No. 12/X/STD(GRID)/GM/CEA - Whereas the draft of the Central Electricity Authority (Grid Standards) Regulations, 2006 was published, as required by Sub-section (3) of Section 177 of the Electricity Act, 2003 (36 of 2003), read with rule 3 of the Electricity (Procedure for Previous Publication) Rules, 2005;

Now, therefore, in exercise of the powers conferred by sub-section (2) of Section177 read with Section 34 and clause (d) of Section 73 of the Electricity Act, 2003, the Central Electricity Authority hereby makes the following regulations, namely:-

1. **Short Title, commencement and application.**-(1) These regulations may be called the Central Electricity Authority (Grid Standards) Regulations, 2010.

(2) Save as otherwise provided in these regulations, they shall come into force on the date of their publication in the Official Gazette,.

(3) These regulations shall apply to the Entities, Appropriate Load Despatch Centres, and, Regional Power Committees.

2. **Definitions**.- (1) In these regulations, unless the context otherwise requires,-

(a) "Act" means the Electricity Act, 2003;

(b) "Appropriate Load Despatch Centre" means the National Load Despatch Centre, Regional Load Despatch Centre or State Load Despatch Centre or Area Load Despatch Centre as the case may be;

(c) "Area Load Despatch Centre" means the centre as established by the State Transmission Utility or licensee for load despatch and control in a particular area of the State;

(d) "Bulk consumer" means a consumer who avails supply at voltage of 33 kV or above;

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(e) “condition based maintenance” means a set of maintenance actions based on continuous or frequent assessment of equipment condition, which is obtained from either of or a combination of embedded sensors, external tests and measurements;

(f) “disaster management” means the mitigation of the impact of a major breakdown on the system and bringing about restoration in the shortest possible time;

(g) “Emergency Restoration System” means a system comprising of transmission towers or structures of modular construction, complete with associated components such as insulators, hardware fittings, accessories, foundation plates, guys, anchors or installation tools and they like to facilitate quick restoration of damaged or failed transmission line towers or sections;

(h) ”Entity” means a Generating Company including captive generating plant or a transmission licensee including Central Transmission Utility and State Transmission Utility or a distribution licensee or a Bulk Consumer whose electrical plant is connected to the Grid at voltage level 33 kV and above;

(i) “grid disturbance” means tripping of one or more power system elements of the grid like a generator, transmission line, transformer, shunt reactor, series capacitor and Static VAR Compensator, resulting in total failure of supply at a sub-station or loss of integrity of the grid, at the level of transmission system at 220 kV and above (132 kV and above in the case of North-Eastern Region);

(j) “grid incident” means tripping of one or more power system elements of the grid like a generator, transmission line, transformer, shunt reactor, series capacitor and Static VAR Compensator, which requires re-scheduling of generation or load, without total loss of supply at a sub-station or loss of integrity of the grid at 220 kV and above (132 kV and above in the case of North-Eastern Region);

(k) ‘Schedule’ means schedule appended to these regulations;

(l) “time based maintenance” means inspection, cleaning and replacement of parts of the equipment based on a predetermined time schedule.

(m) ”transient stability” means the ability of the power system to maintain synchronism when subjected to a severe disturbance such as a short circuit on a transmission line;

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(n) “voltage unbalance” means the ratio of the maximum voltage deviation of the phase voltage from the average phase voltage to the average phase voltage of the three phases;

(2) Words and expressions used and not defined in these regulations but defined in the Act shall have the meaning assigned to them in the Act.

3. Standards for Operation and Maintenance of Transmission Lines.- (1) All Entities, Appropriate Load Despatch Centres and Regional Power Committees, for the purpose of maintaining the Grid Standards for operation and maintenance of transmission lines, shall,-

(a) make all efforts to operate at a frequency close to 50 Hz and shall not allow it to go beyond the range 49.2 to 50.3 Hz or a narrower frequency band specified in the Grid Code, except during the transient period following tripping.

(b) maintain the steady state voltage within the limits specified below in Table 1:

Table 1

S. No.	Nominal System Voltage (kV rms)	Maximum (kV rms)	Minimum (kV rms)
1	765	800	728
2	400	420	380
3	220	245	198
4	132	145	122
5	110	121	99
6	66	72	60
7	33	36	30

(c) ensure that the temporary over voltage due to sudden load rejection remains within the limits specified in Table 2,-

Table 2

S. No.	Nominal System Voltage (kV rms)	Phase to Neutral Voltage (kV peak)
1	765	914
2	400	514
3	220	283
4	132	170

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Provided that for the voltage level below 132 kV, the temporary over voltage limits as given in Table 2 shall be decided by the State Commission in the respective State Grid Code.

(d) ensure that the maximum permissible values of voltage unbalance shall be as specified in Table 3 below:-

Table 3

S.No.	Nominal System Voltage (kV rms)	Voltage Unbalance (%)
1	765 and 400	1.5%
2	220	2%
3	33 to132	3%

Provided that Bulk consumers shall avoid unbalanced load during operation:

Provided further that the distribution licensees shall ensure that their loads are not unbalanced.

(e) provide standard protection systems having the reliability, selectivity, speed and sensitivity to isolate the faulty equipment and protect all components from any type of faults, within the specified fault clearance time and shall provide protection coordination as specified by the Regional Power Committee.

Explanation.- For the purpose of this regulation "fault clearance time" means the maximum fault clearance times are as specified in the Table 4 below,-

Table 4

S.No.	Nominal System Voltage (kV rms)	Maximum Time (in milliseconds)
1	765 and 400	100
2	220 and 132	160

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Provided that in the event of non clearance of the fault by a circuit breaker within the time limit specified in Table 4, the breaker fail protection shall initiate tripping of all other breakers in the concerned bus-section to clear the fault in the next 200 milliseconds.

(f) operate the system in a such a way that the Grid System is capable of withstanding one of the following contingencies without experiencing loss of stability:-

(1) outage of one single largest generating unit of the system or
(2) outage of a 132 kV Double circuit line or
(3) outage of a 220 kV Double circuit line or
(4) outage of a 400 kV Single circuit line or
(5) outage of a 400 kV Single circuit line with series compensation or
(6) outage of 765 kV Single circuit line without series compensation or
(7) outage of one pole of HVDC Bipolar line or
(8) outage of an Interconnecting Transformer

(g) operate the system in a such a way that under any one of the following contingencies, the system remains stable and sustains integrity so that no generator loses synchronism and no part gets isolated from the rest of the system:

(1) tripping of a single largest generating unit; or

(2) transient ground fault in one phase of a 765 kV Single Circuit Line close to the bus; or

(3) a permanent single phase to ground fault in 400 kV single circuit line followed by 3 pole opening of the faulted line; or

(4) a permanent fault in one circuit of a 400 kV Double Circuit Line when both circuits were in service in the pre-contingency period; or

(5) a transient single phase to ground fault in one circuit of a 400 kV Double Circuit Line when the second circuit is already under outage; or

(6) a three-phase permanent fault in a 220 kV or 132 kV line; or

(7) a permanent fault in one pole of HVDC bipolar in a HVDC Converter Station.

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(h) observe the following permissible limits of voltage fluctuation :-

(i) the permissible limit of voltage fluctuation for step changes which may occur repetitively is 1.5 percent:

(ii) for occasional fluctuations other than step changes the maximum permissible limit is 3 percent:

Provided that the standard on voltage fluctuations shall come into force concurrently with clause 4 of Part IV of the Schedule to the Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007.

(2) The transmission licensee shall ensure that the voltage wave-form quality is maintained at all points in the Grid by observing the limits given in Table 5 below,-

Table 5

S.No.	System Voltage (kV rms)	Total Harmonic Distortion (%)	Individual Harmonic of any particular Frequency (%)
1	765	1.5	1.0
2	400	2.0	1.5
3	220	2.5	2.0
4	33 to 132	5.0	3.0

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Provided that the standard on Harmonic Distortion shall come into force concurrently with clause 3 of Part IV of the Schedule to the Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007.

Explanation : For the purpose of this regulation, Total Harmonic Distortion (V_{THD}) expressed as percentage, shall be calculated as under,-

$$V_{THD} = \sqrt{\sum_{n=2}^{n=40} \frac{V_n^{\ 2}}{V_1^{\ 2}}} X100$$

'1' refers to fundamental frequency (50 Hz)

'n' refers to the harmonic of n^{th} order (corresponding frequency is 50 x n Hz)

4. Operation Planning.- The Regional Power Committee shall periodically review the performance of the grid for the past period and plan stable operation of the grid for the future, considering various parameters and occurrences such as frequency profile, voltage profile, line loading, grid incident, grid disturbance, performance of system protection schemes and protection coordination.

5. Maintenance Planning.- (1) The Regional Power Committees shall, before the commencement of the financial year, prepare an annual maintenance plan for the generating stations and the inter-State transmission system in their respective regions keeping in view the demand pattern and maintenance schedule of the generating units and diversity in demand of the States.

(2) The Regional Power Committees shall co-ordinate the annual maintenance plan for Inter-Regional transmission system.

(3) The Regional Power Committees shall review and revise the coordinated generation and transmission system maintenance plan in their monthly operating Committee meetings.

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(4) The State Load Despatch Centre shall in consultation with the concerned transmission licensee, coordinate the annual maintenance plan of Intra-State transmission system taking into account the annual maintenance plan of generating units and inter-state transmission system decided by the Regional Power Committee.

(5) The State Load Despatch Centre shall also review and coordinate the maintenance plan of intra-state transmission system for the next month, taking into account the monthly maintenance plan of generating units and inter-state transmission system prepared by the Regional Power Committee for the next month.

(6) The generating company or transmission licensee shall, before actual shut down, obtain the approval of the Appropriate Load Despatch Centre.

6. Coordination in Operations.- (1) No Entity shall introduce or take out the element of the grid without the concurrence of the Appropriate Load Despatch Centre except in case of imminent risk of safety of plant and personnel in which case it must intimate Appropriate Load Despatch Centre giving reasons therefore.

(2) The Appropriate Load Despatch Centre shall inform all affected parties of the outage.

7. Operating Instructions.- (1) Every generating company and transmission licensee shall provide written operating instructions for each equipment and operating procedure for sequence of operations of power system equipment in their control room.

(2) The operating instructions followed shall not be inconsistent with the manufacturer's instructions.

(3) The operating instructions and procedures may be revised by the generating company or transmission licensee, as the case may be.

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8. Instructions by Regional Load Despatch Centres and State Load Despatch Centres to be recorded.- (1) All operational instructions given by Regional Load Despatch Centres and State Load Despatch Centres through telephone, Fax, e-mail, etc shall be given a unique operating code number and every Regional Load Despatch Centre and State Load Despatch Centre shall maintain a voice recorder for recording and reproduction of conversation with time tag or stamp.

(2) The record of instructions referred to in sub-regulation (1) shall be kept for at least six months.

9. Automatic under frequency Relay.- (1) All Entities shall set their under-frequency (UF) Relays and rate of change of frequency with time Relays in their respective systems, in accordance with the plan made by the Regional Power Committee, to provide adequate load relief for grid security and ensure the operation of these relays at the set frequencies.

(2) All constituents shall submit a detailed report of operation of these Relays at different frequencies to Regional Load Despatch Centre and Regional Power Committee on daily basis and the Regional Power Committees shall carry out inspection of these Relays as and when required.

10. Islanding Schemes.- (1) The Regional Power Committees shall prepare Islanding schemes for separation of systems with a view to save healthy system from total collapse in case of grid disturbance.

(2) The Entities shall ensure proper implementation of the Schemes referred to in sub-regulation (1).

Explanation.- For the purposes of this regulation 'Islanding Scheme' means a scheme for the separation of the Grid into two or more independent systems as a last resort, with a view to save healthy portion of the Grid at the time of grid disturbance.

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11. Categorisation of grid incidents and grid disturbance based on severity of trippings.- The categorisation of grid incidents and grid disturbances shall be as follows:-

(1) Categorisation of grid incidents in increasing order of severity,-

Category GI-1 - Tripping of one or more power system elements of the grid like a generator, transmission line, transformer, shunt reactor, series capacitor and Static VAR Compensator, which requires re-scheduling of generation or load, without total loss of supply at a sub-station or loss of integrity of the grid at 220 kV (132 kV in the case of North-Eastern Region);

Category GI-2 - Tripping of one or more power system elements of the grid like a generator, transmission line, transformer, shunt reactor, series capacitor and Static VAR Compensator, which requires re-scheduling of generation or load, without total loss of supply at a sub-station or loss of integrity of the grid at 400 kV and above (220 kV and above in the case of North-Eastern Region).

(2) Categorisation of grid disturbance in increasing order of severity,-

Category GD-1 - When less than ten per cent. of the antecedent generation or load in a regional grid is lost;

Category GD-2 - When ten per cent. to less than twenty percent of the antecedent generation or load in a regional grid is lost.

Category GD-3 - When twenty per cent. to less than thirty per cent. of the antecedent generation or load in a regional grid is lost;

Category GD-4 - When thirty per cent. to less than forty per cent. of the antecedent generation or load in a regional grid is lost ;

Category GD-5 - When forty per cent. or more of the antecedent generation or load in a regional grid is lost.

Explanation: For the purpose of categorisation of grid disturbances, percentage loss of generation or load, which ever is higher shall be considered.

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12. Reporting of events affecting grid operation.- (1) Any tripping of generating unit or transmission element, along with relay indications, shall be promptly reported by the respective Entity to the Appropriate Load Despatch Centre in the reporting formats as devised by the Appropriate Load Despatch Centre.

(2) The Appropriate Load Despatch Centre shall promptly intimate the event to the Regional Load Despatch Centres and State Load Despatch Centres of the affected regions and States respectively which shall, in turn, take steps to disseminate this information further to all concerned.

13. Reporting of grid disturbance.- (1) The Regional Load Despatch Centre shall inform occurrence of the grid disturbance to the constituents immediately and to the concerned Regional Power Committee at the earliest.

(2) The grid disturbance resulting in failure of power supply to large areas in a State shall also be reported by the Regional Load Despatch Centre to the Authority within twenty four hours of the occurrence of the grid disturbance.

(3) The Regional Load Despatch Centre shall also post on its website a brief preliminary grid disturbance report, indicating the affected area or system, extent of outage and the likely cause of initiation for the benefit of the constituents of the region.

14. Restoration of grid following grid incident and grid disturbance.- (1) The Regional Load Despatch Centre, in consultation with Regional Power Committee, shall develop procedures for enabling restoration and normalisation of the Grid for inter-State system at the earliest, following grid incident and grid disturbance of the categories specified in regulation 11.

(2) The State Load Despatch Centre shall also develop procedures accordingly for restoration of intra-State system.

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(3) The restoration procedures shall be reviewed following any addition of generating station or transmission line or at least once in two years, and revised, if considered necessary by the Regional Load Despatch Centre and State Load Despatch Centre, as the case may be.

(4) The procedures specified in sub-regulations (1), (2) and (3) shall be made available to, and be followed by all concerned Entities, Regional Load Despatch Centres and State Load Despatch Centres.

15. Operational Data during normal operation and during grid incidents and grid disturbances.- (1) All real time operational data as required by the Appropriate Load Despatch Center shall be furnished by the Entities.

(2) All data required by Regional Power Committee, in discharge of the responsibilities assigned to it, shall be furnished by Regional Load Despatch Centre (RLDC).

(3) All operational data, including disturbance recorder and event logger reports, for analysing the grid incidents and grid disturbance and any other data which in its view can be of help for analysing grid incident or grid disturbance shall be furnished by all

the Entities within twenty four hours to the Regional Load Despatch Centre and concerned Regional Power Committee.

(4) All equipment such as disturbance recorders and event loggers shall be kept in healthy condition, so that under no condition such important data is lost.

(5) A real time operation display of the grid position shall also be made available to the Regional Power Committee by Regional Load Dispatch Centre.

(6) Regional Load Dispatch Centre shall classify the grid incidents and grid disturbances according to regulation 11, analyse them and furnish periodic reports of grid incidents and grid disturbances to the Regional Power Committee which shall recommend remedial measures to be taken on the Report of Regional Load Despatch Centre to prevent recurrences of such grid incidents and grid disturbances.

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16. Operational Data Records.- (1) Operational data including equipment and system parameters logged manually and electronically shall be preserved for at least three years.

(2) Logbooks shall be maintained by every manned switchyard and sub-station or at the control centre responsible for operation of the unmanned switchyard and sub-station.

(3) All operations conducted shall be recorded in chronological order and the time of each operation and occurrence of each event shall be recorded in such a manner that there shall be no over-writing and any mistake shall be neatly cut by a line and new words written thereafter.

(4) The observations made during inspection including important parameters and deviation of parameters outside permissible tolerances shall also be recorded in the logbook and all entries must be made in the logbooks immediately.

(5) A record shall be kept of the number of grid incidents and grid disturbances of various categories by the respective Regional Power Committees for each financial year.

(6) A compendium of grid disturbances, indicating details such as the date and time of the disturbance, the sequence of tripping, the cause, and the sequence of restoration, remedial measures taken to avert recurrence of such incidents and disturbances shall be maintained by the respective Regional Power Committee.

17. Communication facilities.- The communication facilities installed by the transmission licensees shall be in accordance with Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007 and shall be maintained in good operating condition.

18. Safety Procedure.- (1) The Entity shall prepare contingency procedures for use of operators at each sub-station and switchyard and these shall be regularly updated.

(2)All operating personnel shall be trained in contingency procedures at regular intervals and the entities shall require their personnel to follow the contingency procedures during operation and maintenance.

(3) The fire fighting equipment shall be made available at all sub-stations, switchyards and converter stations and shall be checked periodically for its upkeep and mock exercises in fire fighting shall be carried out at least once in a year and record maintained.

19. Maintenance of Tools and Equipment.- The maintenance staff shall be made aware of the list of tools, devices and equipment for various maintenance and rectification works on transmission lines, sub-stations, switchyards and converter stations and the tools shall be made readily available and certified for usage.

20. Maintenance Procedures.- The Entity shall prepare maintenance procedures for each equipment in line with the manufacturer's recommendations and prudent utility practices.

21. Hot Line Methods.- (1) The hot line techniques for maintenance of critical transmission lines and sub-stations shall be adopted wherever possible.

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(2) Only trained staff shall be used for the hot line techniques and the tools employed in such techniques shall have necessary certification from a national or international accredited laboratory before usage.

22. Emergency Restoration System.- Each transmission licensee shall have an arrangement for restoration of transmission lines of 400 kV and above and strategic 220 kV lines through the use of Emergency Restoration System in order to minimise the outage time of the transmission lines in case of tower failures.

23. Inspection and Patrolling.- (1) All essential parameters, which indicate the healthiness of the equipment in a sub-station, shall be inspected by the shift engineer once in each shift and periodically by the officer-in-charge.

(2) Overhead lines shall be patrolled at periodicity decided by the transmission licensee and different patrolling schedules shall be implemented by the transmission licensees for normal terrain, vulnerable terrain and most vulnerable terrain.

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(3) The patrolling schedules for ground inspection of live lines and tower top inspection of de-energised lines shall be separately issued by the licensees.

(4) The important lines shall be inspected by senior engineers after patrolling by junior staff and maintenance works such as tree cutting and replacement of damaged insulators shall be carried out immediately after patrolling, wherever required.

24. Maintenance schedules.- (1) Entities shall identify critical equipment and as far as possible, practice condition based maintenance for such equipment in place of traditional time based maintenance.

(2) In case of time based maintenance, the periodicity of maintenance of lines shall be fixed based on whether they are passing through normal area or polluted area or coastal area and the transmission lines and sub-stations in polluted or coastal areas shall be maintained more frequently.

(3) The maintenance of lines passing through and sub-stations located in such areas should be completed once before onset of winter so as to minimise tripping under

conditions of fog or due to salt deposit on insulator discs in coastal areas and once before onset of summer.

(4) Maintenance and cleaning of various equipment fittings, accessories, primary instruments and sensors shall be carried out when they are de-energised during the shut-down of main equipment so as to minimise shutdown time.

(5) Where defects are observed through condition monitoring or during patrolling and inspection, the maintenance work on various items of equipment may be advanced depending on the condition of the equipment.

25. Use of diagnostic techniques for condition monitoring of equipment.- The diagnostic methods of maintenance shall be preferred over traditional time based maintenance. For purpose of this regulation, devices or methods specified in the Schedule shall be used.

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26. Thermo – vision scanning.- The Thermo-vision scanning for hot spots on all overhead lines and sub-station equipment at voltage level of 220 kV and above shall be carried out at least once a year and necessary remedial measures shall be taken where hot spots are detected.

27. Failure analysis.- (1) All failures of equipment and tower collapse shall be analysed by the Entity to avoid recurrence and a copy of the report shall be submitted to the Regional Power Committee and the Authority.

(2) The Authority may appoint a group of experts for investigation and analysis and the representatives of manufacturers may be invited to participate in such analysis.

(3) All relevant data which may help the group of experts in analysing the failures shall be furnished by the respective Entities.

(4) The recommendations of the group of experts shall be submitted to the Authority and the recommendations accepted by the Authority shall be implemented and

circulated to all within the organisation and to other concerned organisations to prevent recurrence of similar failures.

28. Inventory control and spare part management.- (1) The required spare parts shall be kept in stock, to ensure speedy the maintenance of the equipment.

(2) Computerised materials management system shall be developed by the Entities to optimise inventory.

29. Maintenance Audit.- (1) An internal committee may be established by the Entities to verify whether actual maintenance works are carried out at site in compliance of the procedures and the policy of the transmission company.

(2) The observations of the Committee shall be put up to the management of the Entity for perusal and taking corrective action, if any.

30. Residual life assessment.- The residual life assessment shall be carried out for all major equipments including transformers, reactors, breakers, as envisaged by the relevant standards specified by the Bureau of Indian Standards, manufacturer's instruction or industry best practices and suitable remedial action for breach of the same shall be taken by the management of the Entity.

31. Disaster management.- (1) The maintenance staff shall be trained in disaster management and a detailed procedure for the same shall be developed by the Entity and displayed prominently.

(2) This detailed procedure shall be reviewed periodically and also based on mock exercises carried out by the Entity.

(3) The maintenance staff shall be trained in emergency restoration procedures for managing major failures and breakdowns.

(4) The equipment including vehicles, diesel generating sets and fire fighting equipment and Emergency Restoration System for transmission lines shall be kept available at sub-station or at appropriate location for disaster management.

32. Maintenance records.- The records of all maintenance carried out for each equipment shall be kept in the table and formats in electronic form and hard copy

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and the next due date for maintenance of each item of work shall be clearly marked in such tables and formats.

33. Training.- (1) Every person involved in operation and maintenance of transmission lines shall be trained at the induction level and at least once in a year.

(2) The shift staff shall be trained to make them thorough in carrying out operations at each sub-station and every person concerned with real time operation shall be trained.

(3) Every grid operator shall undergo training in real time digital simulator and a refresher course at least once in two years.

(4) The maintenance personnel of every entity shall also be trained in preventive and breakdown maintenance of various equipment and the personnel shall be trained in various detailed maintenance procedures.

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Secretary
Central Electricity Authority

SCHEDULE

(See regulation 25)

The Devises and Methods for Condition Based Monitoring of Equipment

(1) Hot line puncture detection of insulators

(2) Vibration measurement of the line

(3) Pollution measurement of the equipment

(4) Dissolved Gas Analysis of Transformer oil

(5) Frequency response analysis of transformers/reactors

(6) Tan δ and capacitance measurement

(7) Circuit breaker operational analyzer

(8) Dynamic contact resistance measurements of breakers

(9) Third harmonic resistive current measurements of surge arresters

(10) Recovery voltage measurements of transformers/reactors

(11) Vibration measurements of the reactors

(12) Steady state and Dynamic testing of protective relays

(13) Signature Analysis

(14) Partial Discharge measurement for transformers/Gas insulated Switchgear

(15) Static resistance meter for circuit breakers, isolators, bus bar joint, earth switches etc.

(16) Ground tester for measurement of resistivity of soil and ground resistance

(17) Battery impedance test equipment

(18) Insulator tester

(19) SF6 gas leakage detector and dew point

(20) Power quality Analyzer

(21) Fibre optic cable testing devices

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