EASTERN REGIONAL POWER COMMITTEE
14, GOLF CLUB ROAD, TOLLYGUNGE
KOLKATA-700033

MINUTES OF THE 7th PROTECTION SUB-COMMITTEE MEETING HELD AT ERPC, KOLKATA ON 12.08.2010 (THURSDAY) AT 11:00 HOURS

List of participants is enclosed at Annexure-I.

Member Secretary, ERPC welcomed the esteemed delegates and Shri Pradeep Modi of M/s A. Eberle in the 7th Protection sub-Committee meeting. He expressed his concern that this group is meeting after a gap of more than one year. It may be for the reason that there was no agenda item. We should have a system of bringing on record the instance that there is no issue for discussion. Therefore, he suggested that regular notice shall be issued for holding of the Protection sub-Committee meeting on quarterly basis. Agenda items shall be called upon and in the event of no agenda item, the meeting shall be called off. Everyone agreed to the above suggestion. He then requested Superintending Engineer (Power System) of ERPC to take up agenda items one by one, after the presentation on "Voltage Collapse Prediction Relay" by Shri Pradeep Modi of M/s A. Eberle.

PART - A

ITEM NO.: 0 PRESENTATION ON "VOLTAGE COLLAPSE PREDICTION RELAY" BY SHRI PRADEEP MODI OF M/S. A. Eberle

Shri Pradeep Modi of M/s A. Eberle gave an exhaustive presentation giving details of the features and its application as well as its comparison with Phasors Measurement Unit (PMUs) which is enclosed at Annexure-F. He also explained the dynamic power system stability monitoring (CPSys). Members appreciated and enlightened with the various queries on the above subject.

ITEM NO.:1 CONFIRMATION OF THE MINUTES OF THE 6th PROTECTION SUBCOMMITTEE MEETING OF ERPC HELD AT ERPC, KOLKATA ON 21.07.2009

The minutes of the above meeting were circulated vide letter no. ERPC/SE (OPRN)/ PROTECTION/ 2009/

No comments have been received from any constituent. If there is no comment, the minutes of the meeting may please be confirmed.

The minutes of the 6th Protection Sub-Committee meeting were confirmed, without any modifications.

PART - B FOLLOW-UP ACTIONS OF THE PREVIOUS MEETINGS

The status on follow up action as furnished by respective constituents.

ITEM NO. 1 **DVC**

(Item No. 1.2 (iii) & 1.4 of MoM of the 6th Protection sub-committee)

Replacement of old relays by numerical relays in Mejia TPS, CTPS & Bokaro 'B' after analyzing the incidences on 01.04.09, 11.02.09.

Deliberation in the meeting

DVC representative confirmed that the work for replacement of old relays by numerical relays is in progress. At Mejia TPS and all 220 kV lines emanating from Chandrapura as well as Bokaro" B" TPS, the numerical relays have already been in place.

ITEM NO. 2 **WBSETCL**

(**Item No. 2 (3) & (2) of MoM of the 6th Protection sub-committee)**

Incorporation of bus-bar differential protection scheme at all tie substations of WBSETCL.

Installation of bus differential relay (RADSS) at Bidhannagar 220kV sub-station was planned. The order for procurement of the relay was in progress.

Replacement of CTs in WBSETCL S/Stns where tan-delta values were higher than 1.0

Deliberation in the meeting

WBSETCL informed that all 400kV S/Stns of WBSETCL system are having bus-bar differential protection. Bus-bar differential protection at Bidhannagar 220kV S/Stn is expected to be commissioned by mid September.

Further, the replacement of CTs would be taken up after the assessment of residual life analysis to be done by CPRI. The status report would be prepared and furnished shortly.

ITEM NO. 3 **CESC**

(Item No. 2 (6) of MoM of the 6th Protection sub-committee)

Adequate battery back-up in all substations of CESC.

Deliberation in the meeting

CESC informed that battery back-up arrangement for input of all auxiliary contacts to SCADA system has already been done.

ITEM NO. 4 OHPC

Status of installation of 400kV New CVTs at Indravati HPS.

OHPC confirmed that the faulty CVTs of Indravati HPS was replaced by new 400 kV CVTs on 08.7.2010. The corresponding over voltage setting is made at 110% with 10 ms time settings.

ITEM NO. 5 **SIKKIM**

(Item No. 3 of MoM of the 6th Protection sub-committee)

The circuit breaker and proper protection and metering arrangement to be provided at both Sagbari sub-station (LILO of 132 kV Rangit-Melli line) and Rohtak sub-station(66 kV Rangit-Melli line) respectively .

Representative of Sikkim apprised that 132kVSagbari S/Stn has not yet been connected to the grid by LILO of 132kV Rangit-Melli line. The same will be done in September, 2010 when metering and protection at Sagbari will be ready.

The progress of Rohtak 66 kV S/s is awaited from Sikkim.

ITEM NO. 6 **NTPC**

(Item No. 1.7 of MoM of the 6th Protection sub-committee)

At KhSTPP Inter connecting transformers take supply from 400 kV side and feed 132 kV buses and this 132 kV bus is connected with 11 kV station bus through station transformer.

With the operation of bus-bar protection, these 132 kV buses were devoid of supply from 400 kV side which in turn resulted into loss of supply at 11 kV station bus. As a result, on 25.04.09 the unit# 5 and 6 lost their GT cooler supply, which was fed from 11 kV station buses and tripped. Power supply to auxiliaries was modified by providing supply from both station buses as well as unit transformer. These modifications were already implemented for unit#5 and #7, and would be implemented for unit#6 subsequently.

Deliberation in the meeting

NTPC representative confirmed that the modification of power supply to auxiliaries both from station buses as well as unit transformer for the KhSTPS unit no.6 has been completed in the month of February'10, as was earlier done for unit no. 5 & 7.

The status of the above was intimated by the respective constituents as mentioned under Part-B. Member Secretary, ERPC once again advised to intimate the progress of all the action plans drawn in the meeting to report to ERPC/ERLDC so as to ensure documentation and record by ERPC Secretariat.

PART – C NEW AGENDA ITEMS

ITEM NO. 1 CONSIDERATION OF FORMAT FOR REPORTING BY THE CONSTITUENTS:

(a) System Disturbance Report

(b) Protection Performance Index –transmission lines / elements – As proposed by ERLDC

It was noted with concern that number of partial disturbances occurred in Eastern Region during May, 2010 and a number of tower collapse reported in the constituent systems including CTU during April / May, 2010. It has also been observed that the detailed report from the constituent side in this regard has not been received at ERPC/ ERLDC. This has caused severe hindrance in analyzing the grid incidences and thereby, suggesting remedial measures to prevent such recurrence in future could also not been taken appropriately.

In this connection GM, ERLDC vide its Fax Message No. **158 dated 03.06.2010** invited attention of the SLDCs of the constituents as well as CTU / ISGS power stations to furnish written report as per IEGC Clause No. 5.9.6 for proper analysis. In order to streamline the procedure of reporting grid incidences as mandated in IEGC, ERLDC has proposed the reporting of the incidents as enclosed at **Annexure A & B**. The format of the above was also presented in a meeting held at ERPC, Kolkata on 15.07.2010 on the subject of discussion on new IEGC related issues which is in place w.e.f 03.05.10.

Members may please consider the format as a standard reporting format of System Disturbances by the constituents for analysis at ERPC / ERLDC level and further discussion in the Protection sub-Committee meeting.

Deliberation in the meeting

After detailed discussion all the constituents agreed the formats in Annexure-A & B may be followed / used by all agencies to start with, for reporting of tripping of all important grid elements, that are listed in the Operating Procedure of Eastern Region. In case of any difficulty in implementation, the formats will be reviewed in due course.

Flash reports of incidents will be preceded by detailed report as per format specified in IEGC.

ERLDC informed that NHPC and OPTCL had already adopted the format for reporting of past disturbances, so analysis of such disturbances and remedial measures to avoid such events are being examined by ERLDC.

ITEM NO. 2 DISCUSSION ON 'SYSTEM SECURITY ASPECTS' (PART-5) UNDER CLAUSE 5.2 (k), (n), (o) & (t) OF NEW IEGC IMPLEMENTED FROM 03.05.2010

Hon'ble CERC has notified new IEGC which had been implemented with effect from 03.05.2010. The new IEGC has assigned some additional responsibility to RPC for its Protection sub-committee apart from already existing responsibilities. In this connection, one day meeting was arranged at ERPC on 15.07.2010 to address all IEGC related issues and to build up awareness among ERPC constituents. The response from the constituents was encouraging.

In Part-5 of new IEGC under clause 5.2 "System Security Aspects" it was decided in the said meeting that Protection Sub-Committee of ERPC will deal with the items as detailed below:

IEGC Clause No.5.2	Items	Responsibility of Protection sub-Committee
Sub section - **k**	Power System Stabiliser	1. It may finalise plan for PSS tuning which may be vetted by ERPC subsequently. 2. It may constitute a sub-group for checking of PSS and also decide on periodicity of checking / further tuning 3. To create awareness on PSS tuning holding workshop which may be arranged at ERPC. 4. PSS tuning exercise may be funded from capped pool fund.
Sub-section **- n**	Automatic Under Frequency Relay (AUFR) & Df/Dt relay	1. It may decide the quantum of load relief for each constituent at different stages of under frequency settings. The settings and connected load of each constituent will be reviewed on half yearly basis. 2. Monthly report of UFR operation in the respective constituent system to be furnished to ERPC/ERLDC. 3. A small group may be formed to carry out inspection of UFR / periodicity of inspection and method of testing of UFR setting.
Sub-section - **o**	System Protection Schemes(SPS)	1. It will be finalised such scheme in consultation with ERLDC as and when basis. 2. Such scheme will be vetted by ERPC before implementation.
Sub-section- **t**	Voltage Control Measures	1. It will be finalised such scheme for adequate voltage control measures. 2. This will be vetted by ERPC.

Protection sub-committee may decide formation of sub-group to address the above.

Deliberation in the meeting

GM, ERLDC explained the system security aspects under clause 5.2 under new IEGC which was implemented from 03.05.2010. The Protection sub-Committee agreed to constitute a sub-group from ER constituents to deal with the sub-section (k), (n), (o), (t) of IEGC clause 5.2. Nomination of officers from the constituents (preferably located in and around Kolkata city) is to be obtained within 15 days to represent the sub-group for addressing the above issues. It was also decided that the representative from WBPDCL is to be included for the item "Power System Stabilizer".

ITEM NO. 3 ANALYSIS & DISCUSSION ON VARIOUS GRID INCIDENCES WHICH OCCURRED IN CTU / STU SYSTEMS (INCLUDING CESC SYSTEM DISTURBANCE ON 01.07.2010) – REPORTS RECEIVED ONLY FROM ERLDC (REFER ANNEXURE – C) – DETAILED PRESENTATION WITH AREA NETWORK DIAGRAM BY ERLDC

ERLDC presented the area affected due to disturbances reported at Annexure- C for analysis during the meeting. The corresponding analysis and deliberation part is indicated at Annexure-C.

ITEM NO. 4 A. FREQUENT TRIPPING OF 220 RANCHI (PGCIL)-CHANDIL (JSEB) LINE

Powergrid ER-I, Patna reported several unwanted tripping in 220kV Ranchi-Chandil line-I from Chandil end only during April / May, 2010. Those trippings had caused stresses on ICTs and sub-station equipment.

Powergrid may give the details of the incidences and JSEB may furnish the relay indications of such incidences.

Deliberation in the meeting

Powergrid ER-I submitted the tripping details of 220kV Ranchi-Chandil line-I from April to July, 2010. On receipt of the same during the meeting, JSEB agreed to take up with Chandil sub-station in charge on the instances. After analysis of the above by JSEB, a consolidated report will be furnished to ERPC/ ERLDC.

B. OVER VOLTAGE PROBLEM IN ER-I NETWORK

Powergrid ER-I, Patna also reported over voltage problem being faced in the 400kV sub-stations. In most of the sub-station the average voltage remains 425kV and above which is beyond the prescribed normal operating voltage. The continuous exposure of high voltage has caused damages 3 nos. of CTs in at Biharshariff, New Purnea & Ranchi sub-station although tan – delta value of all the three CTs were found within the permissible limits.

Powergrid may please furnish the voltage profile of those sub-stations.

Members may please discuss.

Deliberation in the meeting

The sub-committee expressed concern about existing over voltage problem in the 400kV CTU network particularly from the month of May, 2010 onwards after the nor' ester which caused tower collapses in North Bengal/Bihar areas. ERLDC agreed to over see the causes of over voltage phenomena in the CTU network.
BSEB & OPTCL reported over-voltage problem at Biharshariff 220kV & Jaynagar 220kV sub-stations. After presentation of voltage profile of the above sub-stations as recorded by SCADA, ERLDC opined that upon restoration of 132kV lines to feed loads from Biharshariff 220kV sub-station of BSEB, the over-voltage problem would be controlled to a great extent. Further, in the last ERPC meeting, additional 125 MVAR reactors, one each at Patna and Biharshariff have already been suggested to be installed. This is to be ratified by the Standing Committee on Transmission Planning of ER. Regarding over voltage problem at Jeynagar 220kV S/stn, ERLDC requested OHPC to explore running of more hydro machines on bar in order to absorb reactive power to control over voltage problems.

In overall, ERLDC agreed to examine the issues and corrective actions would be suggested.

ITEM NO. 5 PRESENT STATUS OF EXISTING UFRs INSTALLED IN CONSTITUENT SYSTEMS

Please refer Annexure –D.

The performance of the existing UFRs operation was discussed in the 52nd OCC meeting held on 16.07.10. It was requested by ERLDC to confirm the following:

a) All UFRs are in service
b) The connected load is to be doubled the quantum to be shed
c) To send report on UFR operations as and when called upon to operate and a monthly consolidated report.

Members may please confirm.

Deliberation in the meeting

GM, ERLDC stressed the need for UFRs installed in the constituent system to be in service as a defense mechanism and secured operation of the grid. With the growing system demand in ER, he impressed upon connecting more loads to be covered under different UFRs stages as above. The existing UFR details received from the constituents are indicated under Annexure-D. It was decided that the sub-group in its next meeting will consider for assessment of more connected loads to

be shed in the constituent systems, since the system frequency may not normally touch the first stage frequency setting of UFR for ER (i.e.48.5 Hz).

Constituents agreed to submit the report of the UFR operations on monthly basis for onward transmission to CERC.

The inspection of the UFRs in the constituent systems would be carried out by the sub-group as and when decided and the report of the same would be recorded in the register.

ITEM NO. 6 PRESENT STATUS OF EXISTING CAPACITORS INSTALLED AT DIFFERENT SUB-STATIONS IN THE CONSTITUENT SYSTEM AND PROGRAMME OF FURTHER INSTALLATION DURING 2010-11

Deliberation in the meeting

CESC, WBSEDCL/ WBSETCL, BSEB & OPTCL submitted the capacitors installed at their respective sub-stations. DVC, JSEB & Sikkim were requested to furnish the above information (including consumers end capacitors) at the earliest. The plan for future capacitor installation programme in respect of CESC, WBSEDCL & OPTCL were also received which are indicated in Annexure- E.
GM, ERLDC suggested that the plan for new capacitors in ER could be included in the Power System Development Fund (PSDF) maintained by CERC. It was agreed that the new installation programme of capacitor in the constituent systems will be proposed to be funded from PSDF.

PART -D

ITEM NO. 1 ANY OTHER POINTS

a. NON OPERATION OF AUTO RECLOSE FACILITIES ON TRANSMISSION LINES

A number of partial disturbances occurred in Eastern Region during May, 2010 but not a single case of operation of single phase auto re-closer was reported to ERPC/ ERLDC. In a communication dated 03.06.2010, GM,ERLDC pointed out that either single phase auto re-closers are kept in 'non –auto' mode or are not functioning properly due to insufficient single phase to ground auto re-close dead time, compressor problem etc.

Since, the operation of single phase auto re-closer is extremely essential to prevent undesired tripping of lines due to single phase to ground transient fault, the availability of single phase auto re-closer and keeping them in service is a must for important intra-state / CTU / inter-regional transmission lines.
The issue was further discussed in the 51st OCC meeting and ERLDC requested each constituent to submit the following information in case of non-operation of auto re-closer.

i. Line length
ii. Availability of line reactor (with or without NGR), Reactor Capacity & NGR capacity.
iii. Auto re-close dead time.
iv. DRs of the events in which auto re-close failed.

Members may please discuss.

Deliberation in the meeting

GM, ERLDC cited that during the month of April / May, there were minor grid disturbances occurred in ER system. It was observed that not a single case of operation of single phase re-closer was reported. This clearly reflected that the auto re-closer facility are not functioning or at non-auto mode due to insufficient single phase to ground auto re-close dead time, compressor problem etc. He impressed upon the need of operation of single phase re-closer to prevent undesired tripping of lines during transient faults. He requested the constituents to submit the above requisite information within August 2010 in order to assess / analyse the operation of auto re-closer.

Powergrid ER-II submitted a report of the cases auto re-closers successes during the month of May, 2010. Out of the 8 cases of earth fault registered during the month of May, 2010 occurred in different 220kV & 400kV transmission lines, the auto re-close attempted in 5 cases. The list of the transmission lines of Powergrid having auto-recloser facility was also submitted. Further, 400 kV Farakka-Jeerat line shall be equipped with new numerical Distance Protection relay with DR within three months.

OPTCL representative informed that auto re-close facility is available at Meramundali and Mendhasal 400kV S/stn. in Orissa which are not functioning at present. Action is being taken for making this facility operational.

b. ANALOG TRIGGERING OF DISTURBANCE RECORDERS

At many Substations DR outputs from Numerical relays as well as disturbance recorders are not available/not functioning and are not time synchronized, causing difficulty in analysing tripping events and disturbances. IEGC clause 4.6.3 mandates keeping all recording instruments time synchronized and in working condition and furnishing of the recorded data. However, as a back up to system wide disturbances and to record phenomenon like low frequency oscillation etc. various DR printouts can be made available by enabling the following analog triggers:

– Under-Frequency & Over-Frequency triggering(e.g. 50.50Hz and 49.00 Hz)

– Under-voltage & over-voltage triggering(e.g. 90% & 110%)

– Under and over current

However, such analog triggering would lead to recording of a more number of events and as such downloading of the information to PC at intervals is essential.
The relay suppliers can be asked to provide polling and scheduler software and these could be installed in PCs so that the events are downloaded after every few minutes.

GM, ERLDC has written a letter to all constituents on this subject on 03/06/10.

Members may kindly discuss the issue and furnish programme for implementation.

Deliberation in the meeting

GM, ERLDC stressed the need for disturbance recorder and event logger outputs from the major sub-stations for analyzing the tripping disturbances occurring in the ER grid. The provision of DR & SER outputs has been included in the IEGC clause no. 5.9.6 (c). All DR & SERs at the sub-station are required to be time synchronized to enable correct analysis of the events. The analog triggering as suggested by ERLDC vide letter dated 03.06.10 should be taken up on priority basis and DR outputs shall be e-mailed or faxed to SLDCs and RLDC whenever the disturbances is occurred.

All the constituents requested ERLDC to write to their highest authority of the respective constituents for kind attention and implementation of the proposal.

c. SPECIAL PROTECTION SCHEME (SPS)

ERLDC proposed that JSEB may consider an SPS for rapid reduction of generation at Tenughat TPS whenever the total generation from Tenughat TPS is 300MW or more, and / or 220kV Tenughat - Biharshariff or any 220kV line emanating from PTPS is out of service.

TVNL / JSEB may please opine.

Deliberation in the meeting

GM, ERLDC informed that a Special Protection Scheme would be devised for rapid reduction of generation of Tenughat TPS generation, in case of any of the line emanating from the power station is tripped when the generation from two units of TVNL is more than 300 MW. The scheme would be forwarded to JSEB and TVNL authorities for examination before implementation. The scheme will be placed for discussion in the next Protection sub-Committee meeting.
A number of Special Protection Scheme for ER system is under consideration of ERLDC which are also to be placed for discussion in the next Protection sub-Committee meeting.

d. REPORTING THE OPERATION OF GENERATOR PROTECTIONS

While reporting disturbances, operation of relays of Generator(s) and Generator Transformer(s) are also to be furnished for proper analysis of the disturbance. In case Generator(s)/ Generator Transformer(s) does not trip, starting of relay elements for the same ,if any, need to be furnished to understand the incident properly.

Deliberation in the meeting

The constituents agreed to provide the data / information to ERLDC shortly.

e. TRIPPING INCIDENCES OF IB TPS UNITS (2x110MW) OF OPGC

OPGC vide its communication dated 06.08.2010 requested for inclusion of the following tripping incidences:

Tripping Date / Time (Hrs)	Unit No.	Reason of Tripping	Synchronising date/ time (Hrs)	Remarks
13.09.2009/14:55	1	Frequency Over shoot Load Rejected and unit tripped on ,Generator Reverse Power Relay	14.09.2009/00:23	Total Station Blackout, Start up power availed at 16:00 Hrs, subsequently two times blackout occurred.
13.09.2009/15:10	2	Under Frequency Relay as islanded from main system due to tripping of Budhipadar-Korba	14.09.2009/03:45	
12.10.2009/17:35	1 & 2	Both units tripped on over frequency relay. Fault was originated at Budipadar S/stn due bursting of Y phase LA of 220kV side ATR	12.10.2009/ U#1-13:10 U#2-02:04	CB did not trip to isolate the fault, thereby remote end CB tripped. Total Station Blackout
24.05.2010/17:14	1 & 2	U#1 loss of excitation U#2 Over frequency relay	25.05.2010/ U#1-07:00 U#2-05:43	Fault was snapping of IB TPS –Budhipadar line4 jumper at Budhipadar Total Station Blackout

Members may please discuss.

Deliberation in the meeting

OPTCL representative informed that there was a meeting between OPTCL, OPGC & M/s PRDC Ltd., held on 11.06.2010, wherein a number of decisions have been taken for minimizing the various disturbances as mentioned above. OPTCL agreed to revive the bus bar differential

protection available at Budhipadar 220kV S/stn. within three months time and necessary Protection Coordination, installation of new relays, annual relay testing / maintenances etc. would be carried out jointly with OPGC.

f. EVACUATION CONSTRAINTS AT BUDHIPADAR COMMAND AREA AND PROVISION OF ISLANDING SCHEME WITH MATCHING RADIAL LOAD FOR IB TPS UNITS

OPGC/ OPTCL may please opine.

Deliberation in the meeting

OPTCL representative informed that the issue was considered in the Operation Co-Ordination meeting of Orissa utility systems. The recommendations of power system study for low hydro as well as high hydro condition by M/s PRDC Ltd. has been agreed for implementation. OPTCL will install islanding relay at Budhipadar end and provide carrier communication command for unloading of IB TPS generators shortly.

PART - E

ITEM NO. 1 ADDITIONAL AGENDA

ERLDC circulated additional agenda items during the meeting in respect of :

i) System Protection Scheme for Eastern Regional Grid
ii) Non- availability of SOE data

In order to ensure secured grid operation keeping in view of Available Transfer Capability (ATC) as well as requirement of (n-1) compliance, SPS for flow gate :: (a) Winter & (b) Monsoon season, ERLDC suggested that (a) rapid backing down of generation of one unit each at Farakka STPS, NTPC and Sagardighi TPS , WBPDCL may be planned along with circuit tripping (b) inter-tripping of one or more unit of Teesta-V HPS along with tripping of any circuit of 400kV Purnea –Muzaffarpur line.

ii) ERLDC intimated that SOE is not being received from a number of sub-stations in Eastern Region. A comprehensive list is enclosed. In the absence of SOE proper analysis of trippings / disturbance becomes extremely difficult.
The Protection sub-Committee agreed to the above proposals.

ITEM NO. 2 DATE AND VENUE OF THE NEXT (8th) PROTECTION COMMITTE MEETING

The next (8th) meeting will be held tentatively end of November, 2010.

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Annexure - A

FORMAT FOR REPORTING SYSTEM DISTURBANCES
(Detailed Report by the Constituents)

OCCURRENCE REPORT

(1) Date & Time of Occurrence :

(2) Name of the Sub Station / Generating Station :

(3) Details of Occurrence :

At the time of occurrence the disposition of the feeders was as below

Bus A	**Bus B**

BUS COUPLER BREAKER STATUS (WHETHER "ON" / "OFF")

For one and half breaker scheme

	Feeder I	**Feeder II**	**Tie-breaker (On/Off)**
Diameter 1			
Diameter 2			
Diameter 3			

(4) Sequence of Trippings :

Event Time (hh mm ss)

(5) Relay Indication for Faulted Line/Transformer/Bus :

(A)		Relay Indication	Relay Indication
Sl. No.	Name of Bay / Line	Local End Relay type / Make And Indications	Remote End Relay type / Make And Indications
1.			
2.			
3.			
4.			

(6) Location and nature of Fault :

(7) PLCC counter readings :

	Local end		Remote end	
	Before	After	Before	After
CH I				
CH II				

(8) Analysis :

(9) Restoration :

Sl.No.		From	To	Duration

Remedial Measures / Lesson Learnt

Enclosure ::-

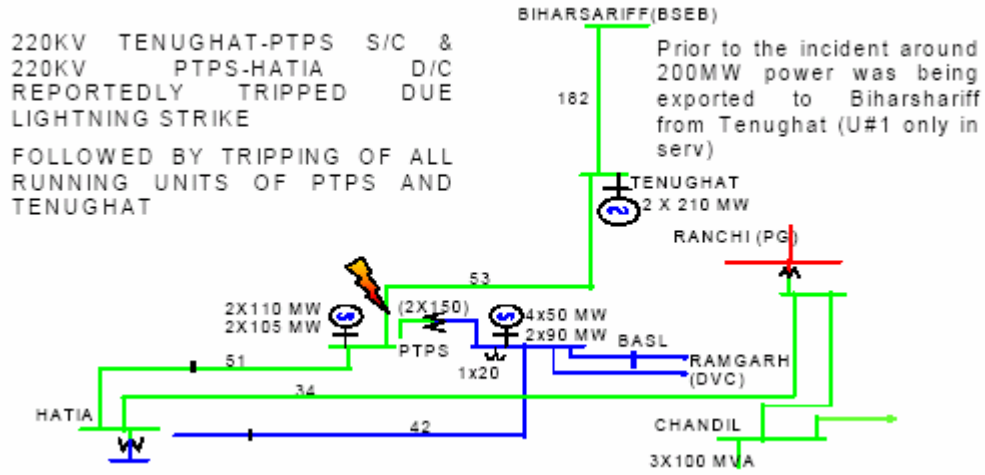
1) **Schematic Diagram showing position of (ON/OFF) breakers, Isolators and Relay Indications.**
2) **DR Charts.**
3) **Event Logger outputs.**

ANNEXURE-C

ANALYSIS & DISCUSSION ON VARIOUS GRID INCIDENCES WHICH OCCURRED IN CTU / STU SYSTEMS (INCLUDING CESC SYSTEM DISTURBANCE ON 01.07.2010)

1. Total loss of generation in JSEB system on 18.12.09; 16:30 Hrs

At 16:30 Hrs of 18/12/09, 220 kV Tenughat-PTPS, 220 kV PTPS-Hatia D/C tripped due to lightning strike on 220 kV Tenughat-PTPS line. Tripping of 132 kV lines from PTPS/Hatia/Chandil was also reported. All running units at PTPS (Unit#1,4,7) tripped due to loss of evacuation path and Tenughat (Unit#1) also tripped leading to entire loss of generation in JSEB system.



The incident was discussed in the 46th OCC meeting held on 12.01.10. However, sequence of cascaded line tripping could not be established. Representative from TVNL informed that 220 kV Tenughat-Patratu tripped from Tenughat end with zone-3 relay indication and unit# 1 was out due to electrical jerk experienced by unit auxiliary system. He pointed out that Tenughat units were out many a time due to fault external to TVNL system.

Tenughat TPS was requested to furnish relay indication of all such incidences to ERPC Secretariat and the matter was also considered to be referred to Protection sub-Committee.

The following points need to be explained:

Tenughat TPS

- How Distance Protection relay sensed fault beyond Patratu TPS from Tenughat end ?
- How the fault was cleared from Patratu end or beyond ?
- Whether the distance protection relay mal-operated ?
- Whether the fault was hanging till Zone-3 time ?
- In case location of fault is between Patratu and Tenughat, the main / back-up relay at PTPS should have also operated. Time coordination with TVNL end relays need to be checked.

Patratu TPS

- Tripping details of 132kV elements / 220/132kV ICT from PTPS need to be furnished.
- Whether tripping of unit auxiliary is due to dip in bus voltage?

JSEB agreed to submit the above information after examination at their end.

2. Disturbance in DVC system on 07/05/10 at 10:44 Hrs

Due to wrong isolator operation of Generator transformer of CTPS#7, the unit started operating on motoring mode which caused severe voltage dip at adjoining stations and led to tripping of Bokaro'B'# 2 & 3 and CTPS#1,2 & 3. All 220KV lines connected to Bokaro'B' and CTPS also tripped. DVC suffered approximately 590 MW generation loss along with equivalent amount of load loss.
All lines restored by 12:25 hrs. CTPS units restored by 17:15 Hrs .Bokaro'B'#2 suffered tube leakage and unit#3 restored at 16:53 Hrs.

A report on the incident has been received from DVC. However, following additional information is required for further analysis:

DVC

- Disturbance recorder and event logger prints from Bokaro'B' and CTPS (old)
- Sequence of tripping of lines and units
- Schematic diagram of the connectivity of lines and U#7 at CTPS-B 220kV buses just prior to the disturbance
- Zone in which the DPR at BTPS for 220kV BTPS-CTPS(old) line sensed fault
- Reason for tripping of CTPS (old) units on overflux protection
- Tripping of 220kV BTPS'B'-Jamshedpur L214 from Jamshedpur end in Zone-I distance protection appears to be a case of over-reaching
- Whether 220kV BTPS'B'-CTPS-B line tripped from BTPS'B' end
- Reason for tripping of 220kV BTPS'B'-Ramgarh 220kV lines.

DVC informed that investigation was in progress. The report will be submitted later on.

3. Disturbance in DVC system on 14/05/10 at 14:40,17:22 and 17:45 Hrs

At 14:40 Hrs of 14/05/10, Bokaro'B'unit-I,II & III tripped due to tripping of 220 KV CTPS- Bokaro'B' D/C , Jamshedpur-Jindal 220 KV S/C and132 KV CTPS- BTPS D/C resuting in isolation of Bokaro'B'' station and subsequent tripping of all units. It was reported that weather was stormy and rainy. Essential power restored within one hour. Units restored on next day i.e 15/05/10.
On the same day again at 17:22 Hrs , all running units of Mejia(I-V) tripped due to fire in 35 MVA Transformer no-2 resulting in Bus fault in 220 KV Main bus –I of Mejia power station which also resulted in tripping of number of lines. Lines restored by 19:26 Hrs. All units except unit #5 restored on 15/05/10.
Again at 17:10 hrs Waria#3 was manually tripped due to tripping of station service transformer when 33 KV lines tripped resulting in loss of auxiliary service. At 17:45

Hrs Waria#4 also tripped due to ATR#2 Differential protection operation due to ingress of water at 6.6 KV tertiary duct and aux. supply was lost. Waria#3 synchronised at 19:20 Hrs and unit#4 at 00:40 Hrs of 15/05/10.
Thus DVC lost 10 units within a span of 3 hrs and total generation came down to 250 MW from around 1700 MW.
DVC has already submitted a report on the incident, copy of which is enclosed.

The following points need further clarification:

DVC

- Location of fault and faulty element(s) need to be identified
- The reason of tripping of lines connected to Bus II, Bus III and Bus IV at MTPS needs investigation
- The reasons for non operation of back up protection of generators also need to be looked into.
- DVC may also furnish details such as EL/DR and other recorder prints for further analysis.

DVC explained the incident in detail.

4. Collapse of NER,BHUTAN and North Bengal system on 15/05/10 at 12:13 Hrs

Network condition:
At Purnea 400kV, only the following elements were in service:
400kV Purnea-Binaguri-I
400kV Purnea – Binaguri –IV
400kV Purnea-Muzaffarpur-II
400/220 kV ICT –I
400/220 kV ICT –II
63 MVAR B/ Reactor (connected to Bus-1 via tie CB)

The following elements were not available due to various reasons as stated below:

400kV Malda – Purnea-I : due to tower collapse
400kV Malda-Purnea –II : was under shutdown
400kV Binaguri- Purnea – II : due to tower collapse
400kV Binaguri-Purnea – III : kept open to control overvoltage
400kV Purnea – Muzaffrapur-I : kept open to control overvoltage
Due to the above outages, 400kV Bus-1 and Bus-2 were coupled only through the tie CB of Binaguri-I and ICT-II diameter, as may be understood by referring to the enclosed switching diagram of Purnea.

Further, 220kV Purnea – Dalkhola D/C was under breakdown

Description of the occurrence

At 11:54 Hrs, 400/220kV ICT-II at Purnea tripped on overflux relay operation. This led to isolation of 400kV Bus-1 and Bus-2 at Purnea and consequently, power flow through 400kV Binaguri-Purnea I & IV, which were connected to 400kV Bus-I, reduced to nil. Prior to such isolation, more than 400MW was flowing through these

two circuits from Binaguri to Purnea. This power thus got diverted through the 2X315MVA 400/220kV ICTs at Binaguri , resulting in sudden jump in each of their flow from 60MW to more than 300MW.
220kV Binaguri to Siliguri D/C flow increased from about -5MW / ckt to around 235MW / ckt
220kV Siliguri to Dalkhola D/C flow reversed from -50 MW to around 200MW per circuit.

At around 12:13 Hrs, the following elements tripped:

220kV Binaguri- Siliguri – I, on snapping of R-phase jumper due to high loading
220kV Siliguri – Dalkhola – I & II , almost simultaneously

With the tripping of 220kV Siliguri – Dalkhola D/C, Siliguri, Binaguri, Birpara, along with Bhutan and NER got isolated from NEW grid. Power exchange with NER reversed and shot up to 300MW export (towards NER). The frequency of the isolated system touched 51.34 Hz and was controlled by drastic reduction of generation by Teesta-V as well as action taken by NER. However, power supply to BSEB at Purnea continued to be maintained from Muzaffarpur, through 400kV Muzaffarpur-Purnea-II and 400/220kV ICT-1 at Purnea, connected to 400kV Bus-II.

At 12:44 Hrs, ICT-II at Purnea was taken into service by closing its main CB and it was understood that an attempt was made by Purnea to close the tie CB also. This resulted in synchronization of 400kV Bus-I of Purnea, energised at NER frequency (50.82 Hz) with 400kV Bus-II energized at the common frequency of ER, NR and WR (49.63 Hz). Such action caused heavy power swing through 400kV Purnea-Binaguri I and IV and collapse of NER, Bhutan, Teesta and N. Bengal sub-system.

It may also be appreciated that with growing complexity of the system and the present depleted condition of the network in and around North Bengal area, any switching action need be coordinated with utmost care and in consultation with the concerned RLDC. Further, any tripping details must be informed to RLDCs without any delay for an appropriate analysis so as to avoid any recurrence of such incident and take proper contingency measure from system operation point of view.

Powergrid agreed to Furnish relay indication, DR/EL print out and other relevant details.

5. Disturbance in DVC system on 20/05/10 at 01:40 Hrs

At 01:40 hrs of 20/05/10, due to delayed operation of relay in 220KV Mejia-Kalyaneswari S/C at Kalyaneswari end for a line fault, all running units of Mejia (unit1-5) tripped due to low voltage. Also, all 220 KV lines connected to Mejia and 132 KV Waria-Chandrapura section tripped resulting in splitting of DVC system into two parts. Subsequently 220 KV Joda-Jindal-Jamshedpur S/C tripped at 01:41 Hrs resulting in tripping of all running units of Bokaro'B'(unit#1&3) and CTPS(unit#1-3). Lines were restored by 05:00 Hrs and units started getting synchronized subsequently.

From the above it appears that delayed tripping of 220KV Mejia-Kalyaneswari S/C at Kalyaneswari end and Subsequent 220 KV tripping of Joda-JSPL-Jamshedpur S/C resulted in near total collapse of DVC system. While a report on the incident has already been prepared by ERLDC (copy enclosed).

DVC

- Explain the incident alongwith relay indication, DR/EL print out.
- The reasons for tripping of auxiliaries and voltage dips / low voltage
- Under-voltage and time delay settings of the contactors of auxiliary motors also need to be checked.

DVC explained the incident in detail.

6. Disturbance in OPTCL system on 27/05/10 at 18:29 Hrs

Prior to the incident 220kV TTPS-Meramundali-II was under shutdown. At 18:29 Hrs 220 KV TTPS –TSTPP S/C tripped on distance protection from TTPS end, 132 KV TTPS-Kamakhyanagar-Duburi ckt tripped from both end on distance protection (due to falling of tree on line) and 132kV TTPS-Jabamayee-Duburi ckt tripped from Jabamayee end on E/F. At 18:57 Hrs, 400 KV Meramundali-Mendhasal S/C tripped from both ends on distance protection, 400/220kV 315 MVA ICT-I tripped on 220kV side E/F and 220/132kV 100MVA ICT 1 & 2 at Meramundali tripped on both sides on DEF protection. 220 KV Meramundali-Bhanjanagar D/C was handtripped due to overloading of 220kV Meramundali-TTPS ckt 1 (ckt 2 was under shutdown). 220kV Meramundali-Bidanasi tripped at Meramundali on E/F. 220 kV TTPS – Joda D/C tripped on overvoltage while 132kV TTPS-Chainpal ckt-1 tripped on E/F and ckt-2 on overvoltage. This resulted in isolation and subsequent tripping of all units of TTPS(#1-6). Weather reported to be stormy. All lines and transformer restored by 21:30 Hrs except 132 KV Kamakhyanagar-OPCL S/C which was out due to falling of tree. TTPS#4 restored at 22:40 Hrs. Other units restored on 28/05/10 except unit#3. The report furnished by OPTCL is enclosed.

OPTCL

- Explain the incident along with relay flags obtained and DR /EL print out.
- Furnish the reason for overvoltage trippings and trip set for overvoltage ?
- In case of fault in 132kV OPCL- K. Nagar section only the relays of this section should trip. Therefore, the tripping from Jabamayee, Duburi etc. appear to be due to maloperation of relays. Reach and time coordination of these relays need to be checked.

Deliberation in the meeting

OPTCL informed that the reason for over voltage at TTPS was due to load thrown of at TTPS bus. The over voltage setting of 220kV TTPS- Joda ckts (at TTPS end only) is 121V(110%), 3 seconds 132V(120%), 5 seconds. Relay indications are indicated on the single line diagram.

OPTCL informed that coordination of all relays at local and remote ends of Meramundali is being checked. The concerned field units of OPTCL have

already been intimated for checking the relay co-ordination of different feeders at TTPS command area.

7. Disturbance in JSEB system on 30/05/10 at 14:32 Hrs

Due to heavy storm and rain, all lines and ICT connected to 220 KV Hatia S/stn tripped. During that time, 132 KV PTPS-Hatia D/C were under shut down. This caused PTPS and TVNL to remain synchronised with rest of the grid through 220 KV Tenughat-Biharshariff S/C, which subsequently tripped at 14:45 Hrs leading to total outage of PTPS and TVNL power station. Lines restored by 15:40 Hrs and unit synchronised subsequently.

JSEB

- Elaborate the incident with relay details and other supporting documents.
- Whether the 220/132kV ICTs at PTPS tripped ?
- The total generation of PTPS and Tenughat is frequently affected whenever one or more of the evacuation routes is lost, JSEB may consider formulating an appropriate SPS to avoid total loss of generation from these stations.

8. Disturbance in JSEB system on 05/06/10 at 08:25 Hrs

At 08:25 Hrs 220 KV PTPS-Hatia-D/C, PTPS-Tenughat S/C and 220/132 KV , 150 MVA ICT-I of PTPS tripped. Also 220 /132 KV ICT-I&II of Hatia tripped. Running unit of PTPS(#1 & 7, gen-110 MW) tripped and load of Ranchi (170 MW) disrupted All lines and ICT restored by 09:15 Hrs. PTPS#1 synchronised at 09:55 Hrs.

JSEB

- The reason of tripping along with relay indication along with sequence of events and other details.

JSEB agreed to submit the above information (7 & 8) after examination at their end.

9. Disturbance in OPTCL system on 05/06/10 at 16:22 Hrs

Due to failure of Y-phase LA of 220 KV U.Kolab-Jaynagar-II at U.Kolab end all lines connected to Jaynagar tripped. 400 KV ICT-II of Jeypore also tripped. Gen loss was around 160 MW. All lines except 220 KV U.Kolab-Jaynagar-II, 220 KV Jaynagar-Balimela-I (was under outage) &220 KV Jaynagar-Balimela-III restored by 18:06 Hrs.

OPTCL

- Due to mal operation / non operation of number of relays at Jayanagar and around Jayanagar, relay coordination is required to prevent reoccurrence of such disturbances.
- Explain the incident with relevant diagram and the trippings along with relay indication and other details like DR/ER print out etc.

Deliberation in the meeting

Due to bursting of LA of 220kV Upper Kolab-Jaynagar circuit-II at Upper Kolab HPS the said circuit tripped alongwith 220kV Balimela_Jaynagar Ckt-III which was group controlled with the above circuit. The power flow through 220kV

Balimela-Jaynagar Ckt-I became zero. High voltage experienced at Balimela bus (around 266kV) and Balimela unit no. 5 & 6 tripped & unit 1 & 8 hand tripped. 220KV Upper Kolab-Jaynagar circuit-I hand tripped from Upper Kolab end and 220kV Upper Kolab- Theruvali tripped on E/F relay at Theruvali end.

OPTCL informed that it has taken necessary action for relay coordination of Jaynagar command area in co-ordination with Jaynagar PG as decided in its 2nd Protection Co-ordination meeting to prevent mal-operation in future.

10. CESC system disturbance on 01/07/10

(i) **Date & Time of Incidence**: 01st July, 2010, 18:09Hrs.

(ii) **Location of Disturbance**: Near 132kV Chakmir S/S in CESC system

(iii) **Initiating cause**: Non-operation of protection at Chakmir end for fault in 132kV Budge-Budge – Chakmir ckt-III

(iv) **Weather Condition**: Normal

(v) **Antecedent condition**:

a) System Frequency: 49.94 Hz
b) CESC generation: 1190MW
c) CESC Demand: 1506MW

(vi) Description and cause of Events:

Prior to the incident, CESC was synchronized with ER through three number 132kV circuits from Kasba(WBSETCL)-Kasba Rec. Stn(CESC). . At other points CESC was drawing power radially. At 18:09 Hrs, there was a fault in 132kV BBGS-Chakmir-III, which could not be cleared from Chakmir end. The fault continued to be fed by BBGS-Chakmir other three 132kV circuits, resulting in tripping of all the 132kV circuits from BBGS end. This caused the major part of CESC, (except loads met radially at Titagarh, Howrah, Liluah and Kasba) to get desynchronized from the grid and gradually collapse on low frequency , as the total generation (from Titagarh, Southern and N. Cossipore stations) was less than the connected load. With the loss of 132kV evacuation path, the entire generation of BBGS got diverted through 220kV BBGS-EMBypass D/C line and ultimately into WBSETCL system through the 132kV Kasba(WB)-Kasba(CESC) T/C tie. All the three circuits of 132kV Kasba(WB)-Kasba(CESC) T/C tie tripped on overcurrent, while the units of BBGS got islanded and survived with Princep St., East Calcutta and Jadavpur loads which were being supplied radially from Kasba(CESC). Due to availability of surplus generation, frequency of the island consisting of BBGS rose to 51 Hz, and U#3 had to be withdrawn.

CESC generation came down from 1190MW to 300MW while the demand met reduced from 1506 to 450 MW

The following points require clarification / elaboration:

- Reason for non-clearance of the fault from Taratala and Majerhat S/stns. in Zone-II / Zone-III protection
- Islands formed and sequence in which they collapsed
- Reason behind Titagarh drawal coming down to NIL, as observed by ERLDC SCADA
- Under frequency and under voltage trip setting for all generators

- UFLS scheme in CESC and load relief actually obtained through UFR operation
- Scheme for islanding of generators on house load and protection for auxiliaries.

Deliberation in the meeting

CESC submitted the detailed report of the incidents giving power flow scenario just prior to the fault. The DR printouts for Chakmir, Majerhat sub-stations are also furnished. There was high resistive single line to ground fault occurred on R-phase of 132kV Budge-Budge-Chakmir line-III at 18.09 .13.150 Hrs but did not clear from Chakmir end as the incoming fuse for the D/C bus were blown off at the time of disturbance and "Communication Failure Signal" came at Budge Budge station.

During elaboration of the incidents CESC representative gave the sequence of events as detailed below:

i. Line 3 tripped through line differential relay at BBGS end.

ii. DC supply to 132kV relay panel at Chakmir failed at the same instant hence, no tripping at Chakmir.

iii. BBGS –Chakmir line -4 tripped through Dist relay zone 2- (0.3 sec.)
Line 1 & 2 tripped through Dist relay zone 3 –(0.5 sec.)

iv. Relay operations occurred at BBGS end only.- (0.55 sec.)
No operation at Chakmir end due to DC supply failure.

v. Fault current reduced from 4KA to OKA in 0.5 sec.
Fault clearing bus- (1.2 sec.)

vi. SRS U#2 tripped at 1.3 sec- Pole slip relay operated
Load on GT 2 – 2974 Amp
Av CT bus voltage -10kV in 33kV bus (Full load 1476 Amp)

vii. SRS U # 1 tripped at 2.7 sec overcurrent

viii. TRS U # 1 tripped at 19.5 sec at Freq. 47.2 Hz.

ix. TRS U# 2 -4 units (Approx) normal frequency at the time of trip – 40 Hz. Other units- 5 units thereafter.

Corrective actions taken by CESC:

- *D/C supply fuse at Chakmir S/Stn. has been replaced.*
- *Tripping scheme for East Kolkata- Princep Street GIS circuit have been commissioned to isolate the Northern & Southern part in case of disturbance at the Southern Part.*
- *Under Frequency Tripping Schemes are being reviewed.*

The investigation committee constituted by Member Secretary, ERPC will examine the incident and suggest remedial measures thereof.

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Annexure -I

List of Participants in the 7th Protection sub-committee meeting of Eastern Region held on 12.08.2010 (Thursday) at ERPC, Kolkata

Organisation	Name	Designation	Contact Number
BSEB	Shri S.K.SENGUPTA	EEE	
JSEB	Shri S.AHMED	ESE (Trans)	9430730503
DVC	Shri P.K.DUTTA	Act. CE(CTC)	9431133846
OHPC	Shri H.P.MAHAPATRA	Manager	9861164943
OPTCL	Shri P.K.BEHURA	Sr. GM (PS) /SLDC	9437041885
	Shri S.K.DAS	DGM /SLDC	9437000261
WBSEDCL	Shri P.P.BISWAS	ADDL. CE/ ALDC	9433394968
WBSETCL	Shri S.NAG	CE /SLDC	9831093513
	Shri S.K.DEY	CE (IT/C/Testing)	9830255465
	Shri A.BISWAS	Addl. CE/SLDC	9239292572
	Shri K.BHATTACHARJEE	SE (Testing)	9830306504
CESC	Shri A.GHOSAL	Dy. Chief Engineer	9831054664
	Shri M.BASU	Sr. Manager (Testing)	
NHPC/RANGIT	Shri A.KUMAR	AM (Elec.)	9800869065
SIKKIM	Shri S.SARBADHYAKSHA	JE	9434318168
POWERLINKS	Shri C.B.SAMANTA	GM(OP)	9434052978
AEBERLE	Shri P.MODI	VP	9819301301
NTPC	Shri H.PANDA	AGM (OS), ER-I	9831800976
	Shri S.C.DAS	DM	9434038940
	Shri S.NAG	DGM (O & M) , FSTPS	9434039376
	Shri R.V.PATNAIK	Sr. Mgr (OS), ER-II	9438233243
	Shri R.P.SINGH	Sr. Mgr (OS), ER-I	
	Shri S.K. SUAR	DGM (E)/ TSTPS	9437042781
POWERGRID	Shri K.NIKHIL	Dy. Manager	9431820218
	Shri S.J.LAHIRI	CM (OS & IT)	9434742016
	Shri S.K.SINGH	CM (OS)	9434740009
ERLDC	Shri P.PENTAYYA	GM	9432669226
	Shri D.K.SRIVASTAVA	AGM	9433041802
	Shri P.MUKHOPADHYAY	DGM	9433041810
	Shri G.MITRA	DGM	943304181
	Shri S.BANERJEE	CM	9433041823
	Shri P.S.DAS	Ch. Manager	9433041837
	Shri M.K.THAKUR	Sr. Engineer	9432351832
ERPC	Shri A.K.RAMPAL	Member Secretary-in-Chair	9432012412
	Shri A.K.BANDYOPADHYAY	SE (O)	9433068533
	Shri J. BANDYOPADHYAY	SE (C)	9432326351
	Shri B.SARKHEL	SE (PS)	9433065724
	Shri G.GHOSH	EE	
	Shri S.P.DATTA	DGM (NTPC)	9433067022
	Shri S.M.JHA	EE	
	Shri P.N.SARKAR	AEE	
	Shri S.PAUL	AEE	
	Shri S.KEJRIWAL	AEE	

ANNEXURE-D

STATUS OF STAGEWISE UNDER FREQUENCY RELAYS (UFRs) INSTALLED AT DIFFERENT SUB-STATIONS / FEEDERWISE / EXPECTED LOAD RELIEF (MW) OF THE ER CONSTITUENTS

Stages	Sl. No.	Name of EHT Sub-stations	Connected 33kV Feeders	Load in MW
BSEB				
I 48.5Hz Frequency	1.	Gaighat	Meena Bazar	15 MW
	2.	Fatuah	Katra	15 MW
			Meena Bazar	22 MW
	3.	Mithapur	PESU-V	18 MW
			Total	70 MW
II 48.2Hz Frequency	1.	Gaighat	City	20 MW
	2.	Mithapur	PESU-I & II	22 MW
			Total	42 MW
III 48.0Hz Frequency		NIL	NIL	NIL
JSEB				
I 48.5Hz Frequency	1.	132 / 33 kV Hatia	Argora	09 MW
	2.	132 / 33 kV Adityapur	Adityapur -I	17 MW
II 48.2Hz Frequency	3.	132 / 33 kV Adityapur	Adityapur-II	13 MW
III 48.0Hz Frequency	4.	132 / 33 kV Hatia	Brambey	11MW
	5.	132 / 33 kV Namkum	Kokar (R)	17 MW
DVC A.				
I 48.5Hz Frequency	1.	Belmuri	WBSEB Belmuri	22.5MW
	2.	Putki	JSEB Godhor f1 (14) + Bhuli f2 (5.1)	17.2MW
			JSEB Ganeshpur (f1) (12)	10.8MW
II 48.2Hz Frequency	3.	Putki	BCCL Bastacola (12.5) BCCL Bhalgora (13.5) BCCL Katras (7.2) + JSEB Katras (10) + JSEB Katras Sijua (2.5)	41.1MW
	4.	Ramgarh	CCL Giddi (16)	14.4MW
			CCL Sirka (6)	5.4MW
III 48.0Hz Frequency	5.	Kumardhubi	DPSCO Dishergarh	28.8MW
			JSEB Mugma	15.3MW
	6.	Kalipahari	WBSEB Kanyapur 929) + ECL Satgram (Fdr 2) (5)	30.6MW
			DPSCO Sheebpur	34.2MW
			DPSCO J.K.Nagar	18.0MW

DVC

B. UFR setting for Emergent Condition of the system

47.6 Hz	1		DPSCO Luchipur	33.8MW
	2	Koderma	JSEB Koderma	27.0MW
			Balajee Electrosteel Ltd.	11.0MW
	3	Giridih	JSEB Giridih	27.0MW
			CCL Giridih	3.4MW
	4	Ramgarh	JSEB Ramgarh (One Fdr)	31.5MW
	5	Burdwan	WBSEB Burdwan	43.2MW
	6	Patherdih	JSEB Gobindpur (19)+ JSEB Mukunda (4) + BCCL Koilanagar (4.7)	24.9MW
	7	Patherdih	Patherdih Rail (14)	11.7MW

WBSETCL

I 48.5Hz Frequency	1.	Liluah 132kV S/ stn.	Liluah, Kona, Baltikuri I & II, Jangalpur, Makardah	63 MW
	2.	Falta 132kV S/stn.	FEPZ IV	08 MW
	3.	NJP 220 /132kV S/stn.	Group Control Transformer for 11kV Feeder & Rabindranagar 33kV Feeder	10 MW
II 48.2Hz Frequency	4.	Siliguri 132 S/Stn.	Deshbandhupar A, Rabindranagar, Siliguri I & II Housing Board	60MW
	5.	Darjeeling 132kV S/Stn.	LKEBONG Happy Valley & Ghoom	35MW
III 48.0Hz Frequency	6.	Salt Lake 132kV S/Stn.	M1-I, M2-I & II,M3-I &II,M5-I & II	83 MW
	7.	NBU 132kV S/Stn.	UJANU,TCF,KHANTAI, PANSIDEWA TEESTA 11 kV, Bagdogra-11kV	23 MW
IV 47.6Hz Frequency	8.	Jeerat 400kV S/Stn.	132kV Barasat I & II, 132kV Ashoknagar I & II,220 kV Kasba I , II & III & Lakshimikantapur	540 MW
	9.	Durgapur 220kV S/Stn.	132kV Bolpur Feeder, 132kV Sainthia Feeder, 132kV Bishnupur I & II Feeder	160 MW
	10.	BTPS	132kV Adisaptagram Ckt. I & II	60 MW

CESC

				Summer	Winter
I 48.5Hz Frequency	1.	Majerhat S/stn. (Gp-1)	33kV Barisha T3 33kV Thakurpukur T1 33kV F. Chakmir S/s-I / Behala T-1	6MW 13MW 4.5MW	5MW 7.5 MW 2MW
		Jadavpore S/ Stn. (Gp-1)	33kV F. Tollygunge D/S T-1 Ballygunge East D/S T-1 (6kV T-1) Fore Shore Rd D/S (4 nos. 6 Fdrs) Princep St D/S (5 nos. . 6 Fdrs)	13MW 9MW 17.2MW 12.8MW	6MW 6MW 9.8MW 10MW
	2.	Majerhat S/stn. (Gp-2)	33kV F.Thakurpukur T-2 /Behala(N) T-1 33kV F. Barisha T-2 / SRS-3/Elgin T-1	26 MW 21MW	14MW 8.5MW
		Jadavpore S/ Stn. (Gp-2)	33kV F. Tollygunge D/S T-1/South City T-1 Shalimar D/S (5 nos. 6kV Fdrs)	26MW 7.3MW	14MW 6.1MW

II 48.2 Hz Frequency	**3.**	**Ritchie D/S Canal D/S Chakmir S/ Stn. Jadavpur S/Stn.**	**6 nos. 6kV Fdrs 6 nos. 6kV Fdrs All 33kV Fdrs & 55 MVA T-1 33kV F.Jadavpur T3, Jadavpur T1**	**10.3MW 17.6MW 45MW 23MW**	**7.9MW 8.6MW 29MW 12MW**
III 48.0 Hz Frequency		**BRS (Liluah S/Stn.)**	**Import 1,2 & 3**	**110MW**	**80MW**
OPTCL	**A**				
I 48.5Hz Frequency (Instant)	**1.**	**Bolangir**	**33kV Dumerbhal 33kV Dunguripali 33kV Patnagarh**	**003 MW 010 MW 006 MW**	
	2.	**Bargarh**	**33kV Dunguri**	**010 MW**	
	3.	**Jaipur Road**	**33kV Anandpur**	**010 MW**	
	4.	**Bhadrak**	**33kV Dhamnagar 33kV Gopinathpur**	**012 MW 011 MW**	
	5.	**Bhanjanagar**	**33kV Khatribarpur 33kV Belaguntha 33kV Surada**	**004 MW 004 MW 007 MW**	
II 48.2Hz Frequency (Instant)	**6.**	**Aska**	**33kV Buguda 33kV Nuagaon**	**006 MW 006 MW**	
		Berhampur	**33 kV Chikiti**	**007 MW**	
		Cuttack	**33 kV Balikuda**	**008 MW**	
		Balasore	**33 kV Nilagiri**	**010 MW**	
		Theruvali	**33 Kv Bisam Cuttack**	**005 MW**	
		Sambalpur	**33 kV Rengali 33kV Putibandh**	**006 MW 014 MW**	
		Rourkela	**33kV Lathikata**	**015 MW**	
III 48.0Hz Frequency		**Chandaka**	**132kV Nimapada**	**025 MW**	
		Duburi	**132kV Duburi- Bhadr- Jajpur (Town)**	**080 MW**	

Proposed UFR scheme by connecting double the quantum of load as per the set frequency

Stages	Name of S/ Stn.	Name of Feeder	Load in MW (Peak)
Stage-I	**Bolangir**	**Dumerbahal**	**3**
48.5 Hz		**Dunguripalli**	10
0.3 Sec		**Patnagarh**	6
	Bargarh	**Dunguri**	8
		Trurunga	**14**
	Jajpur Road	**Kuakhia**	**6**
		Panikoili	**5**
		Anandaur	**11**
	Bhadrak	**Dhamnagar**	**9**
		Chandbali	**10**
		Asurali	**5**
	Bhanjanagar	**Kshertribarpur**	**6**
		Belaguntha	**6**
		Surada	**7**
	Rourkela	**Lathijkata**	**6**
		Birmitrapur	**6**
	Balugaon	**Khalikote**	**9**
		Tangi	**10**
	Khurda	**Bologarh**	**8**
		Banki	**9**
		Total	**154**

Stage-II	**Aska**	**Buguda**	**5**
48.2 Hz		**Nuagaon**	**6**
Inst.		**Budhamba**	**13**
	Berhampur	**Chikiti**	**4**
		Aska	**6**
	Cuttack	**Balikuda**	**7**
		Jagatsingpur	**13**
	Balasore	**Nilagiri**	**7**
		Srijung	**5**
	Theruvali	**Bisam Cuttack**	**5**
	Sambalpur	**Rengali**	**7**
		Putibandh	**10**
		Ainthapali	**10**
	Dhenkanal	**Gondia**	**8**
		Hindol Road	**9**
	Boinda	**Jharpada**	**9**
	Chainlpal	**Talcher**	**7**
		Banarpal	**8**
		Parjung	**5**
		Rengali	**7**
		Total	**151**

Sl. No.	**Name of S/ Stn.**	**Name of Feeder**	**Load in MW (Peak)**
Stage-III	**Cuttack**	**Jagatsingpur**	**33**
48.0 Hz	**Kendrapara**	**Pattamundei**	**23**
Inst.	**Dhenkanal**	**Nuapatna**	**31**
	Bhanjanagar	**Phulabani**	**17**
	Chatrapur	**Balugaon**	**60**
	Bolngir	**Patnagarh**	**25**
		Total	**189**

ANNEXURE-E

CAPACITORS DETAILS

CESC

List of 6/11kV Capacitor Bank

STATION	CAPACITY (MVAR)	STATION	CAPACITY (MVAR)
Alipur	3	Kamarhati	4
Amherst Street	4.5	Kankurgachi	4.8
Auckland	3	Kasba	4.482(11kV)
Akra	4	Kuthighat	4
Baranagar	4.84	Kidderpore	4.5
Bhatpara	4	Liloah	4
Bally	3	Majerjat	3
Barisha	4.5	Maheshtala	4
Barrackpore	6	New Ballygunge East	4
BBD Bag	4	Princep Street	4
Belur	3	Patuli	4(11kV)
Budge Budge	1.5	Rabindra Sadan	4
Budge Budge South	4.8	Rashbehari	4(11kV)
Canal	4.5	Ritchie	4.8
Central Avenue	4	Srerampur	4
Dhakuria	3	Science City	4.8(11kV)
Dum Dum	4.5	Shalimar	3(2x1.5)
Entally D/S	1+3	Sinthia	4.5
Foreshore	3	Southern (Voltas)	6
Fort Gloster	1.59	Southern (Voltas)	4.5
Gourhati	4	South City	4.8
Grey Street	3.6	Strand South	4.842
Howrah Central	3	Strand North	6
Howrah South	4.842	Talpukur	4
Howrah West	4.5	Taratala	4
Jessore West	3	Tollygunge	4.8 (11kV)
Jadavpur	4	**Total**	**215.656**
Jadavpur	4.8(11kV)		

List of 132kV Capacitor Bank

STATION	CAPACITY (MVAR)
Taratala	50
East Calcutta	50
Chakmir	50
Total	**150**

List of 33kV Capacitor Bank

STATION	CAPACITY (MVAR)	STATION	CAPACITY (MVAR)
BBD Bag	15	NCGS	2x10
KRS 33 KV ODY	30	SRS	2x15
KRS M1 SECTION	30	MAJ	2x15
KRS M3 SECTION	30	JAD M1 SECTION	2x15
MSS	20	JAD M2 SECTION	2x10
BRS	15	**Total**	**315**
PRS	30		
PLN	15		

Planned Installation of Capacitor Banks in 2010-11

STATION	CAPACITY (MVAR)	LEVEL
EMSS	50	132kV
Botanical Gardens S/s	30	33kV
6 and 11 KV Distribution Stations	15-20	6/11 kV

Connected Total MVAR = 680.656

BSEB

Capacitor Bank installation at different Grid sub-station of BSEB

Sl. No.	Name of Grid S / Stn.	No. of Capacitor Bank	Capacity
1	Jakkanpur	I	2x 12000 KVAR
		II	2x 12000 KVAR
		III	2x 12000 KVAR
2.	Fatuah	I	2x 12000 KVAR
		II	2x 12000 KVAR
		III	2x 12000 KVAR
3.	Khagaul	I	2x 12000 KVAR
		II	2x 12000 KVAR
		III	2x 12000 KVAR

WBSEDCL

Present Capacitor			Future Plan of Capacitive Compensation		
Sl. No.	Name of EHV S/Stn.	Exist Comp (MVAR)	Sl. No.	Name of EHV S/Stn.	Exist Comp (MVAR)
1	Adisaptagram	10.0	1	Adisaptagram	10.0
2	Bankura	10.0	2	Arambag	10.0
3	Barasat	10.0	3	Asokenagar	10.0
4	Joka	10.0	4	Balurghat	5.0
5	Berhampur	20.0	5	KLC	10.0
6	Bishnupur	10.0	6	Barasat	20.0
7	Bolpur	20.0	7	Basirhat	10.0
8	Ch. Kona Road	10.0	8	Joka	10.0
9	Debogram	20.0	9	Berhampur	10.0
10	Dharampur	10.0	10	Bongaon	10.0
11	Egra	10.0	11	Chanditala	10.0
12	Falta	20.0	12	Coochbehar	5.0
13	Gangarampur	14.4	13	Dalkhola	10.0
14	Gokarna	10.0	14	Dharampur	10.0
15	Kalyani	10.0	15	Domjur	10.0
16	Katwa	20.0	16	Haldia	5.0
17	Kolaghat	10.0	17	Jangipara	5.0
18	Krishnagar	28.8	18	Khanyan	5.0
19	Liluah	20.0	19	Lakhikantapur	5.0
20	Midnapur	10.0	20	Liluah	10.0
21	Moinaguri	10.0	21	Malda	10.0
22	NBU	10.0	22	Midnapur	5.0
23	Raghunathgunj	10.0	23	New Haldia	5.0
24	Rishra	30.0	24	Pingla	10.0
25	Sainthia	20.0	25	Purulia	10.0
26	Salt Lake	45.0	26	Raigunj	10.0
27	Samsi	10.0	27	Raina	10.0
28	Satgachia	20.0	28	Rampurhat	10.0
29	Titagarh	25.0	29	Ranaghat	10.0
	Total	463.2	30	Siliguri	10.0
			31	Sonarpur	10.0
			32	Tamluk	10.0
			33	Tarakeswar	5.0
			34	Titagarh	10.0
			35	Ukhra	10.0
			36	Uluberia	10.0
				Total	325

ANNEXURE-F

Collapse prediction relay of M/S Eberle' – Features and applications

Features

- Use of only local measurements
- Spectral wavelet-analysis with high frequency resolution in the range 0.01 Hz to 98 Hz. Therefore it captures the entire range of oscillations viz. local, intra-area, inter-area, sub-synchronous and super-synchronous.
- Simultaneous evaluation of the harmonic characteristics and comparison with a reference model (fingerprint)
- Detection of collapse-specific frequency modes (fingerprint analysis)
- Measurement of network damping coefficient. Since it is necessary to measure the frequency intervals with a high accuracy, for all measured frequency components the damping measures can be calculated. This is very useful, since a lot of additional tasks can be done with the network.
- Real-time calculation of Stability exponent (Lyapunov exponent). The Lyapunov exponent can be used as a monitor for the dynamical states of a system. It depends not on waveforms, is independent from the system, whether it is nonlinear or stochastic. If the trajectories of a system represents a stable process, then the sign of the Lyapunov exponent is negative. If the system in unstable, the Lyapunov exponent is positive. This is very similar to the eigen values for linear systems.
- Determination of stability limits from on-line computation of damping characteristics and stability exponent
- Tracking of eigen values and determination of the HoPF bifurcation point
- Detection of gradual network breakdowns
- Frequency relay functions (average value, gradient). Both frequency and df/dt plots can be obtained with a high degree of resolution
- Incorporates fault recorder functions
- Ability to communicate and transfer data to SCADA-systems.

Applications:

The relay can be used for

- Robust real-time monitoring and alarming
- High level visualizations
- Real-time security and contingency analysis
- Multiple levels of monitoring and analysis
- Prediction of voltage collapse and frequency collapse and initiating necessary preventive and corrective control measures by observing damping behaviour, and Stability exponent

Comparison with PMUs

While PMUs record system parameters after the initiation of a disturbance, collapse prediction relays can alert the operator about the present as well as the impending state of the system. Thus action of collapse prediction relays precedes that of PMUs.

Training

On purchase of their product , M/S E'berle' is ready to provide one week foreign training, in which , the total number of participants may be equal to the number of relays procured. Thus if one such relay is planned for each constituent of ER with provision for a few additional relays, to be installed at strategic locations of the region, around 10 participants can attend the training. Since provision already exists for funding the cost of such training from PSDF, it will be beneficial to the constituents of ER to avail themselves of this opportunity.

Annexure-F (contd)

Discussion on the presentation of M/S A. Eberle

After the representative of M/s. A.Eberle gave a detailed presentation on collapse prediction relay (CPSys CPR-D/DMR-D), he had also shown some of the data and plots obtained from the relays installed in REL system in Mumbai. He explained in detail various features of the relay, applications and training.

Since the relay is of most recent technological innovation, the members of the Protection Committee asked several questions and clarifications were given by the representative of M/s. A.Eberle. Thereafter, the members requested GM, ERLDC to summaries the relevance of the collapse prediction relay of M/s. A.Eberle for application in ER grid and the way forward issues on procurement of the relay etc.

GM, ERLDC stated that with growing size and complexity of the grid, stability aspects would become very important. Most of the large power systems in the world have experienced at one time or other collapses due to stability aspects and some of these collapses are characterized by phenomenon such as low frequency oscillations (Small signal stability) voltage collapse (slow and fast) etc. The occurrence of such phenomenon in large grids at present is due to pressures from Market operation and the consequent requirement of grid operators to operate power system close to the limits. At times due to non-availability of certain transmission elements (transmission depletion) and violation of TTC, the grid may operate under stressed condition where the network damping would be very low. This stressed condition if subjected to further overloadings or trippings may lead to stability problems such as voltage collapse or low frequency oscillating. For analysing the stability aspects, frequency domain and time domain methods are usually employed by power system analysts. The frequency domain techniques have an advantage of indicating the degree of stability or margin of stability and the availability or lack of damping and its measures. The frequency domain techniques employ eigen value analysis for determination of the above. The time domain techniques determine the stability or instability, critical clearing time etc but not the degree of stability. Therefore, for power system planners and system operators in pre-despatch stage or just before real time operation, the degree of stability, possible low frequency modes and the degree of damping to each of these modes becomes important so that the operators can prepare operational and contingency plans in time to meet real time contingencies. Some of the new stability techniques like Lyapunov method are based on energy function concept and the sign of Lyapunov exponent determines whether the same system is stable or not stable. The energy function based techniques can be used for fast and 'On line" computation of stability determination. In case of assessment of voltage collapse aspects like determination of nose point and its distance from operating point, can be done effectively by tracking of eigen values and determination of HoPF bifurcation point.

Analysis of frequency spectrum in the frequency range of 0.01 to 98 Hz. through spectral analysis would clearly indicate several modes - local, intra-area, inter-area, sub-synchronous and super-synchronous. The damping of low frequency oscillations was found to be most suitable through load damping as compared to PSS tuning, damping through several controllers associated with HVDC, TCSC and other FACT devices. It was also established that the load damping as a counter measure to damp out the low frequency Oscillations (0.1 to 1.2 Hz.) using local measurements was established and found to be highly preferable. Incidentally, CPSys-CPR-D/DMR-D relay of M/s. A.Eberle provides the following applications in the context of the aforesaid aspects :-

1. All the modes in the range of 0.01 to 98 Hz. with 5mHz accuracy through Therefore spectral analysis of the frequency spectrum along with measurement of degree of damping to each of these modes.
2. Calculation of Lyapunov exponent for stability and stability limits.

3. Tracking of eigen values and determination of HoPF bifurcation point for determining the voltage collapse.
4. Using of Spectral wavelet-analysis instead of DFT algorithm to meet the requirement of non-linear analysis as required by real life power systems.
5. Measurement of Frequency (f) and rate of change of frequency (df/dt) with high degree of resolution.
6. Incorporation of Fault Recorder functions.
7. Ability to communicate with and transfer data to SCADA system.

Further the application of synchrophasor technology using PMUs and application of CPSys-CPR-D/ DMR-D relay of M/s. A.Eberle would complement each other. M/s. A.Eberle relays would alert about the state of the present system and degree of stability, damping etc. to alert the operator about the impending contingencies. The PMUs record system parameters after the initiation of the disturbance and operator can respond to some of these in case the operator response is fast enough w.r.t. the power system phenomenon.

The issues summarised by GM, ERLDC were further discussed by the Protection Committee members and it was decided to procure about 10 Nos. of Relays of M/s. A.Eberle for the entire ER grid, to be deployed at strategic locations along with interfacing of the data to SCADA systems. The availability of frequency & rate of change of frequency with high accuracy from different (10 locations) points of the grid would enable better analysis of grid disturbances and tuning of the AUFLS. The proposal with cost estimate would be putup in the ensuing TCC/ERPC meeting. It was also decided that the funding of these relays would be taken up by ERLDC / ERPC with the management / Task Force of PSDF