F=4% of E*	*G=D*(E+F)*	*H=1.18*G*
1	ACCC HTLS Conductor of Capacity 1050A	KM	111.24	1,130,191.70	45,207.67	130,751,425.70	154,286,682.32
2	Silicon Composite type Polymer Insulator						
	(a) Suspension type	Nos.	261	4,918.00	196.72	13,34,941.92	15,75,231.47
	(b) Tension Type	Nos.	216	5,276.00	211.04	11,85,200.64	13,98,536.76
	HARDWARE FITTINGS & ACCESSORIES						
3	Suspension Clamp with String Hardware	Set	249	15,170.00	606.80	39,28,423.20	46,35,539.38
4	Single Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	132	1,22,474.00	4,898.96	1,68,13,230.72	1,98,39,612.25
5	Double Suspension clamp set with String Hardware	Set	6	38,252.00	1,530.08	2,38,692.48	2,81,657.13
6	Double Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	42	1,45,393.00	5,815.72	63,50,766.24	74,93,904.16
7	Vibration Damper & Armor Rods for conductors	Nos.	1424	15,301.00	612.04	2,26,60,168.96	2,67,38,999.37
8	Repair Sleeves	Nos.	156	16,912.00	676.48	27,43,802.88	32,37,687.40
9	M.S. Joint	Nos.	52	1,21,608.00	4,864.32	65,76,560.64	77,60,341.56
10	T- Clamp	Nos.	0	5,680.00	227.20	-	-
11	**(Less) SCRAP value of dismantled ACSR PANTHER conductor,Tension & Suspension Hardware etc.**	Lot	1	(1,14,82,204)	-	(1,14,82,204)	(1,14,82,204)
TOTAL						**181,101,009.24**	**215,765,987.64**

Erection cost of Re-conductoring of 132 KV S/C Adityapur- Rajkharsawa transmission line with HTLS conductor and Polymer insulator						
SI.No.	**DESCRIPTION OF WORK**	**UNIT**	**QTY.**	**Unit Rate (Rs.)**	**Total Price w/o GST (Rs.)**	**Total Price with 18% GST (Rs)**
A	*B*	*C*	*D*	*E*	*F=(D*E)*	*G=1.18*F*
1	De-stringing of existing 132 KV S/C Transmission line with 3 phase ACSR Panther conductor with hardware fittings, insulators …etc	CKM	36	82,830.00	2,981,880.00	3,518,618.40
2	Stringing of 132 KV S/C Transmission line with 3 phase ACCC HTLS conductor with hardware fittings, insulators and accessories… etc. all complete work in 132 kv transmission Lines including all necessary tools and plants, skilled labours, site transportations, ROW etc.	CKM	36	468,848.60	16,878,549.60	19,916,688.53
TOTAL					**19,860,429.60**	**23,435,306.93**

Supply cost of Re-conductoring of 132 KV S/C Rajkharsawa - Chandil line via kandra transmission line with HTLS conductor and Polymer insulator

SI.NO.	DESCRIPTION OF ITEMS	UNIT	QTY	Unit Rate (Rs.)	Unit Rate(Freight & Insurance) (@4%of supply rate)	Total Price w/o GST (Rs.)	Total Price with GST (Rs)
A	*B*	*C*	*D*	*E*	*F=4% of E*	*G=D*(E+F)*	*H=1.18*G*
1	ACCC HTLS Conductor of Capacity 1050A	KM	108.15	1,130,191.70	45,207.67	127,119,441.65	150,000,941.15
2	Silicon Composite type Polymer Insulator						
	(a) Suspension type	Nos.	285	4,918.00	196.72	14,57,695.20	17,20,080.34
	(b) Tension Type	Nos.	162	5,276.00	211.04	8,88,900.48	10,48,902.57
	HARDWARE FITTINGS & ACCESSORIES						
3	Suspension Clamp with String Hardware	Set	279	15,170.00	606.80	44,01,727.20	51,94,038.10
4	Single Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	138	1,22,474.00	4,898.96	1,75,77,468.48	2,07,41,412.81
5	Double Suspension clamp set with String Hardware	Set	3	38,252.00	1,530.08	1,19,346.24	1,40,828.56
6	Double Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	12	1,45,393.00	5,815.72	18,14,504.64	21,41,115.48
7	Vibration Damper & Armor Rods for conductors	Nos.	1384	15,301.00	612.04	2,20,23,647.36	2,59,87,903.88
8	Repair Sleeves	Nos.	152	16,912.00	676.48	26,73,448.96	31,54,669.77
9	M.S. Joint	Nos.	51	1,21,608.00	4,864.32	64,50,088.32	76,11,104.22
10	T- Clamp	Nos.	0	5,680.00	227.20	-	-
11	**(Less) SCRAP value of dismantled ACSR PANTHER conductor,Tension & Suspension Hardware etc.**	Lot	1	(1,11,64,450)	-	(1,11,64,450)	(1,11,64,450)
TOTAL						**173,361,818.25**	**206,576,546.58**

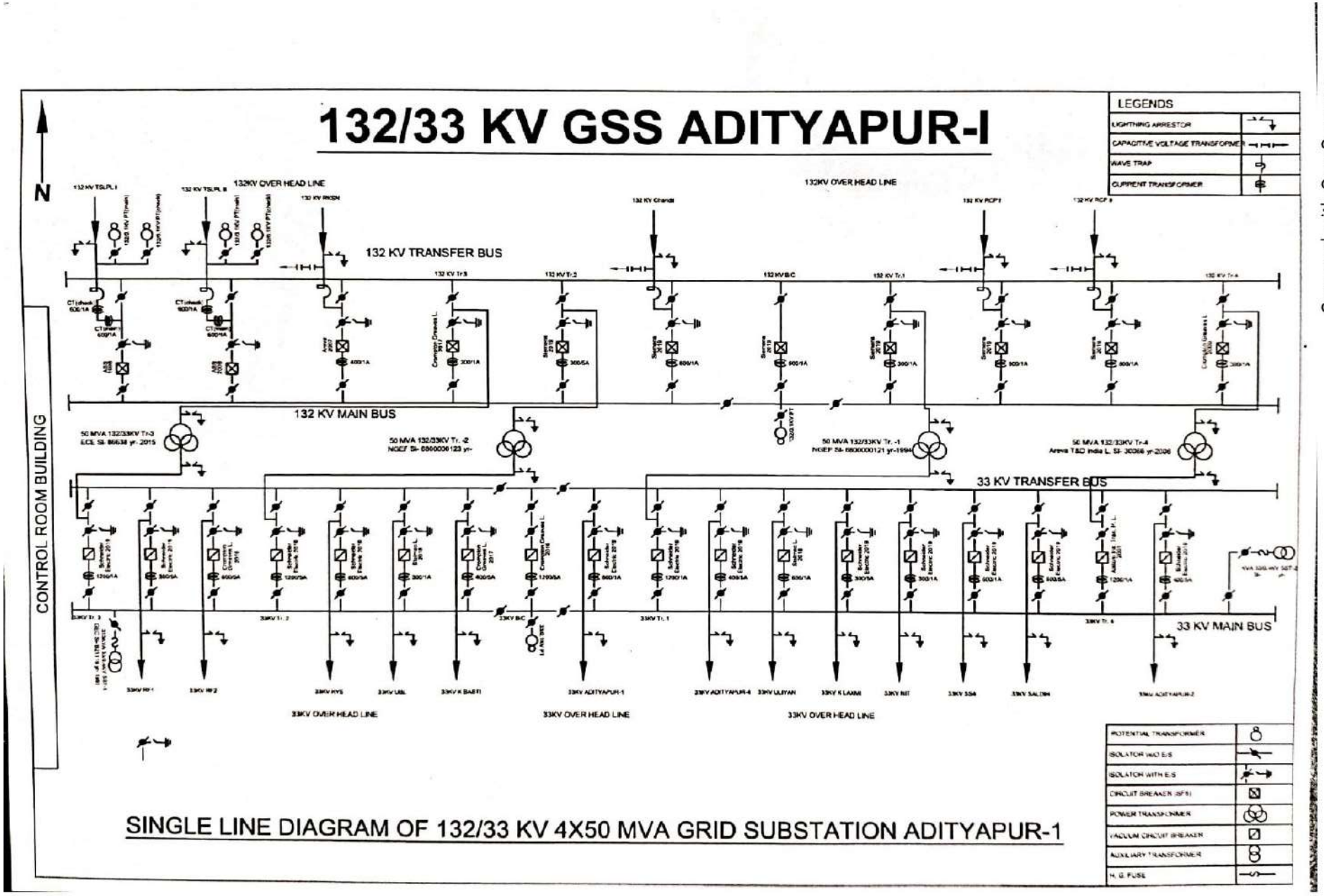
Erection cost of Re-conductoring of 132 KV S/C Rajkharsawa - Chandil line via kandra transmission line with HTLS conductor and Polymer insulator						
SI.No.	**DESCRIPTION OF WORK**	**UNIT**	**QTY.**	**Unit Rate (Rs.)**	**Total Price w/o GST (Rs.)**	**Total Price with 18% GST (Rs)**
A	*B*	*C*	*D*	*E*	*F=(D*E)*	*G=1.18*F*
1	De-stringing of existing 132 KV S/C Transmission line with 3 phase ACSR Panther conductor with hardware fittings, insulators …etc	CKM	35	82,830.00	2,899,050.00	3,420,879.00
2	Stringing of 132 KV S/C Transmission line with 3 phase ACCC HTLS conductor with hardware fittings, insulators and accessories… etc. all complete work in 132 kv transmission Lines including all necessary tools and plants, skilled labours, site transportations, ROW etc.	CKM	35	468,848.60	16,409,701.00	19,363,447.18
TOTAL					**19,308,751.00**	**22,784,326.18**

Supply cost of Re-conductoring of 132 KV D/C Jadugoda - Ramchandrapur LILOed at Sundarnagar transmission line with HTLS conductor and Polymer insulator

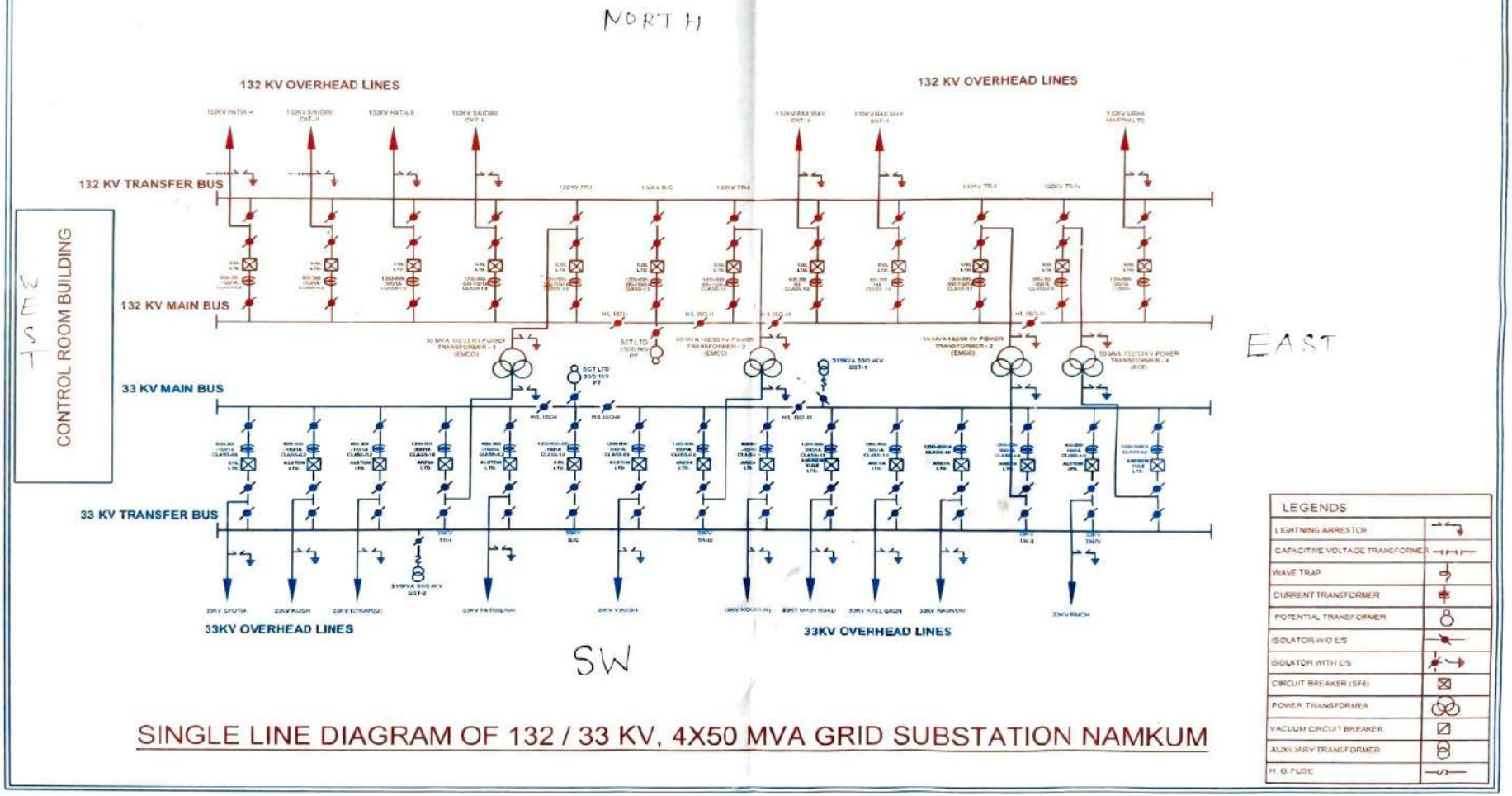
SI.NO.	DESCRIPTION OF ITEMS	UNIT	QTY	Unit Rate (Rs.)	Unit Rate(Freight & Insurance) (@4%of supply rate)	Total Price w/o GST (Rs.)	Total Price with GST (Rs)
A	*B*	*C*	*D*	*E*	*F=4% of E*	*G=D*(E+F)*	*H=1.18*G*
1	ACCC HTLS Conductor of Capacity 1050A	KM	289.224	1,130,191.70	45,207.67	339,953,706.81	401,145,374.04
2	Silicon Composite type Polymer Insulator						
	(a) Suspension type	Nos.	438	4,918.00	196.72	22,40,247.36	26,43,491.88
	(b) Tension Type	Nos.	1632	5,276.00	211.04	89,54,849.28	1,05,66,722.15
	HARDWARE FITTINGS & ACCESSORIES						
3	Suspension Clamp with String Hardware	Set	414	15,170.00	606.80	65,31,595.20	77,07,282.34
4	Single Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	1056	1,22,474.00	4,898.96	13,45,05,845.76	15,87,16,898.00
5	Double Suspension clamp set with String Hardware	Set	12	38,252.00	1,530.08	4,77,384.96	5,63,314.25
6	Double Tension Clamp With Single Pad & Terminal Jumper with String Hardware	Set	288	1,45,393.00	5,815.72	4,35,48,111.36	5,13,86,771.40
7	Vibration Damper & Armor Rods for conductors	Nos.	3670	15,301.00	612.04	5,84,00,856.80	6,89,13,011.02
8	Repair Sleeves	Nos.	211	16,912.00	676.48	37,11,169.28	43,79,179.75
9	M.S. Joint	Nos.	139	1,21,608.00	4,864.32	1,75,79,652.48	2,07,43,989.93
10	T- Clamp	Nos.	0	5,680.00	227.20	-	-
11	**(Less) SCRAP value of dismantled ACSR PANTHER conductor,Tension & Suspension Hardware etc.**	Lot	1	(2,99,02,340)	-	(2,99,02,340)	(2,99,02,340)
TOTAL						**586,001,079.53**	**696,863,695.00**

Erection cost of Re-conductoring of 132 KV D/C Jadugoda - Ramchandrapur LILOed at Sundarnagar transmission line with HTLS conductor and Polymer insulator						
SI.No.	**DESCRIPTION OF WORK**	**UNIT**	**QTY.**	**Unit Rate (Rs.)**	**Total Price w/o GST (Rs.)**	**Total Price with 18% GST (Rs)**
A	*B*	*C*	*D*	*E*	*F=(D*E)*	*G=1.18*F*
1	De-stringing of existing 132 KV D/C Transmission line with 6 phase ACSR Panther conductor with hardware fittings, insulators …etc	CKM	46.8	46.8	165,660.00	7,752,888.00
2	Stringing of 132 KV D/C Transmission line with 6 phase ACCC HTLS conductor with hardware fittings, insulators and accessories… etc. all complete work in 132 kv transmission Lines including all necessary tools and plants, skilled labours, site transportations, ROW etc.	CKM	46.8	46.8	703,275.10	32,913,274.68
TOTAL					**40,666,162.68**	**47,986,071.96**

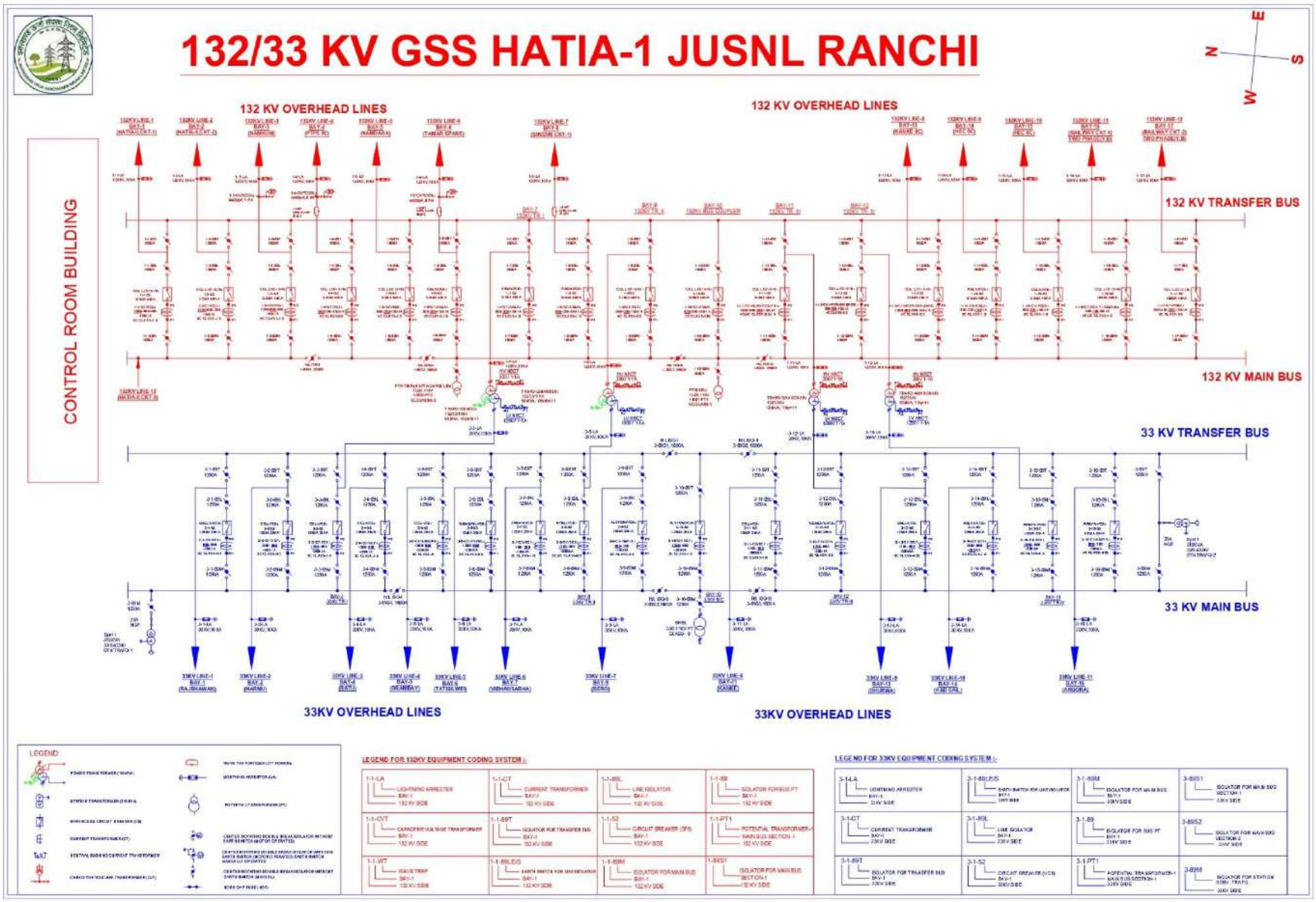
SWITCHYARD DRAWINGS & DETAILS OF EXISTING LINES ANNEXURES

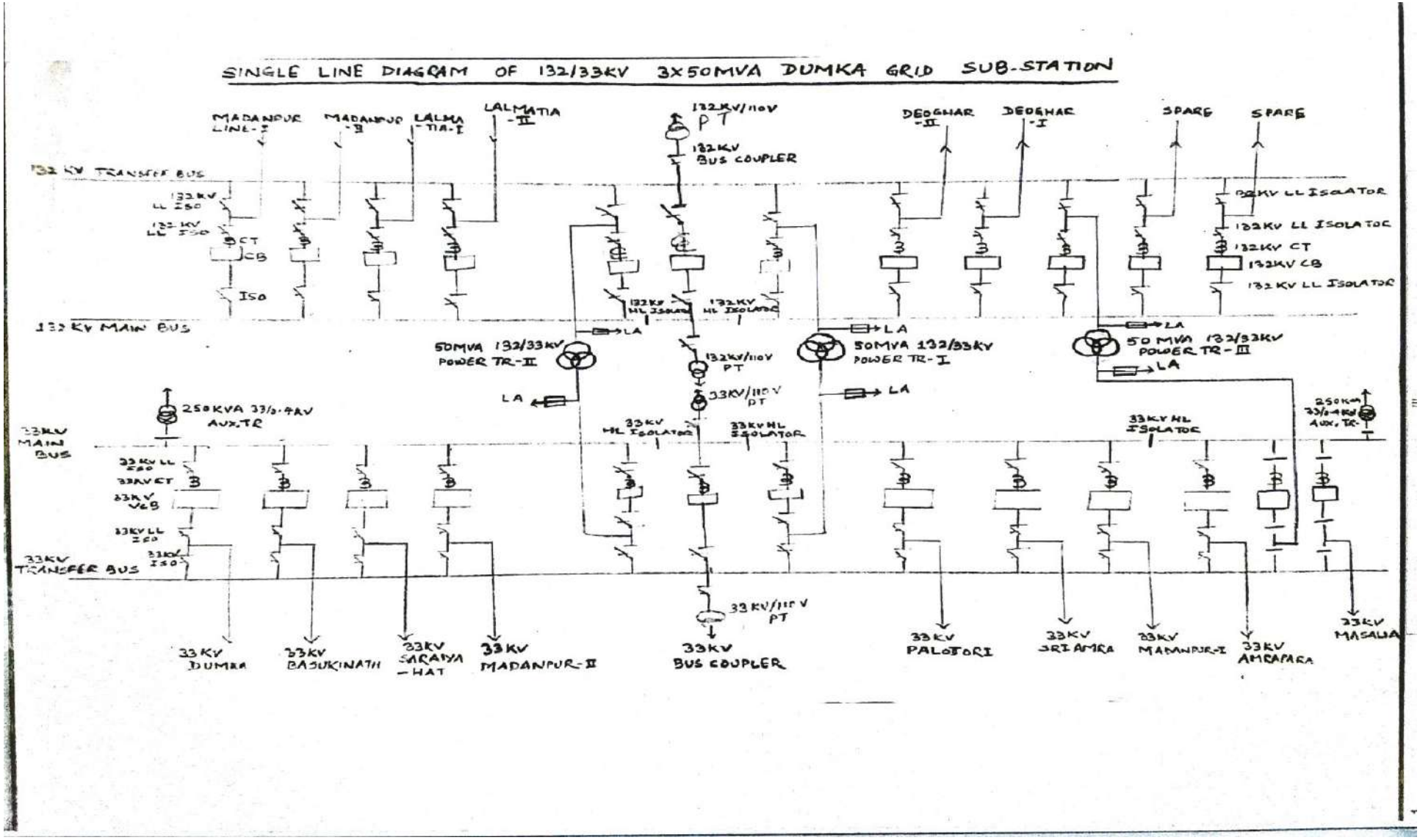


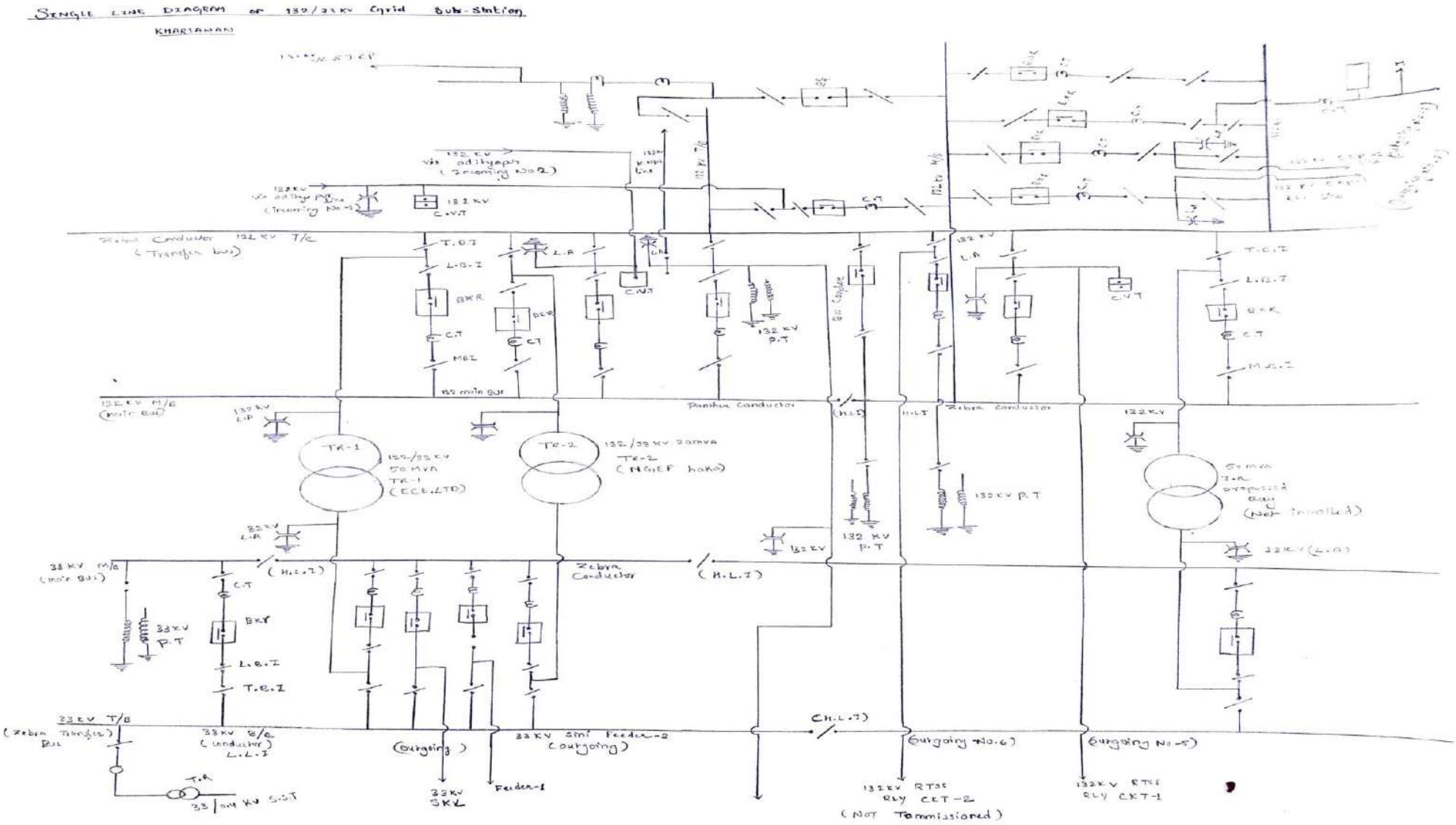
132/33 KV GSS NAMKUM, JUSNL, RANCHI



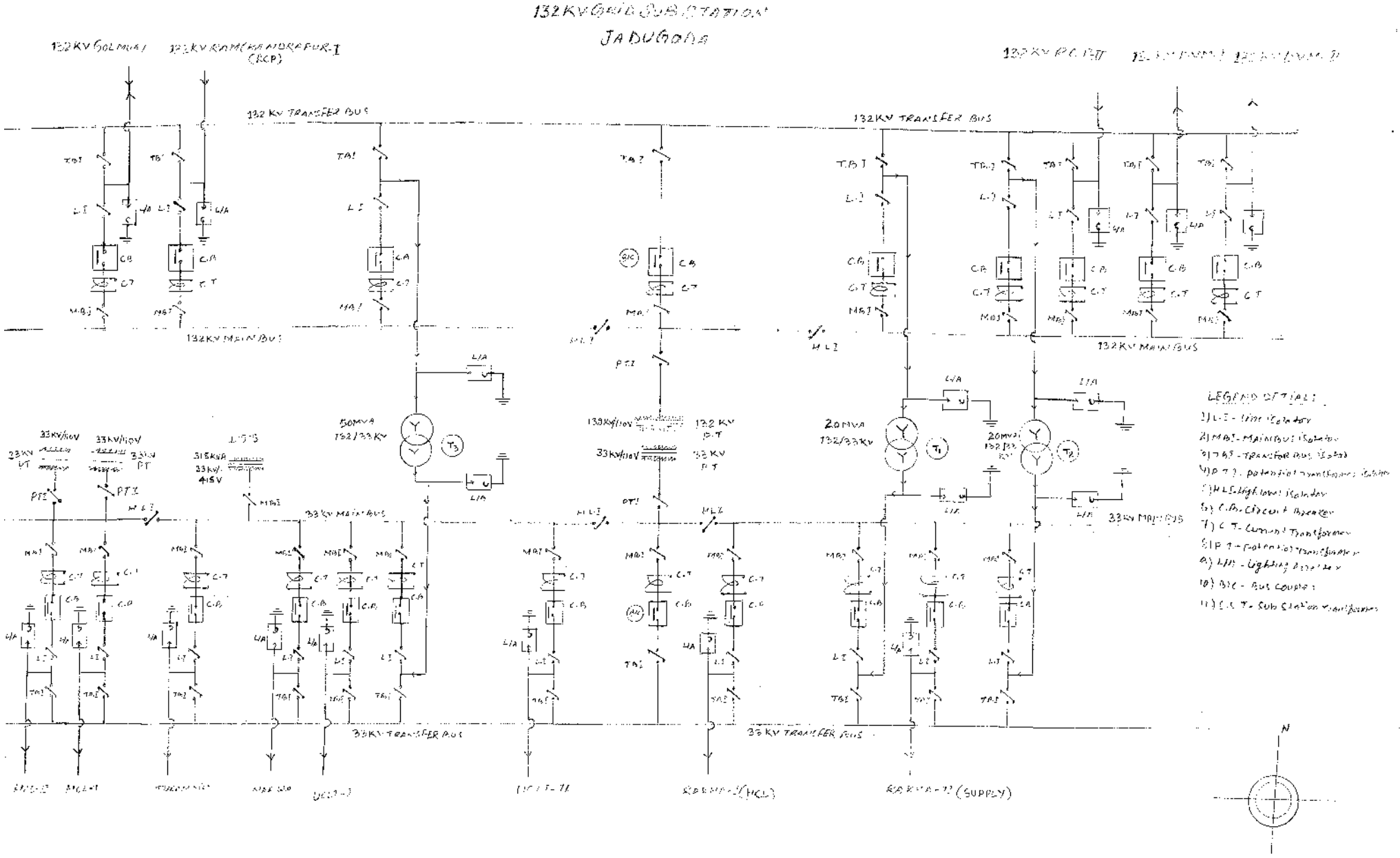
SINGLE LINE DIAGRAM OF 132 / 33 KV, 4X50 MVA GRID SUBSTATION NAMKUM

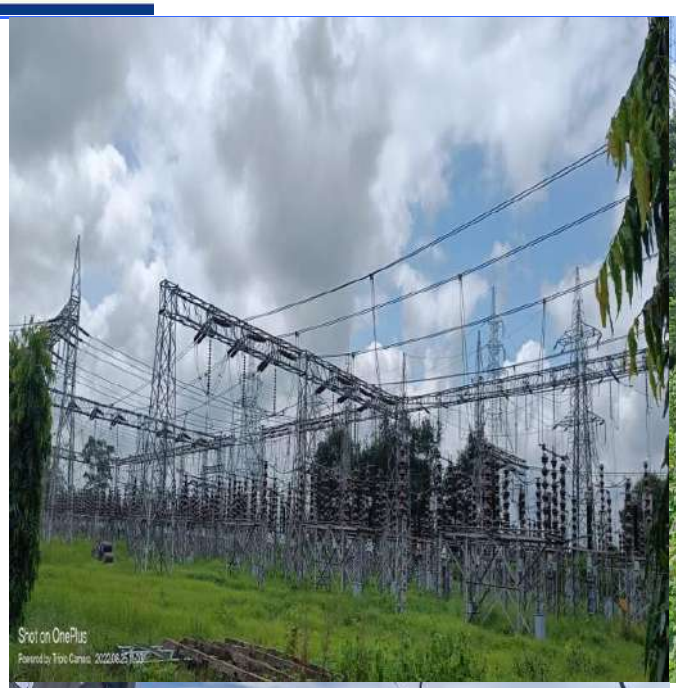

132/33 KV GSS HATIA-1 JUSNL RANCHI
132 KV OVERHEAD LINES
132 KV OVERHEAD LINES
CONTROL ROOM BUILDING
132 KV TRANSFER BUS
132 KV MAIN BUS
33 KV TRANSFER BUS
33 KV MAIN BUS
33KV OVERHEAD LINES
33KV OVERHEAD LINES
LEGEND
LEGEND FOR 132KV EQUIPMENT CODING SYSTEM :-
LEGEND FOR 33KV EQUIPMENT CODING SYSTEM :-


SINGLE LINE DIAGRAM OF 132/33KV 3X50MVA DUMKA GRID SUB-STATION
MADANPUR LINE-I
MADANPUR -II
LALMATIA -III-I
LALMATIA -II
132KV/110V PT
132KV BUS COUPLER
DEOGHAR -II
DEOGHAR -I
SPARE
SPARE
132 KV TRANSFER BUS
132KV LL ISO
132 KV LL ISO
CT
CB
ISO
132KV LL ISOLATOR
132KV CT
132KV CB
132 KV LL ISOLATOR
132 KV MAIN BUS
132KV HL ISOLATOR
132KV HL ISOLATOR
LA
50MVA 132/33KV POWER TR-II
50MVA 132/33KV POWER TR-I
50 MVA 132/33KV POWER TR-III
132KV/110V PT
33KV/110V PT
250KVA 33/0.4KV AUX.TR
250KVA 33/0.4KV AUX. TR.
33KV MAIN BUS
33KV HL ISOLATOR
33KV HL ISOLATOR
33KV HL ISOLATOR
33KV LL ISO
33KV CT
33KV VCB
33KV LL ISO
33KV ISO
33KV TRANSFER BUS
33KV/110V PT
33KV DUMKA
33KV BASUKINATH
33KV SIKARIYA -HAT
33KV MADANPUR-II
33KV BUS COUPLER
33KV PALOJORI
33KV SRI AMRA
33KV MADANPUR-I
33KV AMRAPARA
33KV MASALIA



SINGLE LINE DIAGRAM OF 132/33 KV RAJKHARSAWA GRID SUBSTATION


132KV GOLMURI
132KV RAMGARH
132 KV TRANSFER BUS
132KV MAIN BUS
50MVA
132/33KV
33KV MAIN BUS
33KV TRANSFER BUS
20MVA
132/33KV
LEGEND OF TAG :
1) L.I - Line Isolator
2) MBI - MAIN BUS Isolator
3) TBI - TRANSFER BUS Isolator
4) P.T. - potential transformer
5) H.L.S - high lowl isolator
6) C.B - Circuit Breaker
7) C.T - Current Transformer
8) P.T - potential transformer
9) L.A - Lightning Arrester
10) B.C - Bus Couple
11) S.T - Sub Station transformer



PHOTOS OF EXISTING LINES & SWITCHYARD

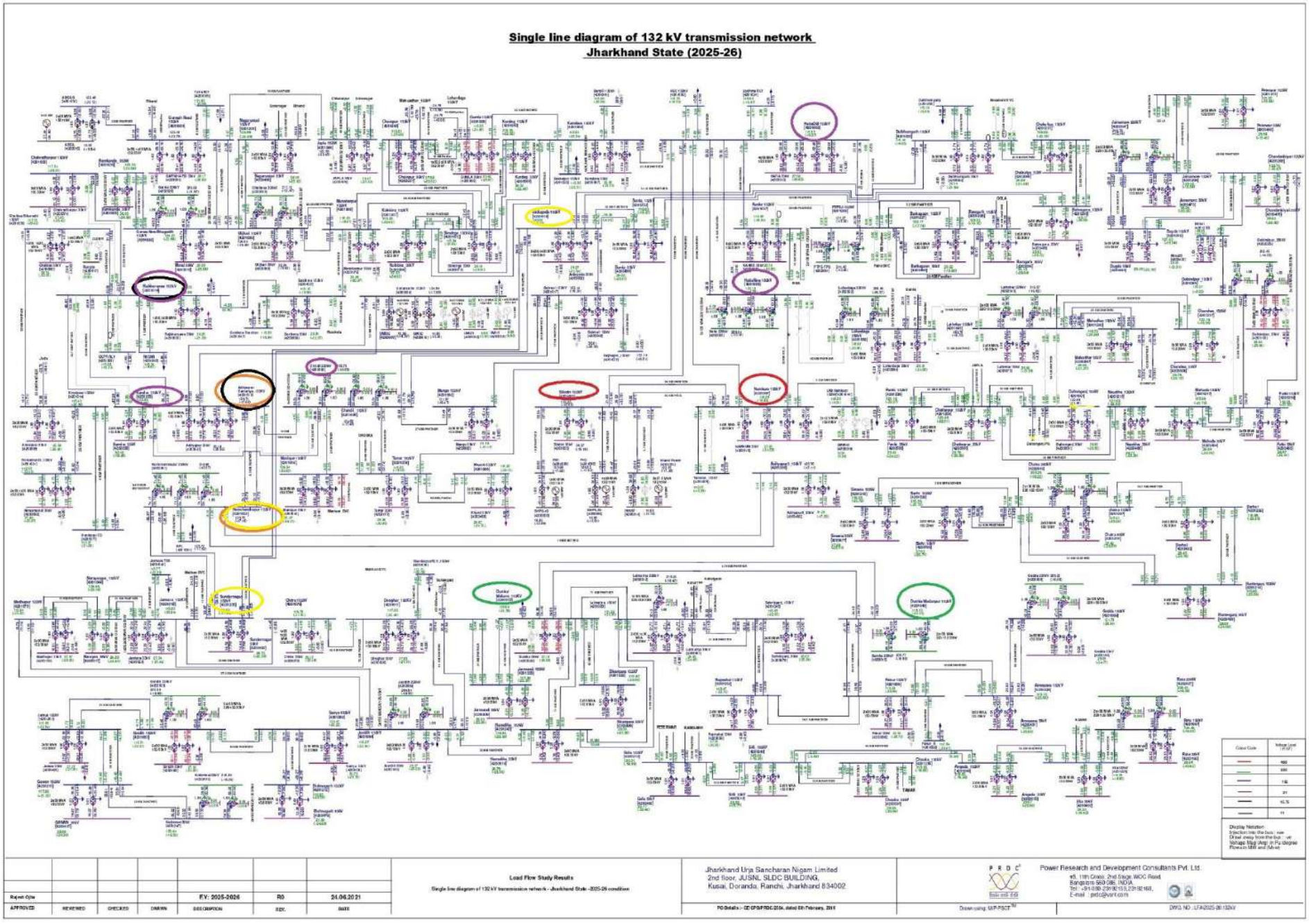
PHOTOS OF EXISTING LINES & SWITCHYARD

DETAILS REGARDING JUSNL 132KV HTLS CONDUCTOR

Sr. No	District	Name of line	Type of existing conductor	% Loading (2025-2026) (N-1 contigency)	whether covered in any other scheme (YES/No)	Circuit 1 (Length in CKm)	Circuit 2 (Length in CKm)	Ageing of Insulator (years)	Date of commissioning of line	Rating of CT (CT Ratio)	Rating of PT (PT Ratio)	Rating of Isolator	Rating of circuit breaker	SLD of switch yard with equipment rating	Is any tapping on line for dadicated consumer	N-1 contigency raised in past 5 years (Nos.)	Status Of Earthing	Approximate % age loading after reconductoring with HTLS during N-1 contengiency in 2025-26
1	Saraikela	Adityapur(Gamariya) to ramchandra pur 132 KV D/C	Panther	110	NO	8.3	8.3	21	2001	800/1	132KV/110V	1600 Amp	145KV,40KA	Yes	No	2 times in a year	Good	44
2	Ranchi	Namkum - Sikidri 132 KV	Panther	125	NO	34	0	5	2017	600/1	132KV/110V	1250 Amp	145KV,40KA	Yes	No	NO	Good	50
3	Ranchi	Hatai old - Hatai new 132 KV D/C	Panther	135	NO	0.6	0.6	9	2013	1200/1	132KV/110V	1600 Amp	145KV,40KA	Yes	No	3 times in a year	Good	54
4	Dumka	Dumka 220/132 to Dumka/Maharo 132KV DC	Panther	191	NO	1.8	1.8	7	2015	600/1	132KV/110V	1250 Amp	145KV,40KA	Yes	No	No	Good	76
5	W.Singhbhum	Adityapur - Rajkharsawa 132 KV S/C	Panther	108	NO	36	0	6	1973	400/1	132KV/110V	1250 Amp	145KV,40KA	Yes	No	No	Good	43
6	W.Singhbhum	Rajkharsawa - Chandil line via kandra 132 KV S/C	Panther	112	NO	35	0	5	1960	800/1	132KV/110V	1250 Amp	145KV,40KA	Yes	No	No	Good	45
7	E.Singhbhum	Jadugoda - Ramchandra pur LILOed at Sundarnagar 132 KV D/C	Panther	130	NO	46.8	46.8	3	2019	600/1	132KV/110V	1250 Amp	145KV,40KA	Yes	No	No	Good	53

ANNEXURE II SINGLE LINE DIAGRAM OF JUSNL NETWORK (LOAD FLOW STUDYRESULTS)

Single line diagram of 132 kV transmission network
Jharkhand State (2025-26)



Rajeet Ojha				FY: 2025-2026	R0	24.06.2021
APPROVED	REVIEWED	CHECKED	DRAWN	DESCRIPTION	REV.	DATE

Load Flow Study Results
Single line diagram of 132 kV transmission network - Jharkhand State -2025-26 condition

Jharkhand Urja Sancharan Nigam Limited
2nd floor, JUSNL SLDC BUILDING,
Kusai, Doranda, Ranchi, Jharkhand 834002

PO Details:- CE/SP&PRC/236, dated 6th February, 2017

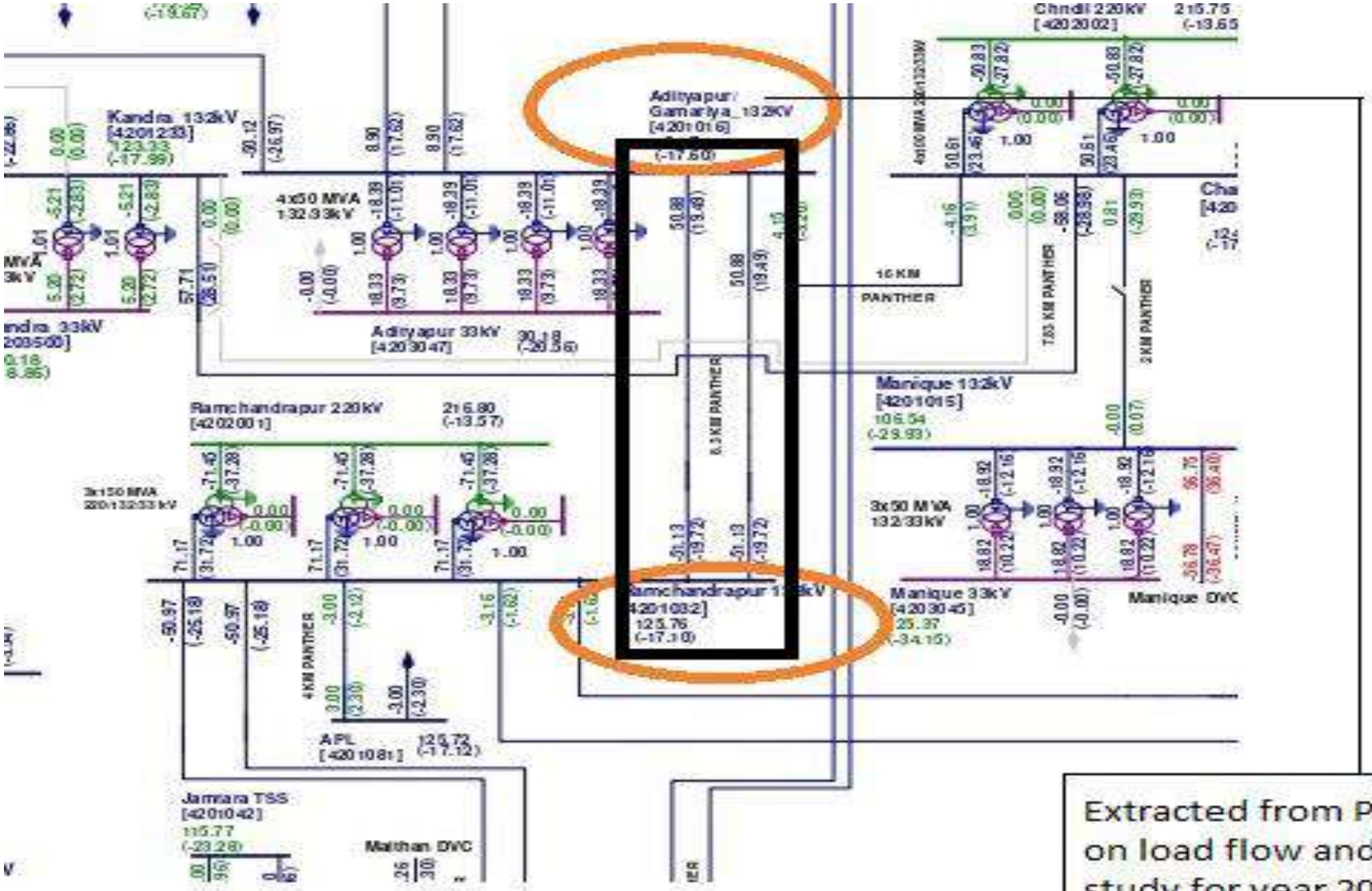
Power Research and Development Consultants Pvt. Ltd.
#5, 11th Cross, 2nd Stage, WOC Road,
Bangalore 560 086, INDIA.
Tel : +91-080-23192153,23192168,
E-mail : prdc@vsnl.com

Drawing using: MiPOWER

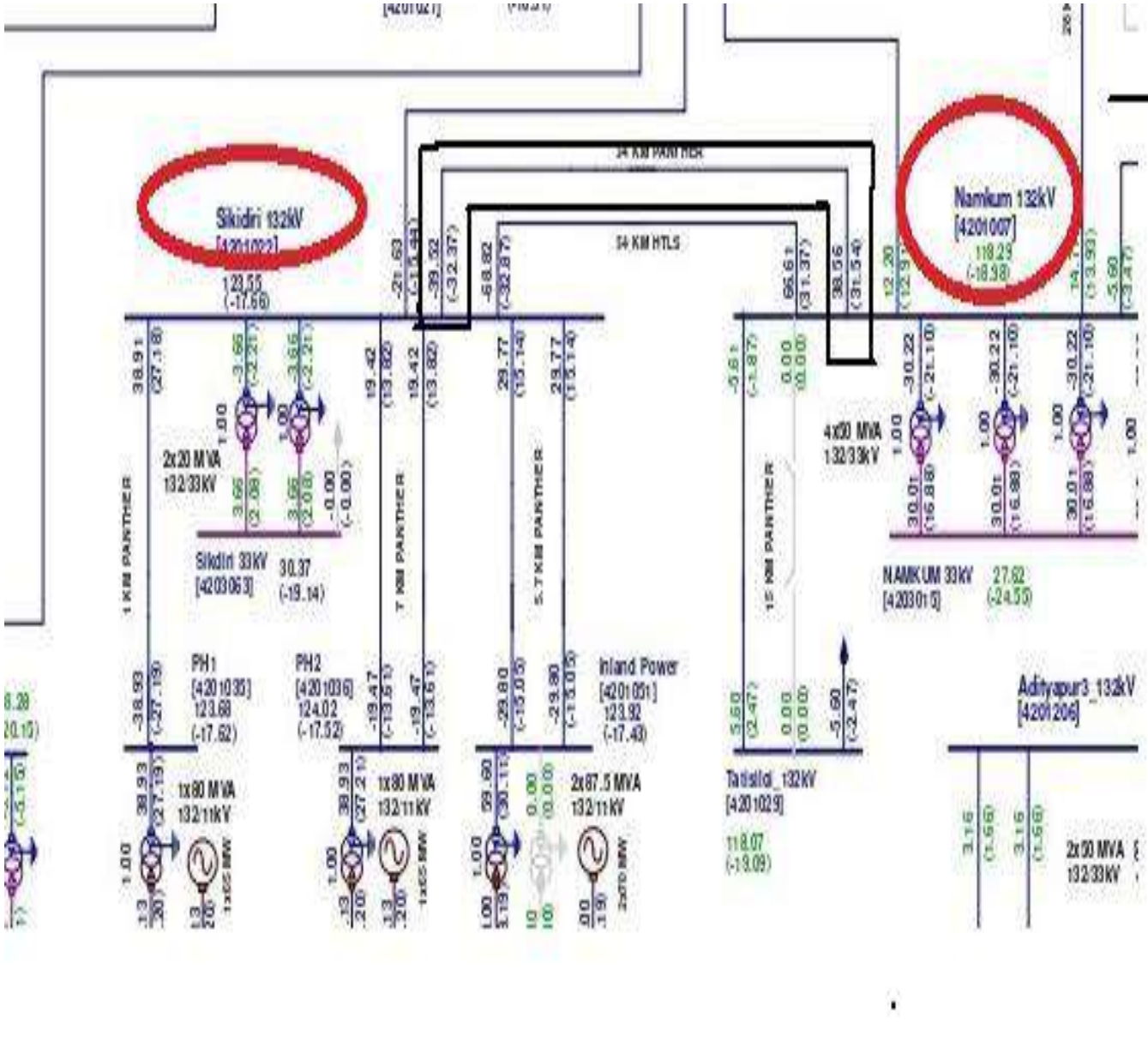
DWG NO.: LFA2025-26 132kV

Color Code	Voltage Level (in kV)
	400
	220
	132
	33
	11 / 6.6
	11

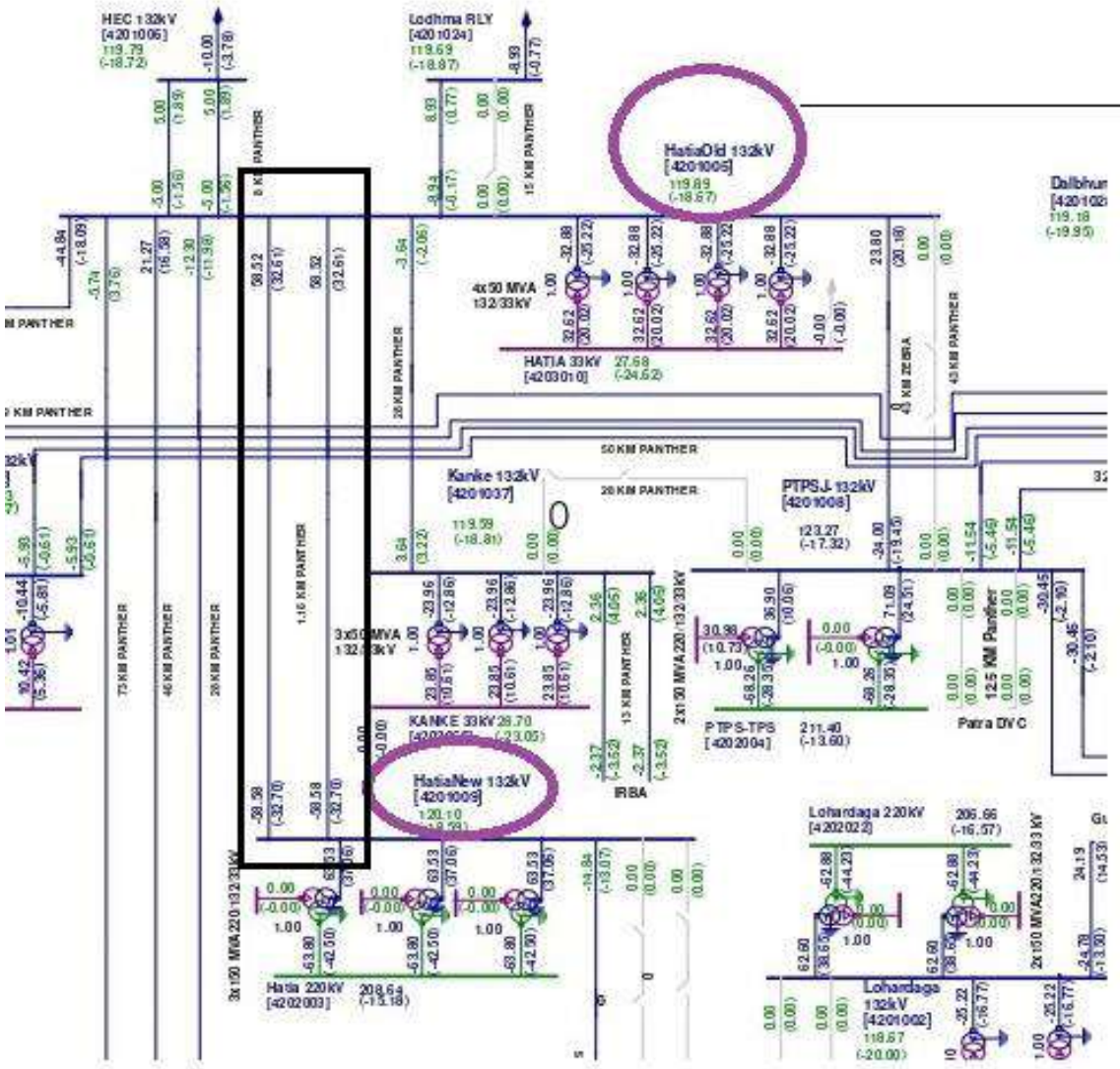
Display Notation:
Direction into the bus : +ve
Direct away from the bus : -ve
Voltage Mag(Ang) in Pu (degree)
Flows in MW and (Mvar)



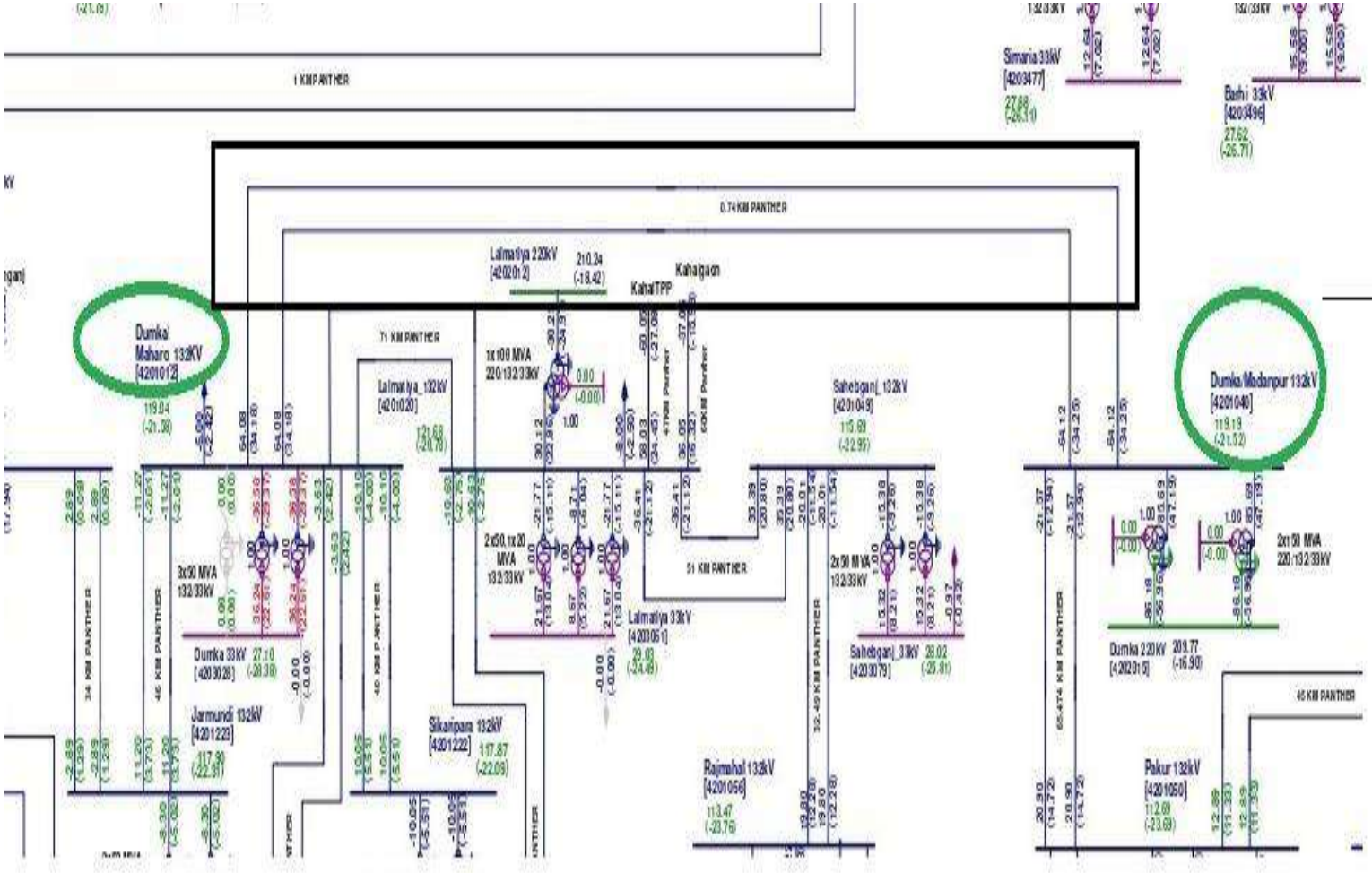
Extracted from PRDC report on load flow and short circuit study for year 2025-26
Doc ref. No. PRDC/DWG. No: LFA/2025-26/132KV



Extracted from PRDC report on load flow and short circuit study for year 2025-26 Doc. Ref. No. PRDC/DWG.No.:LFA/2025-26/132 KV



Extracted from PRDC report on load flow and short circuit study for year 2025-26 Doc. Ref. No. PRDC/DWG.No.:LFA/2025-26/132KV



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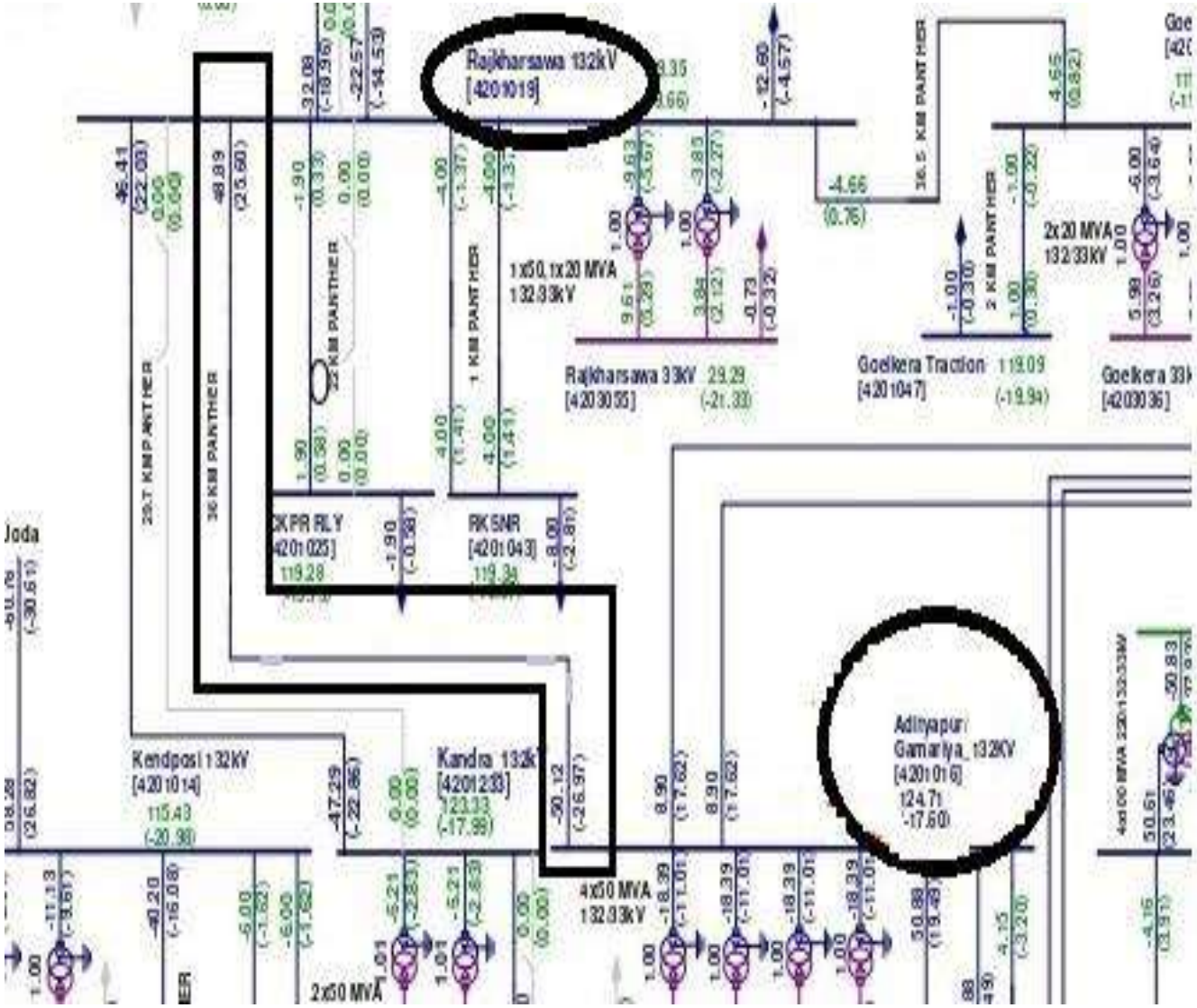
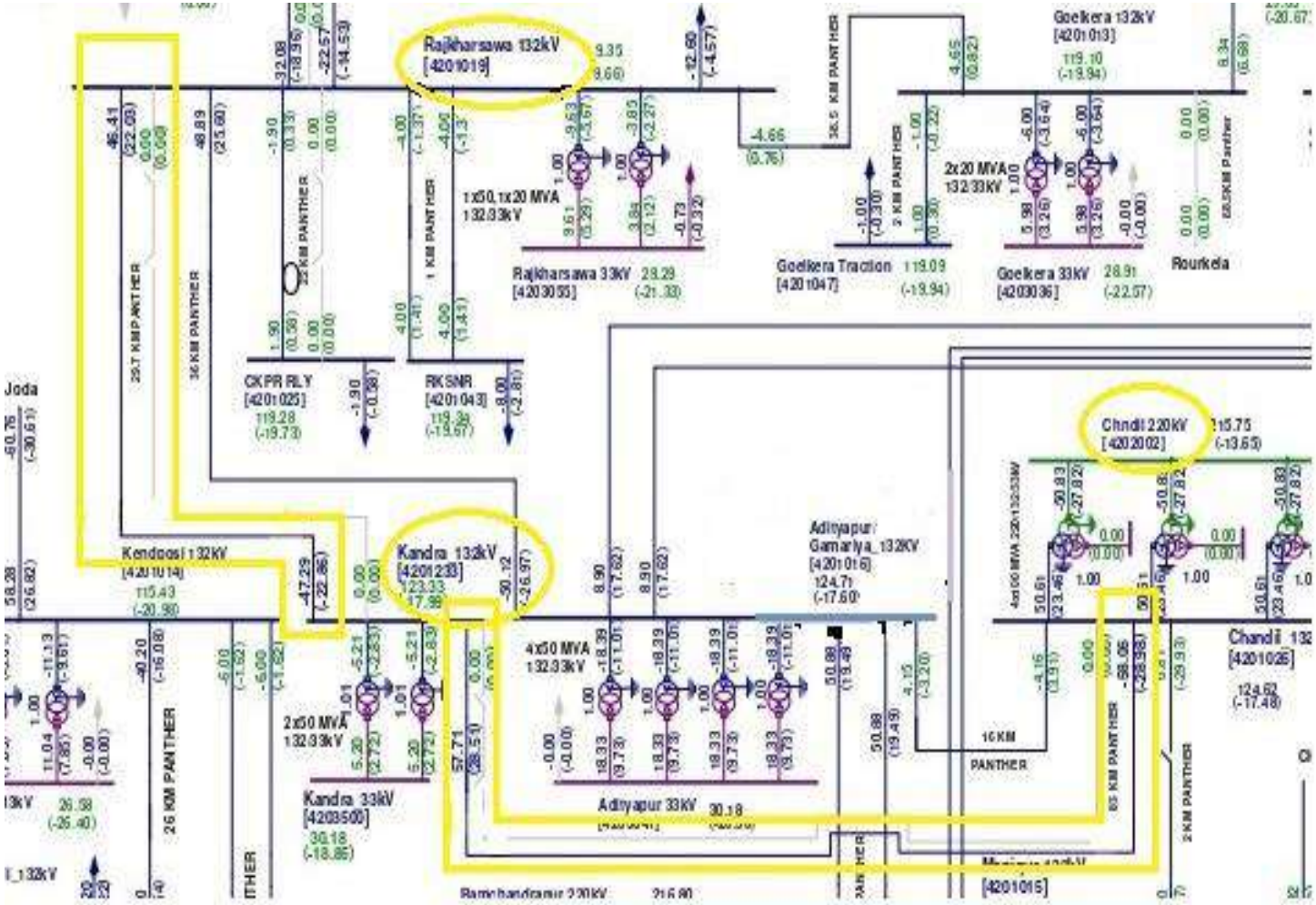
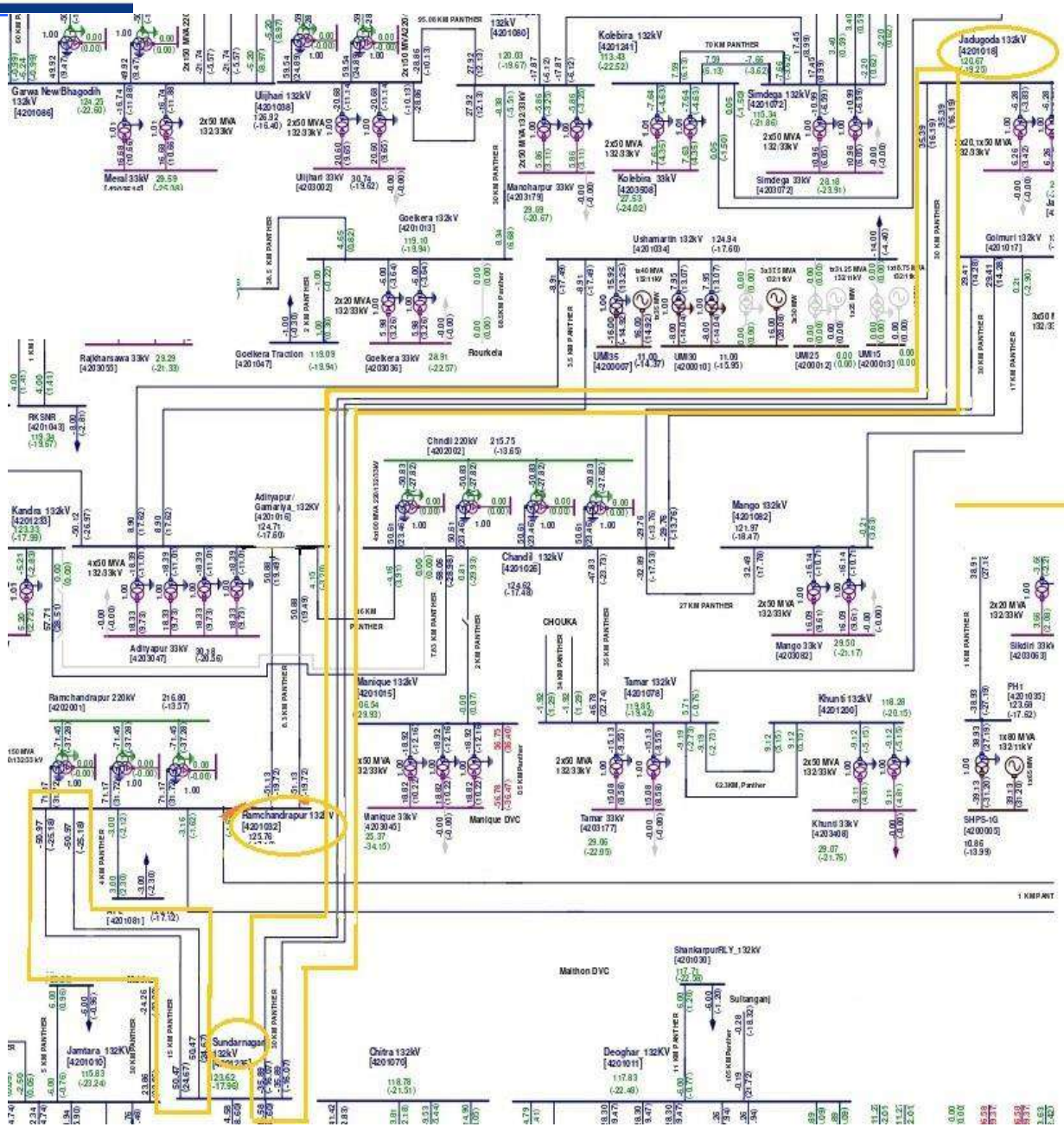


Extracted from PRDC report on load flow and short circuit study for year 2025-26 Doc. Ref. No. PRDC/DWG.No.:LFA/2025-26/132 KV



Extracted from PRDC report on load flow and short circuit study for year 2025-26 Doc. Ref. No. PRDC/DWG.No.:LFA/2025-26/132 KV



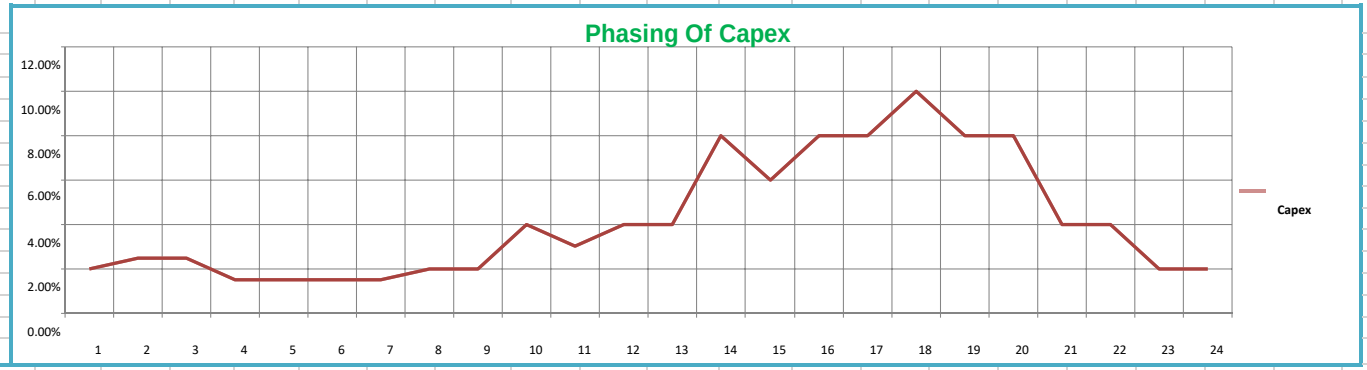
Extracted from PRDC report on load flow and short circuit study for year 2025-26 Doc. Ref. No. PRDC/DWG.No.:LFA/2025-26/132 KV

ANNEXURE III CAPITAL EXPENDITURE SCHEDULE

JUSNL HTLS RECONDUCTORING CAPEX SCHEDULE

Equity (Rs. Crores)	48.29	Note:	Equity	30%
Debt (Rs. Crores)	112.69		Debt	70%

TOTAL PROJECT COST (Rs. Crores) WITHOUT CONTINGENCY **160.98** Crores



Activity	Progress
Detailed Design	10.00%
Factory Acceptance Test - FAT	10.00%
Installation of Equipments	20.00%
Site Testing & Commissioning	20.00%
Site Acceptance Test - SAT	20.00%
Testing & Commissioning	10.00%
Trial operation and Taking Over	10.00%

MONTHLY PROJECT PROGRESS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0																								
Detailed Design	20%	25%	25%	15%	15%																			
Factory Acceptance Test - FAT						15%	15%	20%	20%	20%	10%													
Installation of Equipments										10%	10%	20%	20%	20%	10%	10%								
Site Testing & Commissioning														20%	20%	30%	20%	10%						
Site Acceptance Test - SAT																	20.0%	30.0%	30.0%	20.0%				
Testing & Commissioning																		20%	20%	20%	20%	20%		
Trial operation and Taking Over																				20%	20%	20%	20%	20%
PHASING OF CAPEX (%)	2.00%	2.50%	2.50%	1.50%	1.50%	1.50%	1.50%	2.00%	2.00%	4.00%	3.00%	4.00%	4.00%	8.00%	6.00%	8.00%	8.00%	10.00%	8.00%	8.00%	4.00%	4.00%	2.00%	2.00%
Capex required in Rs. Crores	3.22	4.02	4.02	2.41	2.41	2.41	2.41	3.22	3.22	6.44	4.83	6.44	6.44	12.88	9.66	12.88	12.88	16.10	12.88	12.88	6.44	6.44	3.22	3.22
Equity Available distributed equally (%)	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%	1.25%
Equity Available distributed equally (Rs. Crores)	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01
Debt or Loan Required (Rs. Crores)	1.21	2.01	2.01	0.40	0.40	0.40	0.40	1.21	1.21	4.43	2.82	4.43	4.43	10.87	7.65	10.87	10.87	14.09	10.87	10.87	4.43	4.43	1.21	1.21
Debt Opening Balance (Rs. Crores)	1.21	1.21	3.22	5.23	5.63	6.04	6.44	6.84	8.05	9.26	13.68	16.50	20.93	25.35	36.22	43.87	54.73	65.60	79.69	90.55	101.42	105.84	110.27	111.48
Debt Addition (Rs. Crores)	0	2.01	2.01	0.40	0.40	0.40	0.40	1.21	1.21	4.43	2.82	4.43	4.43	10.87	7.65	10.87	10.87	14.09	10.87	10.87	4.43	4.43	1.21	1.21
Debt Closing Balance (Rs. Crores)	1.21	3.22	5.23	5.63	6.04	6.44	6.84	8.05	9.26	13.68	16.50	20.93	25.35	36.22	43.87	54.73	65.60	79.69	90.55	101.42	105.84	110.27	111.48	112.69
Interest Rate (Monthly) (%) Annual 8%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%	0.67%
IDC Calculated on monthly basis(Rs. Crores)	0.008	0.021	0.035	0.038	0.040	0.043	0.046	0.054	0.062	0.091	0.110	0.140	0.169	0.242	0.293	0.365	0.438	0.531	0.604	0.676	0.706	0.736	0.744	0.752

Total IDC (Rs. Crores)	**6.942**

ANNEXURE IV TOWER SCHEDULE

POWER SYSTEM OPERATION CORPORATION LIMITED
National Load Despatch Centre
(Designated as Nodal Agency in accordance with Regulation 5 of CERC (PSDF) Regulations, 2014)
(PSDF-Secretariat)

Office Address: B-9, 1st Floor, Qutub Institutional Area, Katwaria Sarai, New Delhi -16
Tel: 011-26524521, 26536959 Fax: 011-26524525, 26536901
Website: https://psdfindia.in/. Email psdf@posoco.in ; nldc.psdf2020@gmail.com

Ref: NLDC-PSDF/TESG-55th meeting/2021-22/ Dated: 13th October, 2021

To,

General Manager (Contracts & Material)
Jharkhand Urja Sancharan Nigam Ltd
JUSNL Building, Kusai Colony, Ranchi-834002
Email: cetjusnl@gmail.com, cetrans@jusnl.in

Subject: Observation of 55th meeting of TESG held on 14.06.2021

Proposal Name: Reconductoring of existing 132 kV Line by HTLS conductor at JUSNL in Jharkhand State (Proposal No: 304).
Sir,

The subject proposal of M/S JUSNL and the inputs furnished by them were discussed in the 55th TESG meeting held on 14.06.2021. The relevant extracts of deliberations and observations recorded during the meeting are as per the attached Annexure-I.

It is requested to kindly provide the inputs for the observations as per the Annexure-I at the earliest.

Thanking you,

Yours faithfully

Suhas Dambhare
Convener of Techno Economic Subgroup
General Manager
NLDC-POSOCO

Copy to:

1. CE(NPC), CEA
2. ED, NLDC-POSOCO

JUSNL, Jharkhand: Reconductoring of existing 132 kV Line by HTLS conductor at JUSNL in Jharkhand State (Proposal No: 304).

Estimated cost Rs 49.64 crores.

Summary of the project:

As per the Transmission lines study conducted by the JUSNL for 13th plan period (2021-22) few of the of the 132 kV line observed that the loading is higher than 80% of its rated normal capacity during normal operating condition. In order to increase the overall reliability of JUSNL network and relieve congestion, renovation of these lines are necessary. This can be achieved through installation of new transmission lines or increasing the power transfer capacity by use of higher capacity conductor. Construction of new transmission lines lead to high capital cost, long lead times and involved land acquisition, forest clearance, right of way issue etc. Whereas reconductoring through existing conductor with higher transfer capacity, (HTLS) is proposed.

As per the study report, the following lines are proposed with HTLS conductor:

1. Existing 132 kV D/C line from Ramchandrapur (220/132/33 kV SS) to Adityapur (132/33 kV SS). Total line length details are as follows:

a) Ckt#1- 33 Ckms (with 1 kM LILO to Mango SS)
b) Ckt#2- 31 Ckms

2. Existing 132 kV D/C line from Golmuri (132/33 kV SS) to Chandili (220/132/33) kV SS. Total line length details are as follows:

a) Ckt#1- 8.3 Ckms
b) Ckt#2- 8.3 Ckms

Deliberations in the Meeting:

The TESG members discussed the proposal for upgradation of lines with HTLS conductor and it was decided that the points discussed during approval of the PSTCL Punjab HTLS proposal shall be checked in the DPR and if any inputs are required then the Entity shall be asked to submit the same.

CE (NPC), CEA informed that the load flow study submitted by the Entity is not visible and entity shall be asked to submit the same again. It was also decided that the HTLS conductor of cost shall be arrived at by selecting the most economically suitable conductor for desired performance. If the Entity

desires to use any other conductor whose cost is more, then the overhead cost shall be bared by the Entity.

The observations of the TESG members are as per below.

TESG Observations and inputs required from JUSNL:

The TESG members have sought following inputs from JUSNL on proposal no 304:

TESG observations and input sought from JUSNL	
TESG Member	Input required
NLDC	Format A-5 is need to be filled up and signed by authorized person. Standing Committee recommendation to be submitted by entity. Format A-6 (Undertaking) shall be filled up and signed by authorized person. Detailed item wise Action plan (Time line) for execution of Project right from tendering, supply and erection, commissioning, taking over of project, Disbursal of final grant and financial closer with NLDC to be submitted by the Entity.
PSETD	The date of commissioning of existing transmission lines may be submitted. It may submitted that in the past 5 years, at how many occasions the contingency situation have arrived during which power flow have been restricted due to limitation of power transfer capability of these lines,. The present usage of transmission lines is within limit of their full capacity. Further, the capacity of transmission lines may get restricted due to capacity of terminal equipment. The requirement of re-conductoring of the transmission lines with HTLS conductors needs to be justified with proper system study report and vetting by Eastern Regional Power Committee (ERPC). It may be ensured that terminal equipment have sufficient capacity to cater to the increased power flow after re-conductoring. Expected increase in the power flow capacity of the lines over the existing system after the uprating with the proposed HTLS conductor may be submitted. The expected usage percentage of transmission lines with the proposed HTLS conductors may also be submitted.) As the voltage level of transmission line remains same after re-conductoring, the tower accessories and insulators of the existing line can be used if they are in good condition and are capable to produce satisfactory performance under high temperature of conductor. Hence, the requirement of no. of the Tower

	Accessories and Insulators & associated hardware fittings and may be reviewed. Further, the quantity of insulators and insulator clamps mentioned for, suspension type towers in the 132 kV D/C Adityapur-Ramchandrapur transmission line, and for suspension and tension type towers in the 132kV D/C Chandil –Golmuri transmission line, appears to be on higher side and may be reviewed.) It is understood that existing insulator strings are giving satisfactory performance and not much pollution level is observed in the traversing areas of the transmission lines. Hence, the rational for use of polymer type insulators in the proposed transmission lines may be submitted.) The audit of existing tower structures may be carried out to ensure the structural strength of existing structures and a certificate verifying that existing structure are suitable for re-conductoring may be submitted.) Observations: There are multiple High Performance Conductors (HPC) available which provide advantages like low sag and high current carrying capacities and are suitable for re-conductoring of transmission lines and. However, depending on the type of conductor, the cost of such conductor may vary between 1.5 to 5 times the costs of conventional ACSR/ AAAC conductors. As no. of conductors are available to provide the desired performance, in view of restricting the cost of subject project, the committee may decide the suitable conductor to be used in the project in place of ACCC conductor as proposed in the DPR
NPC	) Board approval for seeking grant from PSDF is to be provided.) Tower Healthiness Certificate preferably by institutions like CPRI or Authorised State Agency or NABL accredited Labs is required to confirm that whether it can support the enhanced capacity of conductors during its useful life i.e. more than 35 years.) JSUNL need to provide detailed system Load flow study report clearly depicting the overloading of existing both lines i.e. 132kV D/C line from Ramchandrapur (220/132/33kV substation) to Adityapur (132/33kV substation) and 132kV D/C line from Golmuri (132/33 substation to Chandil (132/33kV substation). Further, JSUNL needs to provide the analysis for expected increase in power flow capacity of both the lines after reconductoring with HTLS conductor.

	) JSUNL shall submit the details of past instances wherein any contingency situation has arisen due to which power flow was restricted on these lines.) Cost estimate for this project is based on DPR prepared by TPDD/TCE which need to be verified/confirm with supporting documents such as recently placed LOA/Purchase Order of any similar project for Reconductoring of 132kV lines.) Total estimated cost also includes miscellaneous cost which is 5% of total cost and it includes cost for crop compensation, damage compensation etc. which is not permitted to be funded from PSDF fund.) JSUNL to confirm whether capacity of Bay equipment at terminal substations for enhanced capacity of the lines is sufficient or require up gradation to support reconductoring of existing proposed transmission lines.) Total price with GST for "supply cost of reconductoring of 132kV D/C line from Adityapur -Ramchandrapur transmission line with HTLS conductor and Polymer insulator" as provided by JUSNL needs to be verified/rechecked for any computational error.) JSUNL has preferred ACCC conductor for reconductoring of the both lines, however they need to provide the justification by providing cost benefit analysis for ACCC conductors compared to other HTLS conductors.) The salvage value of ACSR conductor i.e. scrap value of dismantled ACSR PANTHER conductor, etc. is Rs.49.80 lakhs. However, JSUNL needs to provide the basis of cost estimate for the salvage value of ACSR conductor. Further, the entity has excluded the salvage value of dismantled material from the Cost Estimates.) Statutory approvals are required for the project from Regional Power (standing) Committee (Transmission Planning) or in case if the proposed line is incidental to the Interstate Transmission System (ISTS) than approval is required from National Committee (Transmission Planning) i.e. standing committee.) Entity may also ensure cyber security of the system in line with the various Acts and regulations.) The utility may also ensure to comply PPP- MII (Make in India) order issued by the Government of India.
PGCIL	) NIL
CTU	) NIL

Additional Inputs	) Utility may confirm that the BoQ of the proposed Project is prepared on the actual basis as the length of the line and number of tower are known beforehand.) Utility may also confirm that if ampacity, maximum sag, maximum conductor diameter are not provided by the utility, the grant would be given for the cost of cheapest HTLS conductor available achieving desired parameters.

The TESG decided that above observations may be communicated to JUSNL by NLDC and proposal will be further examined after submission of the inputs by the entity.

Annexure D.1

Updated Anticipated Peak Demand (in MW) of ER & its constituents for October 2023

1	**BIHAR**	**Demand (MW)**	**Energy Requirement (MU)**
	NET MAX DEMAND	7402	4414
	NET POWER AVAILABILITY- Own Sources	554	312
	Central Sector+Bi-Lateral	6687	3990
	SURPLUS(+)/DEFICIT(-)	-160	-112
2	**JHARKHAND**		
	NET MAXIMUM DEMAND	1800	1037
	NET POWER AVAILABILITY- Own Source	480	193
	Central Sector+Bi-Lateral+IPP	918	648
	SURPLUS(+)/DEFICIT(-)	-602	-196
3	**DVC**		
	NET MAXIMUM DEMAND	3188	2162
	NET POWER AVAILABILITY- Own Source	5976	3527
	Central Sector+MPL	416	299
	Bi- lateral export by DVC	2156	1436
	SURPLUS(+)/DEFICIT(-) AFTER EXPORT	1048	228
4	**ODISHA**		
	NET MAXIMUM DEMAND (OWN)	5950	3809
	NET MAXIMUM DEMAND (In Case of CPP Drawal)	6366	3143
	NET POWER AVAILABILITY- Own Source	3888	2530
	Central Sector	1905	1259
	SURPLUS(+)/DEFICIT(-) (OWN)	-156	-20
	SURPLUS(+)/DEFICIT(-) (In Case, 600 MW CPP Drawal)	-572	646
5	**WEST BENGAL**		
	WBSEDCL		
5.1	NET MAXIMUM DEMAND	8072	4386
	NET MAXIMUM DEMAND (Incl. Sikkim)	8077	4390
	NET POWER AVAILABILITY- Own Source (Incl. DPL)	5690	2905
	Central Sector+Bi-lateral+IPP&CPP+TLDP	2747	1732
	EXPORT (To SIKKIM)	5	4
	SURPLUS(+)/DEFICIT(-) AFTER EXPORT	360	248
5.2	**CESC**		
	NET MAXIMUM DEMAND	1940	983
	NET POWER AVAILABILITY- Own Source	765	507
	IMPORT FROM HEL	540	349
	TOTAL AVAILABILITY OF CESC	1305	856
	DEFICIT(-) for Import	-635	-127
	WEST BENGAL (WBSEDCL+CESC+IPCL)		
	(excluding DVC's supply to WBSEDCL's command area)		
	NET MAXIMUM DEMAND	10012	5369
	NET POWER AVAILABILITY- Own Source	6455	3412
	CS SHARE+BILATERAL+IPP/CPP+TLDP+HEL	3287	2081
	SURPLUS(+)/DEFICIT(-) BEFORE WBSEDCL'S EXPORT	-270	125
	SURPLUS(+)/DEFICIT(-) AFTER WBSEDCL'S EXPORT	-275	121
6	**SIKKIM**		
	NET MAXIMUM DEMAND	104	51
	NET POWER AVAILABILITY- Own Source	8	3
	Central Sector	81	57
	SURPLUS(+)/DEFICIT(-)	-15	9
	EASTERN REGION		
	NET MAXIMUM DEMAND	27898	16842
	NET MAXIMUM DEMAND (In Case of CPP Drawal of Odisha)	28306	16176
	BILATERAL EXPORT BY DVC (Incl. Bangladesh)	2156	1436
	EXPORT BY WBSEDCL TO SIKKIM	5	4
	EXPORT TO B'DESH & NEPAL OTHER THAN DVC	642	478
	NET TOTAL POWER AVAILABILITY OF ER	28501	16876
	(INCLUDING CS ALLOCATION +BILATERAL+IPP/CPP+HEL)		
	SURPLUS(+)/DEFICIT(-)	598	696
	SURPLUS(+)/DEFICIT(-) (In Case, 600 MW CPP Drawal of Odisha)	190	30

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OFFICE OF THE CHIEF LOAD DESPATCHER, SLDC

ODISHA POWER TRANSMISSION CORPORATION LIMITED

GRIDCO Colony, P.O.-Mancheswar Rly. Colony, Bhubaneswar-751017,

CIN – U40102OR2004SGC007553

email id: cld_sldc@sldcorissa.org.in

No. CLD (OS) – 239 / 2020 / 2190 (2) Dt.13 .09.2023

From:

Shri B.B.Mehta,
The Director cum CLD,
SLDC, OPTCL,
Bhubaneswar-17

To

Shri N.S.Mondal,
The Member Secretary,
ERPC, Kolkata - 33

Sub: Agenda of Odisha SLDC for 207th OCC Meeting (enclosed).

Dear Sir,

Kindly incorporate the agenda of Odisha SLDC in the forthcoming 207th OCC Outage planning Meeting & 207th OCC Meeting to be held on dt.14.09.2023 & 15.09.2023 respectively on "Idle charging 220KV Balimela – U.Sileru line from both end on rotation basis".

Yours faithfully;

Encl: As above

Director cum CLD

Copy forwarded to the:

1. E.D, ERLDC, Kolkata for kind information.