भारत सरकार
Government of India
विद्युत् मंत्रालय
Ministry of Power
केंद्रीय विद्युत् प्राधिकरण
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No. CEA/PLG/RP&T/15/11/2024/ 21-25 दिनांक/ Date: 7th July, 2025

To,

1. Principal Secretary/ Secretary(Power/Energy) of all State Governments/UTs.
2. Head REIAs.
3. Solar Power Developers Association.
4. Wind Power Developers Association.
5. CMD, Grid Controller of India.

Subject: CEA Guidelines for Automatic Weather Stations for Solar and Wind Power Plants.

Sir/Madam,

As you are aware that solar and wind generation depends on weather conditions. There are issues of not getting accurate weather forecast. Many a time, forecasting errors result in significant financial penalties under the Deviation Settlement Mechanism.

2. Accurate measurement of critical meteorological parameters would optimize RE generation. Also, it would improve overall generation predictability, efficiency, enhance grid reliability and ensure regulatory compliance.

3. In view of above, there is need to install Automatic Weather Stations in Solar and Wind Power Plants. Accordingly, CEA has prepared the Guidelines for the same.

4. A copy of "CEA Guidelines for Automatic Weather Stations for Solar and Wind Power Plants" is enclosed for necessary action please.

5. Further, all Renewable Energy Implementing Agencies are requested to suitably include the requirement of Automatic Weather Stations in bid documents.

भवदीय/ Yours faithfully,

संलग्नक/ Encl.: as above.

राकेश
07/07/2025

(राकेश कुमार/ Rakesh Kumar)
सचिव/ Secretary

प्रति/ Copy to:

1. Secretary, Ministry of Power.
2. Secretary, Ministry of New & Renewable Energy.
3. Secretary, Ministry of Earth Sciences.

CEA Guidelines for Automatic Weather Stations (AWS) for Solar and Wind Power Plants

(July-2025)

CEA Guidelines for Automatic Weather Stations (AWS) for Solar and Wind Power Plants

1. Objective

Measurement of critical meteorological parameters for accurate, real-time measurement of weather to enable optimization of RE generation. This would improve overall generation predictability, efficiency, enhance grid reliability and ensure regulatory compliance.

2. Location and Site Preparation for Installation of AWS

The Automatic Weather Station (AWS) should be installed at a location within the renewable energy project site. For **solar power plants**, the AWS should be located in terrain that closely resembles the overall site conditions, with irradiance sensors mounted at the **same tilt and orientation** as the photovoltaic modules. For **wind power projects**, the AWS must be positioned in areas that reflect the true wind regime of the site, turbulence zones, or artificial barriers.

Typically, one AWS per RE plant is to be installed for 50 MW and above RE (or as per respective SERC regulation) capacity connected at intra state network and ISTS connected RE plants shall be governed by respective regulations of CERC.

The area of the AWS site should be 10 m x 10m. The site should be levelled and made free of obstructions such as buildings, structures, trees, bushes or equipment that could cause shading, turbulence, or other local interference. Herbicide should be sprayed and sites should be cleaned.

2.1 Fencing for the AWS site with Gate

a) The height of the fencing for the AWS site (10 m X 10 m) must be 1.5 meters from the ground level.
b) The fencing angle should be of size 50 mm x 50 mm x 6 mm and pre-coated with red-oxide. Length of the angle shall be 2.5 meters i.e. (0.5 m below ground level).Each angle shall be grouted in concrete blocks of site (0.5 m x 0.5 m x 0.5 m). Angle iron should be painted with 2 coating of synthetic enamel paint.
c) Two MS angles must be used diagonally at each of the four corner angles of the site.
d) Distance between each fencing angle should not be more than 2 m.

2.2 Chainlink Fencing

a) Dimensions of GI Chain link: 10 cm x 10 cm and of Gauge: 10 (3 mm diameter).
b) GI chainlink mesh must be stretched on the fencing angles.
c) Entry Gate Dimensions: 2 m x 1 m x 6 mm (Length x Width x Thickness) of MS angle with locking facility and painted with white/ silver colour.

2.3 Mast Specification for AWS

a) The mast shall be 10 m in height and tiltable which is made of anodized Aluminum alloy suitable for coastal stations.
b) Three stainless steel guy wires (rust proof) support is to be provided for the mast.

c) The mast shall be painted in red and white colour scheme.
d) Concrete Platform for the mast should be 2.0 ft x 2 ft (length x width) and 4 ft height (3.0 ft below ground level and 1.0 ft. above the ground level). All concrete shall be in ratio of 1:1.5:3 and well compacted after being laid.

2.4 Rain Gauge foundation

The Rain gauge foundation must be of dimensions 1 ft x 1ft (length x width) and 2ft height (1.0 ft below ground level and 1.0 ft above the ground level).

2.5 Earthing for signal ground and Lightning Arrestor

1. All AWS stations shall be provided with 2 earth pits - one for signal earth, and another for lightning arrestor.
2. AWS Data Acquisition System (DAS) enclosure should be grounded with local earthing.
3. The earth pits shall ensure 100 % protection for all sensors and systems from severe lightning.
4. The lighting arrestor rod shall be made of copper and mounted on the top of the AWS tower. It should be of thickness 12 mm and of one-meter length with a connected copper wire of dimension 15-meter length and 6 mm thickness (gauge). At the other end of the copper wire is earthing rod of dimensions 15 mm in thickness and 1.8m in length, which is about 1.8 m deep-buried into the ground. On the bottom of earthing rod, one copper plate of dimension (30 cm x 30 cm x 3 mm) should be connected.

2.6 Sensor Installation

a) A rain gauge sensor will be installed at a distance of 3 meters from the tower.
b) The Ambient Temperature/Relative Humidity sensors shall be installed on the horizontal boom of 1.5 m fixed at 2 m height on the 10 m Tiltable mast.
c) Ultrasonic wind sensors will be installed on the horizontal boom of 1.5 m fixed at 10 m height on the 10 m Tiltable mast.
d) Pressure sensor will be kept inside the Enclosure of Datalogger.

3. Measuring Parameters

AWS shall be capable of measuring the following parameters and converting them to digital format for transmission to the Data Acquisition System (DAS).

3.1. Parameters for Wind Plants for developing NWP model

a) Barometric Pressure (Pascal)
b) Ambient Air Temperature (°C)
c) Wind Speed (meter/second)
d) Wind Direction (degrees from true north)
e) Relative Humidity (%)

3.2. Parameters as per CERC/SERC regulations for Solar Plants

a) Global Horizontal Irradiance (GHI) - Watt per meter square
b) Global Inclined Irradiance (GII)- Watt per meter square
c) Rainfall (mm)

4. Technical Specifications

4.1 Specifications of Sensors

4.1.1	**Pyranometer for measurement of GHI and GII**		
I)	Sensor Type		Thermopile-based Pyranometer
a)	Spectral Range		285 to 3000 nm
b)	Measurement range		0 to 2000 W/m^2
c)	Response time		≤ 5 seconds
d)	Sensitivity		5 to 20 µV/W·m^2
e)	Non-linearity		< ±0.5%
f)	Directional Error (up to 80°)		< ±10 W/m^2
g)	Temperature Response		< ±2%
h)	Operating Temperature Range		−20°C to +60°C
i)	Output		Digital/Analog
j)	Protection Level (Housing)		IP 65 or above
4.1.2	**Temperature and Humidity Sensor with Radiation Shield**		
I)	**Temperature**		
a)	Measurement Range		-40°C to +60°C
b)	Resolution		0.01°C or better
c)	Accuracy		± 0.35 °C or better
II)	**Relative Humidity**		
a)	Measurement Range		0 to 100%
b)	Resolution		0.1%
c)	Accuracy		± 3% or better
III)	**Output**		Digital/Analaog
IV)	**Radiation Shield**		
a)	Type		Thermoplastic
b)	Louvered		Minimum 9
c)	Ventilation		Natural
4.1.3	**Ultrasonic Wind sensors**		
I)	**Wind speed**		
a)	Measurement Range		0 to 75 m/s or better
b)	Resolution		0.01 m/s or better
c)	Accuracy		± 2% or better
d)	Threshold		0.01 m/s
II)	**Wind Direction**		
a)	Measurement Range		0 to 359.9°
b)	Accuracy		± 3° or better
c)	Resolution		1°
III)	**Protection level Housing**		IP65 or above
IV)	**Output**		Digital
4.1.4	**Atmospheric Pressure Sensors**		
a)	Measurement Range		60000 Pa to 110000 Pa
b)	Resolution		10 Pa
c)	Accuracy		± 20 Pa
d)	Output		Digital

4.1.5	**Siphon Tipping Bucket Rain Gauge sensor**		
I)	Sensor type		Siphon control mechanism with dual switch with varistor protection and Tipping Bucket
a)	Orifice Size/ collector diameter		The specified diameter of the collector rim should be 200 mm
b)	Collector Area		The specified Collector Area should be 314 cm^2
c)	Switch		Rugged Magnetic Proximity
d)	Resolution		0.5 mm per tip or better
e)	Output		0.1 sec switch closure
f)	Rainfall capacity		Unlimited
g)	Accuracy		±2% or better, for rain rate up to 25 mm/hr ±3% or better, for rain rate between 25mm/hr to 50 mm/hr ±4% or better, for rain rate between 50mm/hr to 100 mm/hr ±5% or better, for rain rate>100 mm/hr
h)	Material of Outer Body/housing (Base/Collector)		Any one of the following: 1. Marine grade stainless steel 2. Fibre glass Reinforced Plastic (FRP) 3. UV resistant ABS plastic 4. Anodized Aluminum alloy (Al 99.5 grade)
i)	Levelling		Suitable levelling adjustment screws and circular spirit level must be provided on the base of TBRG for levelling the Tipping bucket Mechanism.
j)	Debris protection filter		Suitable (Wire mesh) debris protection filter should be provided inside the collector.

4.2 Data Acquisition System (DAS)

4.2.1. Hardware Capabilities

a) The DAS should support inputs (analogue, digital), counters, frequency, and quadrature /shaft encoder.

b) All the Analog, Digital and SDI-12 channels in the DAS must be compatible with the sensors installed and integrated with the system.

c) The DAS should have provision to interface all the sensors installed at the site and able to accept all sensor inputs without external signal conditioning.

d) To facilitate data processing, the DAS shall have a provision for a 24-hour Real-Time Clock (RTC) powered by a battery (with minimum one-year lifetime) to ensure that time is maintained even during power outages.

e) DAS system should have the functionality of time synchronization to a satellite-based reference time source, preferably NAVIC, isolated from internet.

f) DAS should have a keypad (Non-touch screen) and a backlit LCD/LED display (internal/external unit) with menu-driven facility to display the command and data characters.

g) DAS should have a suitable port to interface with any external display unit.

h) The DAS should have the capability to store at least 30 days data for specified parameters in distinct multiple log files for each sensor and other related parameters.

i) The data stored in DAS should be in encrypted form (AES 256 bit algorithm or higher) to ensure its confidentiality with following measures:
   1. Access to data stored in DAS shall be restricted to only authorized personnel based on principle of AAA mechanism.
   2. Retrieval of such encrypted data shall be in a standard format and restricted through Serial port / Ethernet port only to a dedicated, whitelisted and sanitized PC / laptop, without the requirement of any additional software, over and above the application software deployed for DAS. Further, shall ensure that flow of such data shall be unidirectional only i.e. from DAS to such external device but not reverse.

j) The DAS shall have the facility to sample the output of the attached sensors with user-selectable sampling intervals.

k) The DAS shall have provision to easily include and change the "Unique station identification code", "Station Name", "Time of observation and transmission", "Measurement schedule" and "Sensor identification information", for all parameters, as mandatory requirements. Any change in the DAS should be properly logged along with user, date and time details and:
   1. Such logs shall be retained for minimum period of 180 days.
   2. A record of all changes implemented in DAS shall be maintained.

4.2.2. Communication Capabilities

a) The DAS shall be have a dedicated sealable slot for accommodating plug-in type bi -directional communication module which shall integrate the respective cellular technology (3G/4G/5G / cellular network compatible) with the DAS, leading to seamless exchange of data with National Centre for Medium Range Weather Forecasting (NCMRWF). The Plug-In module shall be field swappable/ replaceable.

   The DAS shall ensure that such exchange of real time information and data thereof over Cellular network, shall be over secured connection, subject to condition that such exchange of sensitive information and data thereof over such connection shall be encrypted to ensure its confidentiality, integrity and privacy.

b) DAS shall have provision to integrate with local plant level SCADA system on MODBUS/IEC-104 through TCP/IP communications. Redundant ports for IEC-104/MODBUS communication shall be available in the system. Also, ensure the following:

1. The interconnection of DAS system with the SCADA is permitted on the basis of risk assessment and approval of head or board of utility, as applicable.
2. The deployment of suitable perimeter level cyber security devices, including firewall, at point of interconnection of DAS with SCADA systems such that the deployed security system meets the requirements of, inter alia, detection and filtering of OT related protocols as well as traffic; content, user and application based filtering; deep packet inspection, intrusion detection; geo-fencing; user controlled updates; detection based on signature and behavioral anomalies and filtering thereof.
3. The continuous monitoring of such interconnection for detection of malicious activities and corrective measures thereof.
4. The logs associated with such interconnection shall be retained for a period of 180 days.

c) The remote access if required to DAS, may be permitted for meeting emergency and troubleshooting requirements. Also, ensure the following:
   1. The remote access to cyber assets, if necessary, may be permitted only for troubleshooting and emergency requirements, as per an established procedure.
   2. This remote access may be granted after conducting a comprehensive risk assessment along with identification of effective measures thereof and such access shall be continuously monitored to detect any anomaly or unauthorized attempts.
   3. Such remote access is safe and secured through suitable control measures including minimum duration with least privileges, multi-factor authentication and geo-fencing.

d) The protocol details of data transmission (every minute of logged data) through this port have to be documented properly so that any authorized user can interface their device/ display unit.

4.2.2.1. Modem for Cellular Communication (GPRS, 3G,4G,5G compatibility with dual SIM Facility):

A 5G/4G-based Modem (compatible with 3G) with dual SIM facility having provision of fast and reliable wireless data communications along with support for IP-based access to the central server IP. The Modem shall be compatible with all service providers' SIM. The following technical specifications are indicative:

a) Cellular communication facility with fast and reliable wireless data communications.
b) Remote dial-up facility.
c) Shall support SFTP.
d) Accept dual standard SIM cards.
e) Ethernet/RS 232/485 interface with DAS.

f) Indication of network availability (signal strength).
g) Suitable High gain Antenna for reliable communication.

In future, if any of this technology becomes obsolete, the same should be replaced with the higher version available without any data gap. Both the SIMs should not be of the same generation and the higher should be compatible with the lower generation.

4.2.3. Data Sampling

a) The sampling and measurement interval for individual parameters shall also be user selectable.
b) Provision of disseminating the data from AWS site at an interval of 15 minutes; but can be changed (by manual process only) to 1 minute whenever required during extreme weather event and heavy rainfall seasons. In case of requirement of remote access, the same shall be permitted as per established procedure for ensuring remote access, as stated in clause number 4.2.2 (c).

4.2.4. Data Quality Control(QC)

a) The DAS should have a facility to apply Quality Control procedures such as Gross error checks and time consistency checks for sensors interfaced. Detailed QC procedures and algorithms proposed to be implemented at field sites shall be in accordance with WMO No.8 "Guide to Meteorological Instruments and Methods of Observation" Part-III Chapter 1 and Part-II Chapter 1, Seventh Edition, 2008.
b) Data quality control has to be applied as real-time QC performed at the Data-logger of AWS.
c) **QC of raw data (signal measurements):** The basic QC is performed at an AWS site. This QC level is relevant during the acquisition of Level I data and should eliminate errors of technical devices, including sensors, measurement errors (systematic or random), and errors inherent in. Some errors introduced during the measuring process must be eliminated.
d) **Plausible value check (The gross error check on measured value):** Each sample should be examined to check if its value lies within the measurement range of a particular station. If the value fails the check, it is rejected and not used in the further computation of the relevant parameter.
e) **Check on Plausible rate of change (The time consistency check on measured values):** This check is to verify the rate of change (unrealistic jumps in the values). After each signal measurement, the current sample shall be compared to the preceding one. If the difference between these two samples is more than the specified limit then the current sample is identified as a suspect and not used for the computation of the average. However, it is still used for checking the temporal consistency of the sample.
f) **Check on Inter-sensor checks:** Internal consistency checks of a variable against other variables, based upon established physical and meteorological principles.

4.2.5. Cyber Security

a) The DAS should be adequately protected through Firewall using IDS system and Deep Packet Inspection facility and whitelisting of IPs connected through cellular network may be enabled.

b) All Data & Logs must be suitably maintained for reproduction if needed for forensic analysis for a minimum period of 180 days as per CERT-In Direction.

c) User settings, credentials, authentications must be stored in encrypted format.

d) Data transferred through cellular network (3G/4G/GPRS) must be over secured connection, and be suitably encrypted while in transit to ensure its confidentiality, integrity and privacy.

e) Cyber Security controls as per CEA Guidelines 2021 or amendments thereof may be adhered especially for the IP based communicable devices.

4.3 Power Supply

The complete AWS station shall have the capability for unattended operation at remote places using Maintenance Free (MF) Battery, Solar Charge controller (Maximum Power Point Tracker) and rechargeable through a Solar panel .

(i) Battery: Suitable capacity MF (Maintenance Free Battery).

(ii) Solar Charge controller: It should charge the supplied Sealed Maintenance Free (SMF) battery with a suitable solar panel and also overload protection, Short circuit protection, Protection from the lightning strike and Under-voltage protection.

(iii) Solar Panel: Suitable solar panel to charge the SMF battery.

4.4 Weatherproof FRP enclosure

a) Two separate enclosures are required for AWS. Weatherproof Enclosure of AWS should be FRP Enclosure (IP 66) and for outdoor use to provide a degree of protection against falling dirt, rain, sleet, snow, windblown dust, splashing water, and hose-directed water.

c) One enclosure FRP Enclosure (IP 66) suitable to keep Datalogger, solar charge Controller and switch with the suitable fuse for power supply to the Data logger and UHF Transmitter.

d) Another separate FRP Enclosure (IP 66) for MF batteries.

e) Silicone gasket is used for both Enclosures in harsh environments and extreme temperatures.

f) FRP Enclosure (IP 66) enclosures should be designed for outdoor applications that require corrosion protection against chemicals and water. From humble to harsh environments, it safeguards vital electrical and electronic components with enclosures, climate control and accessories to help keep operations up and running smoothly.

g) Enclosure with hinged door and locking facility.

h) Data Pockets provide convenient storage for wiring diagrams, operation manuals and other documentation inside an enclosure.

5. System Configuration of AWS

a) The AWS equipment along with the data communication system should incorporate state-of-the-art technology and provide the capability for unattended operation in all weather conditions. The system shall run using Maintenance Free (MF) battery(s), rechargeable through a solar panel. The battery shall be capable to run the system for a minimum period of 20 days on full load during total cloudy or foggy conditions without charging through the solar panel.

b) Transmission of data at user-defined measurement schedule from field stations using mobile telemetry over cellular network (GPRS/3G/4G/5G etc.) shall be over secured connection, using SFTP (Secure File Transfer protocol), simultaneously to at least two static whitelisted IP addresses in file format compatible with requirements of NCMRWF and ensure uninterrupted reception and archival of data at the central data server located at NCMRWF/Indian Meteorological Department (IMD).

c) Integration of AWS data to local plant SCADA system installed at site as per clause number 4.2.2 (b).

d) The AWS data (.csv format) shall also be received at IMD/NCMRWF Central Server via SFTP service facility as per user-defined time interval (1 min to 15 min).

6. AWS Data sharing

Data from the AWS site shall be transmitted through the cellular network modem following IMD Mobile Telemetry protocol and its data format to NCMRWF.

7. Suitable provisions for testing, calibration & maintenance of AWS shall be specified by IMD.

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