

**MINISTRY OF POWER**  
(CENTRAL ELECTRICITY AUTHORITY)  
**NOTIFICATION**

New Delhi, the 21st February, 2007

**No. 12/X/STD (CONN)/GM/CEA.**—Whereas the draft of the Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2006 were published as required by Sub-section (2) 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 powers conferred by Section 7 and clause (b) of Section 73 read with Sub-section (2) of Section 177 of Electricity Act, 2003, the Central Electricity Authority hereby makes the following Regulations for regulating the technical standards for connectivity to the grid, namely :—

**1. Short title and commencement**

- (1) These Regulations may be called the Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007.
- (2) These Regulations shall come into force on the date of their publication in the Official Gazette.

**2. Definitions**

In these regulations, unless the context otherwise requires,—

- (1) "Act" means The Electricity Act, 2003 (No. 36 of 2003);
- (2) "Appropriate Load Despatch Centre" means the National Load Despatch Centre (NLDC), Regional Load Despatch Centre (RLDC) or State Load Despatch Centre (SLDC) or Area Load Despatch Centre as the case may be;
- (3) "Area Load Despatch Centre" means the centre as established by the state for load despatch and control in a particular area of the state;
- (4) "Appropriate Transmission Utility" means the Central Transmission Utility or State Transmission Utility as the case may be;
- (5) "Automatic Generation Control" (AGC) means capability to regulate the power output of selectable units in response to total power plant output, tie-line power flow, and power system frequency;
- (6) "Automatic Voltage Regulator" (AVR) means a continuously acting automatic excitation control system to regulate a generating unit terminal voltage;
- (7) "British Standards" (BS) means those standards and specifications approved by the British Standards Institution;
- (8) "Bulk consumer" means a consumer who avails supply at voltage of 33 kV or above;
- (9) "Earth Fault Factor" at a location in a three-phase system means the ratio of 'the highest root mean square (r.m.s.) phase-to-earth power frequency voltage on a sound phase during a fault to earth (affecting one or more phases)' to 'the r.m.s. phase-to-earth power frequency voltage which would be obtained at the selected location without the fault';
- (10) "Earthing" means connection between conducting parts and general mass of earth by an earthing device;
- (11) "Energy Management System" (EMS) means a complete system comprising software for facilitating operation of a power system, maintaining safety, reliability and economy;
- (12) "Event Logging Facilities" means a device provided to record the chronological sequence of operations of the relays and other equipment;
- (13) "Frequency" means the number of alternating cycles per second [expressed in Hertz (Hz)];
- (14) "Generating Unit" means an electrical Generator coupled to a prime mover within a Power Station together with all Plant and Apparatus at that Power Station (up to the Connection Point) which relates exclusively to the operation of that generator;
- (15) "IEC Standard" means a standard approved by the International Electrotechnical Commission;
- (16) "Indian Standards" (IS) means standards specified by Bureau of Indian Standards;
- (17) "Interconnection point" means a sub-station or switchyard at which point the interconnection is established between the requester and the grid;
- (18) "Isolator" means a device for achieving isolation of one part of an electrical system from the rest of the system;
- (19) "Maximum Continuous Rating" (MCR) of a generating unit means the maximum continuous output in MW at the generator terminals guaranteed by the manufacturer at rated parameters;

- (20) "New Unit" means a generating unit for which the requester is seeking connection to the grid;
- (21) "Power Factor" means the cosine of the electrical angle between the voltage and current complexors in an AC electrical circuit;
- (22) "Power System Stabilizer" (PSS) means controlling equipment which receives input signals of speed, frequency and power to control the excitation via the voltage regulator for damping power oscillations of a synchronous machine;
- (23) "Protection System" means the equipment by which abnormal conditions in the grid are detected and fault clearance, actuating signals or indications are initiated without the intervention by the operator;
- (24) "Reactive Power" means in relation to an AC electrical system, the product of root mean square (r.m.s.) voltage, root mean square (r.m.s.) current and the sine of the electrical phase angle between the voltage complexor and current complexor, measured in volt-amperes reactive (VAR);
- (25) "Requester" means a person such as a Generating Company including captive generating plant or Transmission Licensee (excluding Central Transmission Utility and State Transmission Utility) or Distribution Licensee or Bulk Consumer, who is seeking connection of his new or expanded electrical plant to the Grid at voltage level 33 kV and above;
- (26) "SCADA" means Supervisory Control and Data Acquisition System that acquires data from remote locations over communication links and processes it at centralised control location for monitoring, supervision, control as well as decision support;
- (27) "Site Common Drawing" means a drawing prepared for a connection site, which depicts layout of connection site, electrical layout, common protection and control drawings and common services;
- (28) "Site Responsibility Schedule" (SRS) means a Schedule for demarcating the ownership, responsibility for control, operation and maintenance of the equipment at the interconnection point;
- (29) "System Protection Scheme" means a scheme designed to detect abnormal system conditions and take predetermined, corrective action to preserve system integrity and provide acceptable system performance;
- (30) "Thermal Generating Unit" means a generating unit using fossil fuels such as coal, lignite, gaseous and liquid fuel;
- (31) "Total Harmonic Distortion" (THD) means a measure of distortion of the voltage or current wave form (which shall ideally be sinusoidal) and is the square root of the sum of squares of all voltage or current harmonics expressed as a percentage of the magnitude of the fundamental;
- (32) "Transmission System" means a network of transmission lines and sub-stations;
- (33) "Under Frequency Relay" means a relay which operates when the system frequency falls below a pre-set value;
- (34) "User" means a person such as a Generating Company including captive generating plant or Transmission Licensee (other than the Central Transmission Utility and State Transmission Utility) or Distribution Licensee or Bulk Consumer, whose electrical plant is connected to the grid at voltage level 33 kV and above; and
- (35) "Voltage Unbalance" means the deviation between highest and lowest line voltage divided by Average Line Voltage of the three phases.

The words and expressions used and not defined in these regulations but defined in the Act shall have the meanings assigned to them in the Act.

### 3. Applicability of the Regulations

These regulations shall be applicable to all the users, requesters, Central Transmission Utility and State Transmission Utility.

### 4. Objectives

- (1) The aim of these regulations is to ensure the safe operation, integrity and reliability of the grid.
- (2) The new connection shall not cause any adverse effect on the grid. The grid shall continue to perform with specified reliability, security and quality as per the Central Electricity Authority (Grid Standards for Operation and Maintenance of Transmission Lines) Regulations, as and when they come into force. However, these regulations are not to be relied upon to protect the plant and equipment of the requester or user.
- (3) A requester is required to be aware, in advance, of the standards and conditions his system has to meet for being integrated into the grid.

### 5. Standards

The equipment shall meet the requirements in accordance with the provisions of Technical Standards for Connectivity to the Grid as given in the Schedule of these regulations and Central Electricity Authority (Grid Standards for Operation and Maintenance of Transmission Lines) Regulations as and when they come into force, and Grid Code and the State Grid Code(s) as specified by the appropriate Commission.

**6. General Connectivity Conditions**

- (1) The requester shall be responsible for the planning, design, construction, reliability, protection and safe operation of its own equipment subject to the regulations for construction operation and maintenance and connectivity and other statutory provisions.
- (2) The requester and user shall furnish data as required by the Appropriate Transmission Utility or by the licensee or generating station with whose system the inter-connection is proposed, for permitting inter-connection with the grid.
- (3) The requester and user shall provide necessary facilities for voice and data communication and transfer of on-line operational data, such as voltage, frequency, line flows, and status of breaker and isolator position and other parameters as prescribed by the Appropriate Load Despatch Centre.
- (4) The requester and user shall cooperate with the Regional Power Committee, and Appropriate Load Despatch Centres in respect of the matters listed below, but not limited to :—
  - (a) protection coordination and settings of its protective relays accordingly;
  - (b) agree to maintain meters and communication system in its jurisdiction in good condition;
  - (c) participate in contingency operations such as load shedding, increasing or reducing generation, islanding, black start, providing start-up power and restoration as per the procedure decided by the Appropriate Load Despatch Centre;
  - (d) furnish data as required by Appropriate Transmission Utility or Transmission Licensee, Appropriate Load Despatch Centre, Appropriate Regional Power Committee, and any committee constituted by the Authority of appropriate Government for system studies or for facilitating analysis of tripping or disturbance in power system;
  - (e) carryout modifications in his equipment with respect to short circuit level, protection coordination and other technical reasons considered necessary due to operational requirements;
  - (f) abide by the coordinated outage plan of the state and region in respect of generating units and transmission lines as approved by the Regional Power Committee; and
  - (g) cooperate with the Regional Power Committee for tuning of Power System Stabilizer provided in the excitation system of the generating unit.
- (5) The requester and user shall make arrangements for integration of the controls and tele-metering features of his system into the Automatic Generation Control, Automatic Load Shedding, Special Protection System, Energy Management Systems and Supervisory Control and Data Acquisition System of the respective state or region.
- (6) For inter-connection studies the requester shall make a request for connection in the planning stage to the Appropriate Transmission Utility. In case a requester is seeking inter-connection to a distribution system, such a request will be made to the distribution licensee. The Appropriate Transmission Utility or distribution licensee shall carry out the inter-connection study to determine the point of inter-connection, required inter-connection facilities and modifications required on the existing grids, if any, to accommodate the inter-connection. The study may also address the transmission system capability, transient stability, voltage stability, losses, voltage regulation, harmonics, voltage flicker, electromagnetic transients, machine dynamics, ferro resonance, metering requirements, protective relaying, sub-station grounding and fault duties, as the case may be.
- (7)(1) Every connection of a requester's system to the grid shall be covered by a connection agreement between the requester and
  - (a) Appropriate Transmission Utility in case of connection to Inter-state transmission system or intra state transmission system as the case may be;
  - (b) Distribution licensee in case of inter-connection to distribution licensee's system; and
  - (c) Transmission licensee and Appropriate Transmission Utility, in case of inter-connection to a transmission licensee (tri-partite agreement).
- (2) The connection agreement shall contain general and specific technical conditions, applicable to that connection.

**7. Site Responsibility Schedule**

- (1) A Site Responsibility Schedule (SRS) for every connection point shall be prepared by the owner of the sub-station where connection is taking place.
- (2) Following information shall be included in the Site Responsibility Schedule, namely,—
  - (a) Schedule of electrical apparatus services and supplies;

- (b) Schedule of telecommunications and measurement apparatus; and
- (c) Safety rules applicable to each plant and apparatus.
- (3) Following information shall also be furnished in the Site Responsibility Schedule for each item of equipment installed at the connection site, namely :—
  - (a) the ownership of equipment;
  - (b) the responsibility for control of equipment;
  - (c) the responsibility for maintenance of equipment;
  - (d) the responsibility for operation of equipment;
  - (e) the manager of the site;
  - (f) the responsibility for all matters relating to safety of persons at site; and
  - (g) the responsibility for all matters relating to safety of equipment at site.

#### 8. Access at Connection Site

The requester or user, as the case may be, owning the electrical plant shall provide reasonable access and other required facilities to the licensee or Appropriate Transmission Utility or Appropriate Load Despatch Centre, whose equipment is installed or proposed to be installed at the Connection Site for installation, operation and maintenance, etc. of the equipment.

#### 9. Site Common Drawings

Site Common Drawings shall be prepared for each connection point by the owner of the Sub-station where connection is taking place.

### SCHEDULE

(See Regulation No. 5)

#### Standards for Connectivity to the Grid

##### Part I

##### General

#### 1. Standards and Codes of Practice

- (1) The requester shall follow the industry best practices and applicable industry standards in respect of the equipment installation and its operation and maintenance.
- (2) The equipment including overhead lines and cables shall comply with the relevant Indian Standards, British Standard (BS), or International Electrotechnical Commission (IEC) Standard, or American National Standards Institute (ANSI) or any other equivalent International Standard :  
Provided that whenever an International Standard or International Electrotechnical Commission Standard is followed, necessary corrections or modifications shall be made for nominal system frequency, nominal system voltage, ambient temperature, humidity and other conditions prevailing in India before actual adoption of the said Standard.
- (3) The effects of wind, storms, floods, lightning, elevation, temperature extremes, icing, contamination, pollution and earthquakes must be considered in the design and operation of the connected facilities.
- (4) Installation, operation and maintenance of the equipment by the requester shall conform to the relevant standards specified by the Authority under Section 177, and Section 73 of the Act, as and when they come into force.

#### 2. Safety

The requester shall comply with the Indian Electricity Rules, 1956 till such time Central Electricity Authority (Safety and Electric Supply) Regulations come into force.

#### 3. Sub-station Grounding

Each transmission sub-station must have a ground mat solidly connected to all metallic structures and other non-energised metallic equipment. The mat shall limit the ground potential gradients to such voltage and current levels that will not endanger the safety of people or damage equipment which are in, or immediately adjacent to, the station under normal and fault conditions. The ground mat size and type shall be based on local soil conditions and available electrical fault current magnitudes. In areas where ground mat voltage rises would not be within acceptable and safe limits (for example due to high soil resistivity or limited sub-station space), grounding rods and ground wells may be used to reduce the ground grid resistance to acceptable levels. Sub-station grounding shall be done in accordance with the norms of the Institute of Electrical and Electronics Engineers (IEEE)-80.

#### 4. Metering

Meters shall be provided as specified in the Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006.

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**5. Basic Insulation Level and Insulation Co-ordination**

- (1) Basic Insulation Level (BIL) of various items of equipment and ratings of surge arresters for generating stations, lines and sub-stations shall be decided on the following order of priority, namely :—
  - (a) ensure safety to public and operating personnel;
  - (b) avoid permanent damage to plant;
  - (c) prevent failure of costly equipment;
  - (d) minimise circuit interruptions; and
  - (e) minimise interruptions of power supply to consumers.
- (2) Insulation co-ordination of equipment and lines on both sides of a connection point belonging to the requester and the grid shall be accomplished and the co-ordination shall be done by the Appropriate Transmission Utility.

**6. Protection System and Co-ordination**

- (1) Protection system shall be designed to reliably detect faults on various abnormal conditions and provide an appropriate means and location to isolate the equipment or system automatically. The protection system must be able to detect power system faults within the protection zone. The protection system should also detect abnormal operating conditions such as equipment failures or open phase conditions.
- (2) Every element of the power system shall be protected by a standard protection system having the required reliability, selectivity, speed, discrimination and sensitivity. Where failure of a protective relay in the requester's system has substantial impact on the grid, it shall connect an additional protection as back up protection besides the main protection.
- (3) Notwithstanding the protection systems provided in the grid, the requester and user shall provide requisite protections for safeguarding his system from the faults originating in the Grid.
- (4) Bus Bar Protection and Breaker Fail Protection or Local Breaker Back Up Protection shall be provided wherever stipulated in the regulations.
- (5) Special Protection Scheme such as under frequency relay for load shedding, voltage instability, angular instability, generation backing down or Islanding Schemes may also be required to be provided to avert system disturbances.
- (6) Protection co-ordination issues shall be finalized by the Regional Power Committee.
- (7) The requester and user shall develop protection manuals conforming to various standards for the reference and use of its personnel.

**7. Disturbance Recording and Event Logging Facilities**

Every generating station and sub-station connected to the grid at 220 kV or above shall be provided with disturbance recording and event logging facilities. All such equipment shall be provided with time synchronization facility for global common time reference.

**8. Schematic Diagrams**

The requester and user shall prepare single line schematic diagrams in respect of its system facility and make the same available to the Appropriate Transmission Utility or licensee through which his system is connected and the Appropriate Load Despatch Centre.

**9. Inspection, Test, Calibration and Maintenance prior to connection**

Before connecting, the requester shall complete all inspections and tests finalised in consultation with the Appropriate Transmission Utility or licensee or generating station to which his equipment is connected. The requester shall make available all drawings, specifications and test records of the project equipment pertaining to integrated operation to the Appropriate Transmission Utility or licensee or generating station as the case may be.

**Part II****Grid Connectivity Standards applicable to the Generating Units**

The units at a generating station proposed to be connected to the grid shall comply with the following requirements besides the general connectivity conditions given in the regulations and general requirements given in Part I of the Schedule :—

**1. New Generating Units**

- (1) The excitation system for every generating unit :—
  - (a) shall have state of the art excitation system;
  - (b) shall have Automatic Voltage Regulator (AVR). Generators of 100 MW rating and above shall have Automatic Voltage Regulator with digital control and two separate channels having independent inputs and automatic changeover; and
  - (c) The Automatic Voltage Regulator of generator of 100 MW and above shall include Power System Stabilizer (PSS).

- (2) The Short-Circuit Ratio (SCR) for generators shall be as per IEC-34.
- (3) The generator transformer windings shall have delta connection on low voltage side and star connection on high voltage side. Star point of high voltage side shall be effectively (solidly) earthed so as to achieve the Earth Fault Factor of 1.4 or less.
- (4) All generating machines irrespective of capacity shall have electronically controlled governing system with appropriate speed/load characteristics to regulate frequency. The governors of thermal generating units shall have a droop of 3 to 6% and those of hydro generating units 0 to 10%.
- (5) The project of the requester shall not cause voltage and current harmonics on the grid which exceed the limits specified in Institute of Electrical and Electronics Engineers (IEEE) Standard 519.
- (6) Generating Units located near load centre, shall be capable of operating at rated output for power factor varying between 0.85 lagging (over-excited) to 0.95 leading (under-excited) and Generating Units located far from load centres shall be capable of operating at rated output for power factor varying between 0.9 lagging (over-excited) to 0.95 leading (under-excited). The above performance shall also be achieved with voltage variation of  $\pm 5\%$  of nominal, frequency variation of  $+3\%$  and  $-5\%$  and combined voltage and frequency variation of  $\pm 5\%$ . However, for gas turbines, the above performance shall be achieved for voltage variation of  $\pm 5\%$ .
- (7) The coal and lignite based thermal generating units shall be capable of generating up to 105% of Maximum Continuous Rating (subject to maximum load capability under Valve Wide Open Condition) for short duration to provide the frequency response.
- (8) The hydro generating units shall be capable of generating up to 110% of rated capacity (subject to rated head being available) on continuous basis.
- (9) Every generating unit shall have standard protections to protect the units not only from faults within the units and within the station but also from faults in transmission lines. For generating units having rated capacity greater than 100 MW, two independent sets of protections acting on two independent sets of trip coils fed from independent Direct Current (DC) supplies shall be provided. The protections shall include but not be limited to the Local Breaker Back-up (LBB) protection.
- (10) Hydro generating units having rated capacity of 50 MW and above shall be capable of operation in synchronous condenser mode, wherever feasible.
- (11) Bus bar protection shall be provided at the switchyard of all generating station.
- (12) Automatic synchronisation facilities shall be provided in the requester's Project.
- (13) The station auxiliary power requirement, including voltage and reactive requirements, shall not impose operating restrictions on the grid beyond those specified in the Grid Code or state Grid Code as the case may be.
- (14) In case of hydro generating units, self-starting facility may be provided. The hydro generating station may also have a small diesel generator for meeting the station auxiliary requirements for black start.
- (15) The standards in respect of the sub-stations associated with the generating stations shall be in accordance with the provisions specified in respect of 'Sub-stations' under Part III of these Standards.

## 2. Existing Units

For thermal generating units having rated capacity of 200 MW and above and hydro units having rated capacity of 100 MW and above, the following facilities would be provided at the time of renovation and modernization.

- (1) Every generating unit shall have Automatic Voltage Regulator. Generators having rated capacity of 100 MW and above shall have Automatic Voltage Regulator with two separate channels having independent inputs and automatic changeover.
- (2) Every generating unit of capacity having rated capacity higher than 100MW shall have Power System Stabilizer.
- (3) All generating units shall have standard protections to protect the units not only from faults within the units and within the station but also from faults in transmission lines. The protections shall include but not limited to the Local Breaker Back-up (LBB) protection.

## Part III

### Grid Connectivity Standards applicable to the Transmission Line and Sub-Station

The transmission lines and sub-stations connected to the grid shall comply with the following additional requirements besides the general connectivity conditions under these regulations and General Standards for Connectivity to the Grid as specified in Part I of the Schedule.

- (1) Bus bar protection shall be provided on all sub-stations at and above 220 kV levels for all new sub-stations. For existing sub-stations, this shall be implemented in a reasonable time frame.
- (2) Local Breaker Back-up (LBB) protection shall be provided for all sub-stations of 220kV and above.
- (3) Two main numerical Distance Protection Schemes shall be provided on all the transmission lines of 220 kV and above for all new sub-stations. For existing sub-stations, this shall be implemented in a reasonable time frame.

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- (4) Circuit breakers, isolators and all other current carrying equipment shall be capable of carrying normal and emergency load currents without damage. The equipment shall not become a limiting factor on the ability of transfer of power on the inter-state and intra-state transmission system.
- (5) All circuit breakers and other fault interrupting devices shall be capable of safely interrupting fault currents for any fault that they are required to interrupt. The Circuit Breaker shall have this capability without the use of intentional time delay in clearing the fault. Minimum fault interrupting requirement need be specified by the Appropriate Transmission Utility. The Circuit Breaker shall be capable of performing all other required switching duties such as, but not limited to, capacitive current switching, load current switching and out-of-step switching. The Circuit Breaker shall perform all required duties without creating transient over-voltages that could damage the equipment provided elsewhere in the grid. The short circuit capacity of the circuit breaker shall be based on short-term and perspective transmission plans as finalized by the Authority.
- (6) Power Supply to Sub-Station Auxiliaries, shall:
  - (a) for alternating current (AC) supply (Applicable to new sub-stations) :  
220 kV and above: Two high tension (HT) supplies shall be arranged from independent sources. One of the two high tension supplies shall be standby to the other. In addition, an emergency supply from diesel generating (DG) source of suitable capacity shall also be provided.  
66 kV and below 220 kV: There shall be one HT supply and one diesel generating source.  
33 kV and below 66 kV: There shall be one HT supply.
  - (b) for direct current (DC) Supply (Applicable to new sub-stations): Sub-stations of transmission system for 132 kV and above and sub-stations of all generating stations: There shall be two sets of batteries, each equipped with its own charger.  
For sub-stations below 132 kV: there shall be one set of battery and charger.
- (7) Earth Fault Factor for an effectively earthed system shall be not more than 1.4.

**Part IV**

**Grid Connectivity Standards applicable to the Distribution Systems and Bulk Consumers**

The following additional requirements shall be complied with, besides the connectivity conditions in these regulations and general Standards for Connectivity to the Grid given in Part-I and those applicable to transmission lines and sub-stations in Part -III.

**1. Under Frequency/df/dt Relays**

Under frequency and df/dt (rate of change of frequency with time) relays shall be employed for automatic load control in a contingency to ensure grid security under conditions of falling grid frequency in accordance with the decision taken in the Regional Power Committee.

**2. Reactive Power**

The distribution licensees shall provide adequate reactive compensation to compensate the inductive reactive power requirement in their system so that they do not depend upon the grid for reactive power support. The power factor of the distribution system and bulk consumer shall not be less than 0.95.

**3. Voltage and Current Harmonics**

- (1) The total harmonic distortion for voltage at the connection point shall not exceed 5% with no individual harmonic higher than 3%.
- (2) The total harmonic distortion for current drawn from the transmission system at the connection point shall not exceed 8%.
- (3) The limits prescribed in (1) and (2) shall be implemented in a phased manner so as to achieve complete compliance not later than five years from the date of publication of these regulations in the official Gazette.

**4. Voltage Unbalance**

The Voltage Unbalance at 33 kV and above shall not exceed 3.0%.

**5. Voltage Fluctuations**

- (1) The permissible limit of voltage fluctuation for step changes which may occur repetitively is 1.5%.
- (2) For occasional fluctuations other than step changes the maximum permissible limit is 3%.
- (3) The limits prescribed in (1) and (2) above shall come into force not later than five years from the date of publication of these regulations in the Official Gazette.

**6. Back-energization**

The consumer shall not energize transmission or distribution system by injecting supply from his generators or any other source either by automatic controls or manually unless specifically requested by the Transmission or Distribution Licensee.

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