

MINISTRY OF POWER

WHEREAS the Ministry of Power has published a Regulation with amendments on different dates the following, namely:

(Technical Standards for Connectivity to the Grid) Regulations, 2007

(Notification No.: 12/X/STD(CONN)/GM/CEA, Dated: 21.02.2007)

A. (Technical Standards for Connectivity to the Grid) Regulations, 2006 (First Amendment), 2013,
(Notification No.: 12/X/STD(CONN)/GM/CEA, Dated: 15.10.2013)

B. (Technical Standards for Connectivity to the Grid) Regulations, 2006 (Second Amendment), 2019,
(Notification No.: 12/X/STD(CONN)/GM/CEA/2018, Dated: 06.02.2019)

- Inserted/ Replaced matter is shown as []^A at appropriate place; wordings inserted/ replaced shown within square brackets;
 - In both of above cases; -^A ; superscript A implies that change is caused by Amendment '1'.
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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) ~~^1["Earthing" means connection between conducting parts and general mass of earth by an earthing device;~~

"Earthing" means electrical connection between non-energized conducting parts and the general mass of earth by an earthing device; ¹A

- (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;
- ^A[² In case of Solar Photo voltaic generating station, each inverter along with associated modules will be reckoned as a separate generating unit; ²A*
- (15) **"JEC Standard"** means a standard approved by the International Electro-technical Commission;
- (16) **"Indian Standards"** (IS) means standards specified by Bureau of Indian Standards;

^B[³ (16A) **"installed capacity"**,-

- (i) *in case of coal, lignite, gas engines and hydro stations, means the summation of the name plate capacities of all the units of the generating station or Maximum Continuous Rating of the generating station; and*

¹ Omitted and inserted clause (10) of Regulation 2, vide First amendment (A), 2013

² Inserted text at the end of the clause (14) of Regulation 2, vide First amendment (A), 2013

³ Inserted a new clause (16A) after clause (16) of Regulation 2, vide Second amendment (B), 2019.

(ii) *in case of wind generating stations and generating stations using inverters, means the summation of the name plate capacities of wind turbines or solar generating units, as the case may be;*^{3]B}

(17) ~~^{A]4} "Interconnection point" means a sub-station or switchyard at which point the interconnection is established between the requester and the grid;~~

"Interconnection point" means a point on the grid, including a sub-station or a switchyard, where the interconnection is established between the facility of the requester and the grid and where electricity injected into -or drawn from the grid can be measured unambiguously for the requester;

"Inverter" means a device that changes direct current power into alternating current power;^{4]A}

(18) **"Isolator"** means a device for achieving isolation of one part of an electrical system from the rest of the system:

(19) ~~^{A]5} **"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;~~

"Maximum Continuous Rating" (MCR) will carry same meaning as defined in the Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2010;^{5]A}

(20) ~~^{A]6} **"New Unit"** means a generating unit for which the requester is seeking connection to the grid;~~^{6]A}

(21) **"Power Factor"** means the cosine of the electrical angle between the voltage and current complexots 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) ~~^{B]7} **"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;~~

"Requester" includes a generating company, captive generating plant, energy storage system, transmission licensee (other than Central Transmission Utility and State Transmission Utility), distribution licensee, solar park developer, wind park developer,

⁴ Omitted and inserted clause (17) of Regulation 2, vide First amendment (A), 2013

⁵ Omitted and inserted clause (19) of Regulation 2, vide First amendment (A), 2013

⁶ Omitted clause (20) of Regulation 2, vide First amendment (A), 2013

⁷ Omitted and inserted clause (25) of Regulation 2, vide Second amendment (B), 2019.

wind-solar photo voltaic hybrid system, or bulk consumer seeking connection for its new or expanded electrical plant to the Grid at voltage level 33 kV and above; ^{7]}^B

- (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;

^{A]}^{8(28A)} **"Standard Protection"** means electrical protection functions specified in Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2010; ^{8]}^A

- (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 preset value;
- (34) ^{B]}⁹ ~~"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~~
"user" includes a generating company, captive generating plant, energy storage system, transmission licensee (other than the Central Transmission Utility and State Transmission Utility), distribution licensee, solar park developer, wind park developer, wind-solar photo voltaic hybrid system, or bulk consumer whose electrical plant is connected to the Grid at voltage level 33 kV and above; ^{9]}^B
- (35) **"Voltage Unbalance"** means the deviation between highest and lowest line voltage divided by Average Line Voltage of the three phases,

^{B]}¹⁰ (36) **"wind farm developer"** means a person who has developed or proposes to develop the wind generating station or wind generating farm comprising more than one wind generating unit owned by the developer or any other person;';

(37) **"solar park developer"** means a person who has developed or proposes to develop the solar park or solar generating station comprising more than one solar generating unit owned by the developer or any other person;';

⁸ Inserted a new clause (28A) after clause (28) of Regulation 2, vide First amendment (A), 2013

⁹ Omitted and inserted clause (34) of Regulation 2, vide Second amendment (B), 2019.

¹⁰ Inserted new clause (36), (37) & (38) after clause (36) of Regulation 2, vide Second amendment (B), 2019.

(38) **“wind - solar photo voltaic hybrid system”** means a system of electricity generation, which has combination of wind and solar photo voltaic resources, with or without storage system; ¹⁰]B

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.

2. Applicability of the Regulations

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

3. 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 ^A[¹¹Central Electricity Authority Grid Standards for Operation and Maintenance of Transmission Lines) Regulations Central Electricity Authority (Grid Standards) Regulations, 2010 ¹¹]A, 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 ^A[~~Central Electricity Authority (Grid Standards for Operation and Maintenance of Transmission Lines) Regulations~~ Central Electricity Authority (Grid Standards) Regulations, 2010 ¹²]A 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 inner-connection is proposed, for permitting interconnection 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 Dispatch Centre.

¹¹ In the said regulations, for the words "Central Electricity Authority (Grid Standards for Operation and Maintenance of Transmission Lines) as and when they come into force" the words "Central Electricity Authority (Grid Standards) Regulations, 2010", shall be substituted, vide First amendment (A), 2013.

- (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 at 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 interconnection. 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.
- ^A[¹² Provided that in order to carry out the said study, the requester shall present the mathematical model of the equipment in accordance with the requirements as stipulated by the Appropriate Transmission Utility or distribution licensee, as the case may be.¹²]^A*
- (7) (1) Every connection of a requester's system to the grid shall be covered by a connection agreement between the requester and

¹²Inserted a proviso at the end of the sub-regulation (6) of regulation 6, vide First amendment (A), 2013

- (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 (Lri-partite agreement).
- (2) The connection agreement shall contain general and specific technical conditions, applicable to that connection.

^A[¹³(8) *The State Transmission Utility shall inform the Central Transmission Utility and the Authority, within thirty days of acceptance of application for connectivity of a generating station to electricity system operating at 110 kV and above.* ¹³A

7. Site Responsibility Schedule

- (1) A Site Responsibility Schedule (SRS) for every connection point shall be prepared by the ^A[¹⁴ ~~owner of the substation where~~ *generating company or licensee operating the electricity system to which* ¹⁴A] 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 so 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.

¹³ Inserted a new sub-regulation (8) after sub-regulation (7) of regulation 6, vide First amendment (A), 2013

¹⁴ Clause (1) of regulation, for the words "owner of the sub-station where" the words" generating company or licensee operating the electricity system to which" shall be substituted, vide First amendment (A), 2013

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.

^B[¹⁵ 10. Cyber security.-

The requester and the user shall comply with cyber security guidelines issued by the Central Government, from time to time, and the technical standards for communication system in Power Sector laid down by the Authority.

11. Registration in the Registry maintained by the Authority.-

The user or the requester, as the case may be, shall get its generating unit or station, of such capacity and with effect from such date as specified by the Authority, registered and get an online generated Unique Registration Number from the Authority:

Provided that no generating unit or generating station shall be granted connectivity with the grid without the unique registration number with effect from the date specified by the Authority.

12. Compliance of regulations.-

(1) *The licensee shall ensure that before connectivity to the grid, all the provisions with regard to the connectivity specified under these regulations are complied with by the requester.*

(2) *Before allowing connectivity to the requester, the compliance of the provisions laid down under sub-regulations (2), (3) and (5) of regulation 6 shall be verified by the licensee and the verification of compliance of provisions of other regulations shall be in the form of self-declaration in the proforma of connection agreement which shall be checked and verified by the concerned licensee on sample basis.*

(3) *The user may be disconnected from the Grid by the licensee for non-compliance of any provision of these regulations and any non-compliance of the provisions of these regulations shall be reported by the licensee or the State Load Dispatch Centre or the Regional Load Dispatch Centre, as the case may be, to the appropriate Commission.^{15]}^B*

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.

¹⁵ Inserted 3 new principal Regulation (10), (11) and (12), vide Second amendment (B), 2019.

- (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, lightening, 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.

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) minimize circuit interruptions; and
 - (e) minimize 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.

5. 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.

6. 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.

7. 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.

^A16 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 change over; 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.

¹⁶ Omitted and inserted "Part-II" of regulation, vide First amendment (A), 2013

- (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 II

Connectivity Standard applicable to the generating stations

A. *Connectivity Standards applicable to the Generating Stations other than wind and generating stations using inverters*

These generating stations shall comply with the following requirements besides the general connectivity conditions given in the said regulations and Part I of the schedule:-

A1. For Generating stations which are connected on or after the date on which Central Electricity Authority (Technical Standards for Connectivity of the Grid) Regulation, 2007 became effective

- (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 1.0%.
- (5) 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).

Provided that all generating units commissioned on or after 01.01.2014, ^B[¹⁷ Provided also that all hydro-electric generating units, where Techno-Economic Concurrence has been accorded by the Authority under section 8 of the Act, shall be capable of operating at the rated output at the power factor as specified in such techno-economic concurrence.]^B shall be capable of operating at rated output for power factor varying between 0.85 lagging (over-excited) to 0.95 leading (under-excited).

Provided further that 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 $\pm 5\%$.
- (6) 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.
- (7) The hydro generating units shall be capable of generating up to 110% of rated capacity (subject to rated head being available) on continuous basis.

¹⁷ Inserted brackets and words after "2014" in first proviso of clause (5) of paragraph A1, Part-II, vide Second amendment (B), 2019.

- (8) *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.*
- (9) *Hydro generating units having rated capacity of 50 MW and above shall be capable of operation in synchronous condenser mode, wherever feasible.*

Provided that hydro generating units commissioned on or after 01.01.2014 and having rated capacity of 50 MW and above shall be equipped with facility to operate in synchronous condenser mode, if necessity for the same is established by the interconnection studies.

- (10) *Bus bar protection shall be provided at the switchyard of all generating station.*
- (11) *Automatic synchronisation facilities shall be provided in the requester's Project.*
- (12) *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.*
- (13) *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.*

Provided that hydro generating units shall have black start facilities in accordance with provisions of Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2010 from the date of publication of these Regulations.

- (14) *The standards in respect of the switch yard associated with the generating stations shall be in accordance with the provisions specified in respect of 'Sub-stations' under Part III of these Standards.*

A2. *Generating stations which were already connected to the grid on the date on which Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007 became effective*

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 100 MW 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.*

B. ~~B^[18] Connectivity Standards applicable to the Wind generating stations and generating stations using inverters~~

~~These generating stations shall comply with the following requirements besides the general connectivity conditions given in the said regulations and Part I of the Schedule:-~~

Connectivity standards applicable to the wind generating stations, generating stations using inverters, wind - solar photo voltaic hybrid systems and energy storage systems

The generating stations shall comply with the following requirements in addition to the general connectivity conditions specified under Part 1:

Provided that the energy storage systems shall comply, only with the requirements specified under clause B1 in addition to the general connectivity conditions specified under Part 1.^B

B1. Requirements with respect to Harmonics, Direct Current (DC) Injection and Flicker

- (1) Harmonic current injections from a generating station shall not exceed the limits specified in Institute of Electrical and Electronics Engineers (IEEE) Standard 519.
- (2) The Generating station shall not inject DC current greater than 0.5 % of the full rated output at the interconnection point.
- (3) The generating station shall not introduce flicker beyond the limits specified in IEC 61000.

Provided that the standards for flicker will come into effect from 1st April 2014.

- (4) Measurement of harmonic content, DC injection and flicker shall be done at least once in a year in presence of the parties concerned and the indicative date for the same shall be mentioned in the connection agreement;

Provided that in addition to annual measurement, if distribution licensee or transmission licensee or the generating company, as the case may be, desires to measure harmonic content or DC-injection or flicker, it shall inform the other party in writing and the measurement shall be carried out within 5 working days.

B2. For generating station getting connected on or after completion of 6 months from date of publication of these Regulations in the Official Gazette.

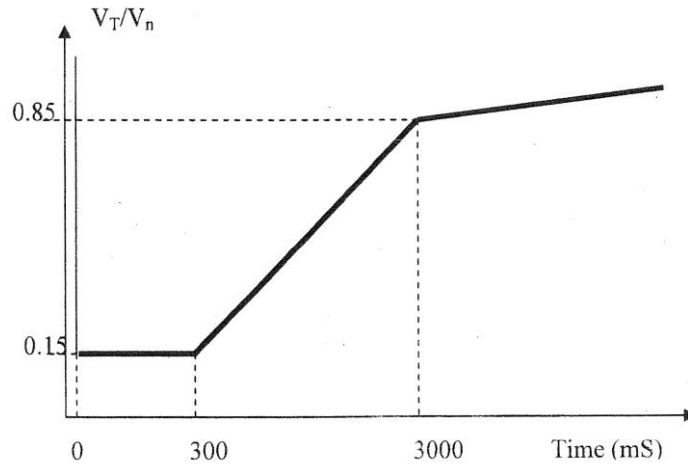
- (1) The generating station shall be capable of supplying dynamically varying reactive power support so as to maintain power factor within the limits of 0.95 lagging to 0.95 leading.
- ~~B^[19] (2) The generating units shall be capable of operating in the frequency range of 47.5 Hz to 52 Hz and shall be able to deliver rated output in the frequency range of 49.5 Hz to 50.5 Hz.~~

~~Provided that above performance shall be achieved with voltage variation of up to $\pm 5\%$ subject to availability of commensurate wind speed in case of wind generating stations and solar insolation in case of solar generating stations.~~

¹⁸ Omitted and inserted paragraph B of Part-II, vide Second amendment (B), 2019.

¹⁹ Omitted and inserted

- (3) ~~Wind generating stations connected at voltage level of 66 kV and above shall remain connected to the grid when voltage at the interconnection point on any or all phases dips up to the levels depicted by the thick lines in the following curve:~~



Where

V_T/V_n is the ratio of the actual voltage to the nominal system voltage at the interconnection point

Provided that during the voltage dip, the individual wind generating units in the generating station shall generate active power in proportion to the retained voltage;

Provided further that during the voltage dip, the generating station shall maximise supply of reactive current till the time voltage starts recovering or for 300 ms, which ever time is lower.

- (4) ~~Wind generating station connected at voltage level of 66 kV and above shall have facility to control active power injection in accordance with a set point, which shall be capable of being revised based on the directions of the appropriate Load Despatch Centre.~~

Provided that as far as possible, reduction in active power shall be done without shutting down an operational generating unit and with reduction being shared by all the operational generating units pro-rata to their capacity.

- (5) ~~The standards in respect of the switchyard associated with the generating stations shall be in accordance with the provisions specified in respect of 'Sub-stations' under Part III of these Standards.~~

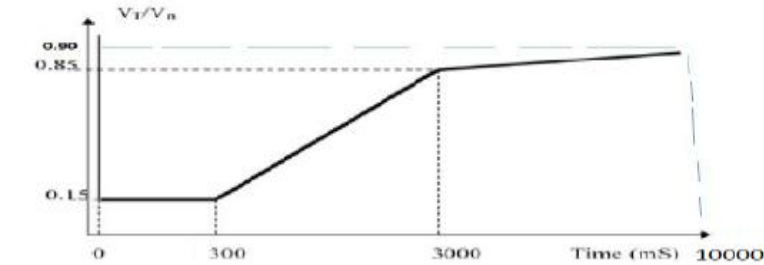
- (2) ~~The generating unit shall be capable of operating in the frequency range 47.5 to 52 Hz and be able to deliver rated output in the frequency range of 49.5 Hz to 50.5 Hz:~~

Provided that in the frequency range below 49.90 Hz and above 50.05 Hz, or, as prescribed by the Central Commission, from time to time, it shall be possible to activate the control system to regulate the output of the generating unit as per frequency response requirement as provided in sub-clause (4):

Provided further that the generating unit shall be able to maintain its performance contained in this sub-clause even with voltage variation of up to + 5% subject to availability of commensurate wind speed in case of wind generating stations and solar insolation in case of solar generating stations.

- (3) *The generating station connected to the grid, shall remain connected to the grid when voltage at the interconnection point on any or all phases dips up to the level depicted by the thick lines in the following curve, namely: —*

VT : Actual Voltage; Vn: Nominal Voltage—



Provided that during the voltage dip, the supply of reactive power has first priority, while the supply of active power has second priority and the active power preferably be maintained during voltage drops, provided, a reduction in active power within the plant's design specifications is acceptable and active power be restored to at least 90% of the pre-fault level within 1 sec of restoration of voltage.

- (4) *The generating stations with installed capacity of more than 10 MW connected at voltage level of 33 kV and above —*

- (i) *shall be equipped with the facility to control active power injection in accordance with a set point, capable of being revised based on directions of the State Load Dispatch Centre or Regional Load Dispatch Centre, as the case may be;*
- (ii) *shall have governors or frequency controllers of the units at a droop of 3 to 6% and a dead band not exceeding ± 0.03 Hz;*

Provided that for frequency deviations in excess of 0.3 Hz, the Generating Station shall have the facility to provide an immediate (within 1 second) real power primary frequency response of at least 10% of the maximum Alternating Current active power capacity;

- (iii) *shall have the operating range of the frequency response and regulation system from 10% to 100% of the maximum Alternating Current active power capacity, corresponding to solar insolation or wind speed, as the case may be;*
- (iv) *shall be equipped with the facility for controlling the rate of change of power output at a rate not more than $\pm 10\%$ per minute.*

- (5) *The generating stations of aggregate capacity of 500 MW and above shall have the provision to receive the signal from the State Load Dispatch Centre or Regional Load Dispatch Centre, as the case may be, for varying active and reactive power output.*

- (6) *The standards in respect of the switchyard associated with the generating stations shall be in accordance with the provisions specified in respect of 'Sub-stations' under Part III of these Standards.*

- (7) *The generating station connected to the grid, shall remain connected to the grid when voltage at the interconnection point, on any or all phases (symmetrical or asymmetrical overvoltage conditions) rises above the specified values given below for specified time —*

<i>Over voltage (pu)</i>	<i>Minimum time to remain connected (Seconds)</i>
<i>1.30 < V</i>	<i>0 Sec (Instantaneous trip)</i>
<i>1.30 > V > 1.20</i>	<i>0.2 Sec</i>
<i>1.20 > V > 1.10</i>	<i>2 Sec</i>
<i>V ≤ 1.10</i>	<i>Continuous</i>

(8) Short Circuit Ratio at the interconnection point where the generating resource is proposed to be connected shall not be less than 5.¹⁹B

B3. ~~*^{B[20} For generating units which are connected before and upto 6 months after the date of publication of these Regulations in the Official Gazette*~~

~~*The generating company and the licensee of the electricity system to which the generating station is connected shall mutually discuss and agree on the measures which can be taken to meet the standards specified in (B1) and (B2) subject to technical feasibility.¹⁸A*~~

Special provision for certain Generating stations :

The generating stations commissioned before the commencement of the Central Electricity Authority (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2018 or commissioned within six months of such commencement shall comply with the provisions of these regulations as if they were not amended.²⁰B

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.
- (4) Circuit breakers, isolators and all other current carrying equipment shall be capable of carrying normal and emergency bad 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.

²⁰ Omitted and inserted paragraph B3 of Part-II, vide Second amendment (B), 2019.

- (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 substations 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 Par-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.~~

^{B_r21} 3. Voltage and Current Harmonics

²¹ Omitted and inserted second and third paragraph of Part-IV, vide Second amendment (B), 2019.

- (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.~~

(2) (i) *The distribution licensee and bulk consumer shall provide adequate reactive compensation to compensate reactive power requirement in their system so that they do not depend upon the grid for reactive power support.*

(ii) *The power factor for distribution system and bulk consumer shall be within ± 0.95 ;*

(3) Voltage and Current Harmonics. –

(i) *The limits of voltage harmonics by the distribution licensee in its electricity system, the limits of injection of current harmonics by bulk consumers, point of harmonic measurement, i.e., point of common coupling, method of harmonic measurement and other related matters, shall be in accordance with the IEEE 519-2014 standards, as amended from time to time*

(ii) *Measuring and metering of harmonics shall be a continuous process with meters complying with provisions of IEC 61000-4-30 Class A.*

(iii) *The data measured and metered as mentioned in sub-paragraph (ii) with regard to the harmonics, shall be available with distribution licensee and it shall also be shared with the consumer periodically.*

(iv) *The bulk consumer shall install power quality meter and share the recorded data thereof with the distribution licensee with such periodicity as may be specified by the appropriate Electricity Regulatory Commission:*

Provided that the existing bulk consumer shall comply with this provision within twelve months from the date of commencement of the Central Electricity Authority (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2018.

(v) *In addition to harmonics, periodic measurement of other power quality parameters such as voltage sag, swell, flicker, disruptions shall be done as per relevant International Electrotechnical Commission Standards by the distribution licensee and the reports thereof shall be shared with the consumer.*

(vi) *The distribution licensee shall install power quality meters in a phased manner within three years from the date of commencement of the Central Electricity Authority (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2018 covering at least 33% of the 33 kV substations each year.²¹^B*

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

~~^A22 The consumer shall not energize transmission or distribution system by injecting supply from his generators or another source either by automatic controls or manually unless specifically requested by the Transmission or Distribution Licensee.~~

The bulk 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 provided for in the connection agreement with the Transmission or Distribution Licensee.²²^A

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²² Omitted and inserted regulation 6 of "Part-IV", vide First amendment (A), 2013