MOST URGENT

No. 12014/02/2010-Credit II
Government of India
Ministry of Agriculture
Department of Agriculture & Cooperation

Krishi Bhavan, New Delhi
Dated 1st March, 2012.

To,

1. APC/Secretary (Agri./coop.) of Government of Andhra Pradesh, Assam, Bihar, Chhatisgarh, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarkhand and West Bengal.
2. Dr. Inder Jit Singh, Joint Secretary, Department of Science & Technology, Technology Bhawan, New Mehrauli Road, New Delhi-110016 (email ID: inder.jit@nic.in).
3. Dr. Swapan Kumar Datta, Dy Director General (Crop Science), Inian Councile for Agricultural Research, Krishi Bhawan, New Delhi-110001 (e-mail ID: ddgcs@nic.in)
4. Shri L. S. Rathore, Scientist G & Head (Agromet), Indian Meteorological Department (IMD), Mausam Bhawan, Lodhi Road, New Delhi.
5. Managing Director & CEO, National Collaterals Management Services Ltd. (NCMSL), Gyatri Towers, 954, AppaSaheb Marathe Marg, Prava Devi, Mumbai 400025
6. Shri M. A. Kharat, CMD, Agriculture Insurance Company of India Ltd. (AIC), Ambadeep, 13th Floor, K.G. Marg, New Delhi-110001.
7. Shri Bhargav Das Gupta, MD & CEO, ICICI-Lombard General Insurance Company Ltd., ICICI Lombard House, 414, Veer Savarkar Marg, Near Siddhi Vinayak Temple Prabhadevi, Mumbai – 400025.
8. Shri S. Narayanan, MD, IFFCO-Tokio General Insurance Company Ltd., IFFCO Tower, 5th Floor, Plot No. 3, Sector 29, Gurgaon – 122001.
9. Shri S.S. Gopalarathnam, MD, Cholamadalam MS General Insurance Company Ltd., Dare House, 2nd Floor, No. 2 NSC Bose Road, Chennai – 600001.
10. Shri Ritesh Kumar, Managing Director, HDFC-ERGO General Insurance Company Limited, 6th Floor, Leela Business Park, Andheri-Kurla Road, Andheri (E), Mumbari – 400 059.

Subject:- Draft report of the Committee constituted for preparation of draft guidelines for setting up Automatic Weather Stations (AWSs) and Automatic Rain Gauge (ARGs) & their accreditation, standardization, validation and quality management of weather data -reg.

Sir,

I am directed to inform that in compliance of one of the recommendation/suggestion of the Evaluation Report of Pilot WBCIS, a Committee has been constituted under the chairmanship of Chairman cum Managing Director, Agriculture Insurance Company (AIC) of India to draft the guidelines for setting up Automatic Waether Stations (AWSs) and Automatic Rain Gauge (ARGs) & their accreditation, standardization, validation and quality management of weather data. The Committee has submitted draft report covering following aspects:

i. AWS equipment standards
ii. AWS installation standards & maintenance standards and
iii. Guidelines for 3rd party accreditation and data certification services.

A copy of the afore said draft report is enclosed**.** It is requested that the report may kindly be examined and comments/views, if any, on the report may kindly be furnish to this Department by 20th March, 2012 so that the report can be finalized and implemented from Kharif 2012 season.

Yours faithfully,

Encl: as above

_sd_
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Chief Director (Crop Insurance)
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Copy to NIC, DAC, Krishi Bhawan, New Delhi with request to kindly up load the letter/reports on the website of this Department for seeking comments/views of all stakeholders.

Copy also for information to PPS to AS (GCP)/PS to JS (C&C), DAC, Krishi Bhawan, New Delhi

Draft Report/Guidelines for setting up

Automatic Weather Stations (AWSs) and

Automatic Rain Gauge (ARGs)

&

their accreditation, standardization, validation and quality management of weather data

for

Implementation of Weather Based Crop Insurance Scheme (WBCIS)

Department of Agriculture & Cooperation
Ministry of Agriculture
Government of India

Background

Weather Based Crop Insurance Scheme (WBCIS) is in pilot form and is implemented since Kharif 2007 season. WBCIS is subsidized programme with subsidies ranging from 25% to 80% of the premium, which are equally shared by the Centre and concerned State. Over a period of last 5 years the size of pilot is expanding and presently about 20% of the country is under the WBCIS pilot.

Weather insurance assumes that there is strong correlation between yield and weather, and its possible to estimate the yield losses by computing the weather deviations. In view of this, WBCIS is presently piloted for those crops where the yield and weather correlation is strong.

While traditional crop Insurance specifically indemnifies the cultivator against shortfall in crop yield, WBCIS is based on the fact that weather conditions affect crop production even when a cultivator has taken all the care to ensure good harvest. Historical correlation studies of crop yield with weather parameters help us in developing weather thresholds (triggers) beyond which crop yield suffer. Payout structures are developed to compensate cultivators to the extent of losses deemed to have been suffered by them using the weather triggers. In other words, **WBCIS uses weather parameters as ‘proxy’ for crop yields in compensating the cultivators for deemed crop losses.**

One serious challenge of weather insurance is ‘basis risk’, which broadly corresponds to difference in the weather experience at the location of weather station and the farm (field) which is referenced to the weather station under the scheme. In other words, the farms closer to the location of weather station tend to experience almost similar weather and therefore the basis risk is lower. Given that the weather aberrations are on the rise and the patterns are changing at micro level, the effectiveness of weather insurance can be enhanced only by enhancing the density of weather station network. Ideally crops within a radius of 5 km from a weather station could be insured with reasonable reduction in basis risk, and anything beyond 5 km tend to increase the uncertainty in terms of increased basis risk. Assuming 5 km radius, about 40,000 weather stations would be required at the national level to service weather insurance.

Given the enormity of the task, private weather data providers have entered the market to supply the data to the insurance companies at a fee. However, in order to fully utilize the public network of weather stations, insurance companies are using the data from private network only in areas where public weather stations are not available.

With increase in private data providers, the need was felt to stipulate certain standards in weather station set up, maintenance and data accuracy. Initially the Government requested IMD to undertake this task of weather station accreditation and validation process. However, IMD could not agree to take up the task because of its preoccupation with more important and urgent tasks. In view of this, Ministry of Agriculture set up a committee consisting of IMD, Agriculture Insurance Company of India (AIC) and National Collateral Management Services Limited (NCMSL) to formulate the standardization guidelines so that such accreditation and validation process could be entrusted to a third party with requisite experience and resources. The Committee has submitted draft report covering following aspects:

iv. AWS equipment standards
v. AWS installation standards & maintenance standards and
vi. Guidelines for 3rd party accreditation and data certification services.

As can be seen from above, the broad usage of weather data under weather insurance is to measure the expected yield losses on account of weather aberrations. This being the case perhaps the weather stations used for weather insurance purpose need not maintain the same level of specifications and standards by IMD for climatological and forecasting purposes. Moreover, under weather insurance the parameter which is used for almost all crops is rainfall (volume, number of rainy days, dry spell and wet spell) whereas parameters like temperature and humidity are used for select crops during Rabi season. Wind speed and direction is rarely used except for crops like mango and banana.

Keeping in mind the above practical circumstances some relaxations have been made in the guidelines.

The IMD is in the process of drafting a detailed guideline related to all aspects of weather data management etc. However, till circulation of detailed guideline by IMD, this guideline will strictly be applicable for use of weather data in the implementation of Weather Based Crop Insurance Scheme and Modified National Agricultural Insurance Scheme being administered by Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India.

CHAPTER-I

A Technical note on Automatic Weather Station (AWS) & Automatic Rain Gauge (ARG)

1. Introduction:

As the technology is proceeding, there is a need for up-gradation of the meteorological observatory network, to ensure real time quality data for weather forecasting, flood forecasting, disaster management, planning & several other purposes. The establishment of the AWS/ARG network is a vital solution of this problem.

2. Automatic Weather Station (AWS) / Automatic Rain Gauge (ARG)

The Automatic Weather Station (AWS) is a "Meteorological station which takes the meteorological data at regular pre-set intervals & transmits it automatically". The automatic rain-gauges station (ARGs) is a "Meteorological station which takes the rainfall data at regular pre-set intervals & transmits it automatically"

Automatic weather stations have got some added advantage over the conventional meteorological observatories. Some of them are:

a) Data quality is not dependent upon the observer.
b) The stations can be established in the remote locations.
c) The data is taken & transmitted at the same time throughout the network.
d) The frequency of the data can be increased as per the need of the user.
e) The homogeneity of networks can be ensured by standardizing the measuring techniques.
f) -The data is available outside the normal working hours.
g) Lowers the operational costs by reducing the number of observers.
h) The quality data is available almost on real time basis which can be used for weather forecasting purpose / Disaster management etc.
i) The health of stations can be monitored at a centralized location.

Some of the disadvantages of the stations are:

a) The loss of the data due to sabotage (Theft of Solar Panel, Battery etc.)
b) The loss of the data for some of the meteorological parameters e.g. amount of cloud, sudden development in the weather etc.

The main parameters recorded by an AWS are:

- Air temperature

- Relative Humidity
- Atmospheric pressure
- Rainfall
- Wind speed
- Wind Direction

As per the need, the following additional parameters can also be obtained from the AWS:

- Visibility
- Soil Moisture & Temperature
- Solar Radiation
- Snow Depth
- Snow Fall
- Leaf wetness

The meteorological data collected by the AWS may be communicated to the desired places mainly in two ways:

a) Satellite Communication
b) GSM/GPRS Network

Each communication mode has got its own advantages & disadvantages:

i. **Satellite Communication**:

Advantages:

- Meant for Remote & inaccessible regions.
- More secured & faster mode of communication.
- The quality control can be implemented at a centralized location.

Disadvantages:

- Data cannot reach the user directly
- In case of any technical failure of satellite or receiving station, the entire network is paralysed.
- Frequency clearance is required from WPC.

The systematic view of satellite based AWS is shown at Annexure-I.

ii. **GSM/GPRS Communication:**

Advantages:

- The data can be accessed by the user directly.
- No frequency clearance required from WPC.

Disadvantages:

- Does not meant for remote regions. Depends solely upon the availability of the GSM / GPRS network.
- Reliability depends upon the service provider of the network.
- Data transfer rate totally depends upon the network.
- Data may be interrupted due to Local factors (Network jam due to some untoward incident)
- It is basically meant for a localized network.

The systematic view of a GSM/GPRS based AWS is shown at Annexure-II.

The data communication may be done using landline telephone connection as well. But, it is usually not recommended as it requires landline telephonic connectivity for the transmission & reception.

The main components of an AWS/ARG station are:

- Data Logger
- Sat Link Transmitter
- Transmitting Antenna
- Battery
- Solar Panel
- Sensors
- GPS antenna
- Earth station for satellite based AWS/ARG & server / Server for GSM/GPRS based AWS/ARG

Data Logger

`This is the heart & brain of the AWS station. Here the data is collected from the various sensors & processed for transmission. The quality & life of the AWS station is wholly dependent upon the data logger. While selecting a data logger the following points should be taken into consideration:

1) It should have adequate number of analogue & digital channels.
2) It must be configurable at the user end.
3) It should have sufficient communication ports, including USB and Ethernet ports.
4) The user must be able to reload/upgrade the software of the data logger in the field using a laptop.
5) It must be remotely programmable.
6) It must have open architecture to connect any commercially available sensor.
7) It must have its own operating system and compiler.

8) The software of the data logger should be able to check the quality of the data collected by the sensors.

Transmitting Antenna

In case of satellite based AWS, this is a directional antenna which transmits the signal to the Satellite. In case of GSM/GPRS AWS, this is an omni directional antenna which transmits the signal to GSM/GPRS network.

Battery

The battery must be maintenance free & it must be of such a capacity that the AWS station will run uninterrupted even in complete cloudy weather for at least 30 days.

Solar Panel

The solar panel should be enough rating to charge the battery during sun.

Sensors

This is the basic unit of the AWS which collect the meteorological data. The quality of the AWS data is solely dependent upon the quality of the sensors in all weather conditions. In general, extra care must be given in choosing a sensor.

The AWS sensor details and characteristics as per standard requirement ar**e:**

Parameter	**Desirable Height above which it is to be installed**	**Characteristics**
Air temperature	2 m	-20 ℃ to +60 ℃, Accuracy: ± 0.2 ℃, Resolution: 0.1 ℃ (plains) -40 ℃ to +40 ℃, Accuracy: ± 0.2 ℃, Resolution: 0.1 ℃ (hills)
Relative humidity	2 m	0% to 100%, Accuracy: ± 3%, Resolution: 1%
Rainfall	0.6 to 1 m	Accuracy: (+ / -) 2% at 240 mm/hr Resolution: 0.5 mm
Wind speed	10 m	1.2 m/s
Wind direction	10 m	$\pm 5^{o}$

Global solar radiation	2 m	
Soil temperature	-20 cm	Accuracy: ±0.4 ℃
Soil moisture	-20 cm	

The detailed specifications of the different sensors can be established by studying the climatology of the region.

In case of agro AWS, 'Leaf temperature' & 'Leaf Wetness' may also be installed.

Usually these specific sensors are installed for specific purposes & in a highly localized network.

GPS antenna

This is the unit which synchronizes the time using the satellite. All the AWS/ARG units must have its own GPS antenna. This antenna must not be located at a centralized location, otherwise the entire network becomes the slave of the centralized located GPS antenna.

Earth station for satellite based AWS/ARG & Server / Server for GSM/GPRS based AWS/ARG

At earth station the data of the satellite based AWS/ARG is received & processed at the server.

The data of the GSM/GPRS based AWS/ARG station is received at the server using the GSM/GPRS based network & processed further.

Here, the health status of the entire network can be checked & a rigorous check over the quality of the data can be imposed, before it is sent to the user unit. Proper care must be given in designing the application software of the server. Some guidelines are:

1) It should have facility to check the quality of the data as per the IMD guide lines.
2) It must have GUI/GIS based interface.
3) It must have web based monitoring system to check the quality of all the individual stations.
4) It should have the facility for secured FTP service.
5) It should generate the data as per IMD requirement

General Requirement

All the components of the AWS must be rugged enough to operate in tropical environment. The general conditions are:

Operating Temperature range: -40^{o}C to 40^{o}C (hills) and 20^{o}C to 60^{o}C

Weather Condition: All weather including heavy rain & wind upto 60 m/s..

3. General Guidelines for the format of the data

The general guidelines for the transmission of the data is:

i. Instantaneous sampled value of air temperature in deg C at every **X**$^@$ interval and at every full hour UTC.
ii. Max. air temperature of the hour (samples taken every minute).
iii. Minimum air temperature of the hour (samples taken every minute).
iv. Daily maximum temperature
v. Daily minimum temperature
vi. Wind speed in meters / sec at every **X**$^@$ interval with 3 minute vector averaging.
vii. Wind direction in degrees at every **X**$^@$ interval with 3 minute vector averaging.
viii. Wind speed in meters / sec (3 minute vector averaging prior to full hour UTC).
ix. Wind direction in degrees (3 minute vector averaging prior to full hour UTC).
x. Daily minimum and maximum wind speed
xi. Daily maximum wind gust.
xii. Instantaneous value of RH at the end of every **X**$^@$ interval and at full hour UTC.
xiii. Daily maximum and minimum value of Relative Humidity.
xiv. Global solar radiation at an interval of **X**$^@$ interval and full hour UTC.
xv. Soil Temperature at an interval of **X**$^@$ interval and full hour UTC.
xvi. Soil Moisture at an interval of **X**$^@$ interval and full hour UTC.
xvii. Dew Point temperature at every **X**$^@$ interval and at full hour UTC
xviii. Hourly rainfall
xix. Battery voltage (hourly)

4. GENERAL GUIDELINES FOR SELECTION OF AN AWS SITE

The AWS/ARG must be located in such a space which ensures the quality of the data. In general, the guidelines to be followed while selecting a site for installing an AWS shall be the same which have been prescribed by IMD for selecting a site for establishing a Meteorological Observatory. However, keeping in mind the weather insurance requirements and large number of weather stations set-up in private sector for the purpose, some relaxations have been made

Norms for site selection:

i. The AWS is to be located on a level piece of ground, covered with short grass or natural earth approximately 5metres X 7 metres in dimension. The proposed AWS site must be free from obstructions like tall buildings, trees etc.

ii. The site should be free from any encumbrance.

iii. Surroundings should be assessed for potential obstructions to selected sensors. Potential sensor contaminants (e.g., water and dust sources) should be identified.

iv. Security aspect has to be given due consideration so as to avoid theft of AWS equipment.

v. The site should preferably be located on the same level as the surrounding area of the station.

vi. The site must be selected in such a way that the distance between the fencing of the site and the proposed AWS mast should be at least 6 feet (2 meters). This distance is recommended to minimize the effect of the fence on the sensors readings especially when weeds and/or debris on the fence act as a horizontal obstruction.

Conditions to be AVOIDED:

i. Obstructions like tall buildings, trees etc.

ii. Location of the site on the edge of a slope, hillocks, cliff or inside a valley

iii. Large industrial heat sources

iv. Location near high-tension power lines

v. Rooftops, Steep slopes, sheltered hollows, high vegetation, shaded areas or swamps

vi. Low places holding standing water after rains.

vii. Underground obstructions like buried cables or conduits.

viii. Pollution influence from surrounding farms and towns.

5. GENERAL Guidelines for selection of an ARG site

(i) The ARG site should be of dimension 4m x 3m.

(ii) The site shall be free from nearby tall buildings, trees, large water bodies, industrial heat source and high tension cables (both overhead and underground).

(iii) The site with steep slope, high vegetation, low lying place holding water after rain shall not be considered for installation of ARG.

6. General Guidelines for Documentation needed for Site Selection

i. The site location should be documented with maps and photographs.
ii. Information as to the location of the site, corresponding to cardinal directions on the compass, descriptions of obstructions (height, distance, and breadth), vegetation and soil characterization are to be documented.
iii. A site diagram with all the requisite details and a database about the station shall be prepared.
iv. Indications of land use in the nearby areas will be useful for study of variations in meteorological parameters.
v. Permission (No Objection Certificate) from the land-holder of the site for installation of a semi-permanent AWS/ARG installation may be obtained and documented.

The coordinates of a station have to be recorded as under:

- ✓ The latitude to the nearest minute.
- ✓ The longitude to the nearest minute.
- ✓ The height of the station above mean sea level, i.e. elevation of the station to the nearest metre (height of pressure sensor which is located in AWS enclosure).

7. Exposure conditions for main sensors of meteorological parameters

Wind speed and direction (wherever these parameters are used in weather insurance):

The wind speed and direction sensors are required to be installed on a mast, at a height of 10m from ground level.

The sensors are required to be located on the mast, which is installed at a distance of at least ten times the height of nearby buildings, trees or other obstructions.

Air Temp & Relative Humidity:

i. The standard measurement height for temperature and relative humidity sensor is 1.25 to 2m. It will be placed in a radiation shield provided with the sensor.

ii. The sensor is to be located at a distance of at least four times the height of obstructions like trees, buildings etc.

iii. The sensors are generally located in an open level area that is at least 5m in diameter.

iv. The site enclosure should be covered by short grass or natural earth.

v. Large paved areas, bitumen surfaces in the vicinity of at least 30m have to be avoided.

Atmospheric pressure:

The Atmospheric pressure being an important meteorological parameter, the elevation of the station to which the station pressure relates is very important and hence the chosen site must be located in a flat terrain.

Rainfall:

i. The rainfall sensor (tipping bucket) is placed in an open area as far as possible at a minimum distance of four times the height of any obstruction.

ii. The standard measurement height is 30 cm above ground level.

Solar radiation:

Solar radiation sensors to be mounted at a minimum height of 3m to ensure easy levelling and cleaning.

Data logger:

It will be housed in a weather-proof enclosure. The enclosure will be mounted on the tower at a height of about 1.5 m.

A pictorial representation of the AWS site is given in Annexure-III. The figure is broadly suggestive and not exhaustive in nature.

8. GENERAL GUIDELINES FOR AWS SITE PREPARATION

The quality of the AWS/ARG data & the life span of the AWS/ARG station is totally dependent upon quality of the installation. The following norms should be accepted for the installation of AWS/ARG.

a) **AWS enclosure**

The approach to the site should be made free of obstacles like bushes, trees etc. and a suitable cement platform must be laid to approach the site.

- The fencing of the AWS/ARG site should be done in such a manner that it ensures the safety of the instruments in the remote locations.
- The instrument should be beyond the reach of pets & the other animals.
- The site should be such that it should provide a healthy platform for maintenance team.

b) **Tower Foundation**

This is the platform on which the life of the AWS/ARG system is dependent. It should be strong enough to sustain the weight of the mast of the AWS/ARG instrument in adverse weather as well.

c) **Rain Gauge foundation**

The foundation of the rain-gauge should be such that it can sustain the sensor even in the case of very heavy rain. The orientation of the sensor should not be perturbed in case of heavy rain.

d) **Anchor Rod and Guy rope**

In case of AWS system, the anchor rod supports the AWS mast. It should be rugged & strong.

e) **Local Earthing**

It is a common perception that most of the outdoor instruments, start malfunctioning because of the improper earthing. It should be done in such a manner that it protects the AWS from the

f) **Painting**

To protect the AWS from environmental hazards & avoid th rusting , the AWS & its various components should be painted accordingly.

9. Common Problems related to AWS/ARG Network

1) The availability of the proper site.

2) Obtaining of NOC (No objection certificate) from the different agencies.
3) The unservicebility of the stations because of sabotage (Theft of Solar Panel, Copper wire, battery & Sensors)
4) The installation & maintenance of the AWS/ARG in difficult regions (e.g Naxal affected regions, North eastern states)
5) The maintenance & calibration of the AWS/ARG for remote locations. The preventive maintenance (Cutting of grass at the site, Cleaning of sensors & solar panel etc.) should be done at the interval of at most **three** months. The calibration of the sensors should be done at least once a year.

10. <u>Points to be considered before commencement of the project:</u>

1) The budget availability.
2) The availability of the proper AWS/ARG site & 'No Objection Certificate' (NOC) from the respective authorities.
3) Transportation of the equipment to the respective sites (Clearance from the respective state governments)
4) The mode of transmission.(Whether satellite based or GSM/GPRS based)
5) The sensors to be attached with the AWS.
6) If satellite based, the WPC clearance.
7) The availability of the satellite & GSM/GPRS network.
8) The duration at which the data will be processed.
9) Calibration & Maintenance strategy.
10) Format of transmission of data.
11) The similar network of the other agencies(To avoid duplicacy)
12) In case of satellite communication, the duration of the transmission has to be selected in such a manner that the transponder of the satellite does not get saturated.

11. <u>Quality Control of the AWS data</u>

The quality of the AWS data has to be ensure at each & every stage. Some important steps are:

Site Level

The AWS sit must be installed as per the established norms.

Sensor Level

All the sensors must be installed as per the norms specified.(It is usually provided by the manufacturer as per the norms of IMD

Data Logger Level

The data logger must check the quality of the data before it is sent to the transmitter. Some of the important aspects which can be verified is:

1) Range
2) Climatological Average
3) Comparison of the data with nearby stations

Transmission level

There are basically two techniques for the transmission of the data in satellite communication. PRBS (Pseudo random burst sequence) & TDMA(Time division multiple access). TDMA is more advanced in terms of data communication, security & quality. IMD has also shifted from PRBS mode to TDMA mode.

In case of GSM/GPRS based communication, the quality of transmission of the data is totally dependent upon the service provider.

Earth Station Level

The quality of the AWS data can be monitored at the server of the earth station as per the norm of the IMD. The brief features the software must have are:

1) Parity check
2) Range check
3) Consistency check
4) Comparison of the data with nearby stations
5) Comparison of the data with climatological average

The above quality check procedure is just suggestive one. The details may be discussed while preparing the specifications.

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CHAPTER-II

Guidelines for Automatic Weather Station, Installation and Maintenance

1. General

An automatic weather station (AWS) is defined as a "meteorological station at which observations are made and transmitted automatically". At an AWS, the instrument measurements are received by a central data-acquisition unit. The collected data from the autonomous measuring devices can be processed locally at the AWS or elsewhere, for example, at the central processor of the network. Automatic weather stations may be designed as an integrated concept of various measuring devices in combination with the data-acquisition and processing units.

2. **Networking**

An AWS usually forms part of a network of meteorological stations, each transmitting its processed data to a central network processing system by various data transmission means. As the tasks to be executed by this central system are strongly related, and often complementary, to the tasks of the AWSs, the functional and technical requirements of both the central system and the AWSs should be very well coordinated. When planning the installation and operation of a network of AWSs, it is of the utmost importance to consider the various problems associated with maintenance and calibration facilities, their organization and the training and education of technical staff. The siting and exposure of stations have an important influence on the performance of the stations and must be studied before they are installed.

3. Automatic weather station hardware

An AWS consists of an integrated AWOS (and data‑acquisition system) or a set of autonomous measuring devices connected to a data-collection and transmission unit. The layout of an AWS typically consists of the following:

(a) On a standard observing area, a series of automated sensors sited at the recommended positions and heights and connected to a data collection unit using interfaces, or a set of sensors installed in close combination, but not affecting each other, directly connected to a central processing unit (CPU) by means of shielded cables, fiber optics, or radio links, GPRS/CDMA modems, UHF transmitters.

(b) A CPU for sensor data acquisition and conversion into a computer readable format, proper processing of data by means of a microprocessor based system in accordance with specified algorithms, the storage of processed data, and their transmission to remote users for meteorological information;

(c) Peripheral equipment such as a stabilized power providing power to the various parts of the station, a real time clock, and built in test equipment for automatic monitoring of the status of vital parts of the station.

4. Sensors

The sensors used for an AWS are the heart and soul of the system. Therefore a great deal of care should be taken while choosing sensors, appropriate to the user's requirements. The meteorological requirements for sensors used at AWSs are not very different from those of sensors at manual observation stations. Because measurements at most AWSs are controlled from long distances, these sensors must be robust, fairly maintenance free and should have no intrinsic bias or uncertainty in the way in which they sample the variables to be measured. In general, all sensors with an electrical output are suitable. A large number of sensors of varying performance and quality (and price) are suitable for use with automatic data acquisition systems.

The manufacturer's sensor specifications should be read very carefully as they can be misleading in some situations and manufacturer's claims can often not be replicated in the laboratory. For example, a manufacturer may quote the response time for a humidity sensing element but not the combined response time of the sensing element, electronics and filter which can be orders of magnitude longer; also, the manufacturer may quote accuracy for a device such as a pressure sensor but give no indication as to confidence limits of the specification. These omissions can make a large difference as to the suitability of the device.

There are a number of fundamental characteristics which make up the accuracy and precision of a sensor.

- **Resolution** - the smallest change the device can detect (this is not the same as the accuracy of the device).
- **Repeatability** - the ability of the sensor to measure a parameter more than once and produce the same result in identical circumstances.
- **Response time** - normally defined as the time the sensor takes to measure 63% of the change.
- **Drift** - the stability of the sensor's calibration with time.
- **Hysteresis** - the ability of the sensor to produce the same measurement whether the phenomenon is increasing or decreasing.
- **Linearity** - the deviation of the sensor from ideal straight line behavior.
- **Traceability**- An unbroken chain of calibration/verificationfrom a primary standard to the device in question. (Eg. NIST, NPL, World Radiometric Reference)

Frequent replacement of lightweight or unreliable instruments can end up costing more than their more costly counterparts. The swapping of sensors can also have a significant effect on the quality of data, frequently introducing discontinuities into a data series. The usefulness of the data obtained from a sensor is heavily dependent on the calibration of the sensor. For data to be comparable with other sites and networks, the calibration of sensors needs to be traceable back to common standards. This is often difficult to establish, particularly with inferior sensors, but is of equal importance regardless of the quality of the sensor.

Integral to the sensor and its calibration, is sensor maintenance. There is no sensor designed which does not need to be cleaned and checked to verify its calibration. It is important that a maintenance program periodically reassesses the calibration of all sensors; otherwise the data quality will degrade.

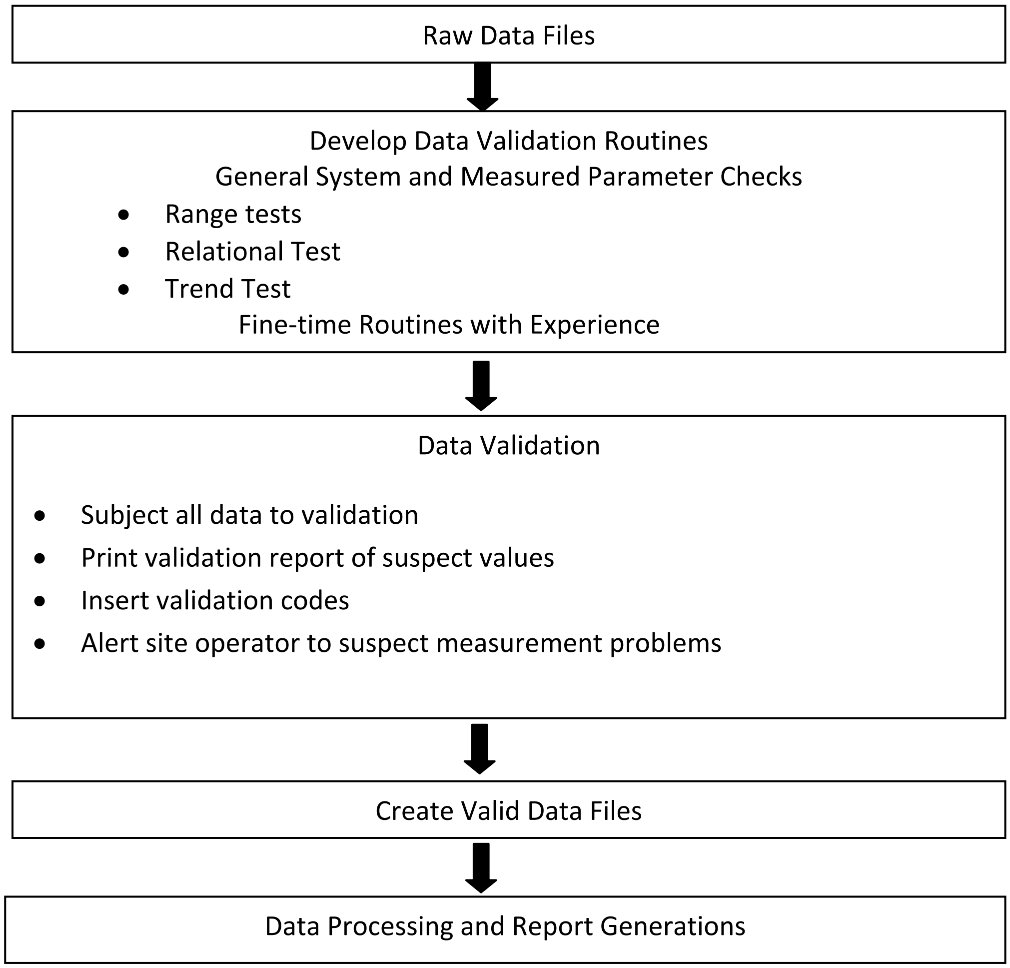
5. Central processing unit

The core of an AWS is its CPU. The main functions of the CPU are data acquisition, data processing & data storage.. In the majority of existing AWSs, all of these functions are carried-out by one microprocessor based system installed in a weather‑proof enclosure as close as possible to the sensors, or at some local indoor location.

6. Quality control

The purpose of quality control at an AWS is to minimize automatically the number of inaccurate observations and the number of missing observations by using appropriate hardware and software routines. Both purposes are served by ensuring that each observation is computed from a reasonably large number of quality controlled data samples. Quality control achieves assured quality and consistency of data output. It is achieved through a carefully designed set of procedures focused on good maintenance practices, repair, calibration, and data quality checks.

7. Maintenance and calibration: Data validation flowchart.



8. **Automatic weather station siting considerations**

The general principle is that a station should provide measurements that are, and remain, representative of the surrounding area, the size of which depends on the meteorological application. Most important points to be considered while selecting the locations are as below;

1) The AWS is to be located on a level piece of ground, covered with short grass or natural earth ideally 15 m x 12 m in dimension. In cases of non-availability of space, 10 m x 10 m would be sufficient.

2) In the case of an Automatic Raingauge Station (ARG) the size of the plot may be 10 m x 7 m.
3) The proposed AWS site must be free from obstructions like tall buildings, trees, etc.
4) The site should be free from any encumbrance.
5) Surroundings should be assessed for potential obstructions to selected sensors. Potential sensor contaminants (e.g., water and dust sources) should be identified.
6) The site should preferably be located on the same level as the roadway of the station.
7) The site must be selected in such a way that the distance between the fencing of the site and the proposed AWS mast should be at least 3 meters. This distance is recommended to minimize the effect of the fence on the sensors readings especially when weeds and/or debris on the fence act as a horizontal obstruction.
8) Conditions to be avoided:
    a) Rooftops, steep slopes, sheltered hollows, high vegetation, shaded areas or swamps
    b) Obstructions like tall buildings, trees etc.
    c) Location of the site on the edge of a slope, hillocks, cliff or inside a valley
    d) Large industrial heat sources
    e) Locations near high-tension power lines
    f) Low places holding standing water after rains
    g) Underground obstructions like buried cables or conduits
    h) Pollution influence from surrounding farms and towns
9) Exposure conditions for sensors of meteorological parameters:
    a) Wind speed and direction
        i) The wind speed and direction sensors are required to be installed on a mast, at a height of 10 m from ground level.
        ii) The sensors are required to be located on the mast, which is installed at a distance of at least ten times the height of nearby buildings, trees or other obstructions.
    b) Air temperature and Relative Humidity

i) The standard measurement height for air temperature and relative humidity sensor is 1.25 to 2 m.
ii) The sensor is to be located at a distance of at least four times the height of obstructions like trees, buildings etc.
iii) The sensors are generally located in an open level area that is at least 9 m in diameter.
iv) The site enclosure should be covered by short grass or natural earth.
v) Large paved areas, bitumen surfaces in the vicinity of at least 30 m have to be avoided.

c) Atmospheric Pressure: The atmospheric pressure being an important meteorological parameter, the elevation of the station to which the station pressure relates is very important and hence the chosen site must be located in a flat terrain.

d) Rainfall
i) The rainfall sensor (tipping bucket) is placed in an open area as far as possible at a minimum distance of four times the height of any obstruction.
ii) The standard measurement height is 30 cm above ground level.
iii) In places where flooding is more, the height may be 1 m from the ground level.

e) Solar radiation: Solar radiation sensors to be mounted at a minimum height of 3 m to ensure easy leveling and cleaning.

9. **Maintenance**

Special protection against environmental factors is often justified, even when initial costs are high. It is evident that, any complex system requires maintenance support. Corrective maintenance is required for component failures. Hardware components may fail for many reasons; computer programs can also fail because of errors in design that can go undetected for a long time. To minimize corrective maintenance and to increase the performance of an AWS, well-organized preventive maintenance is recommended. **Preventive maintenance** is required for all system components, not only cleaning and lubricating the mechanical parts. In view of the increasing reliability of the electronic components of an AWS, preventive maintenance, including services and sensor calibration, will become the controlling factor in maintenance. **Adaptive maintenance** is required to take into account the rapid changes in technology and the availability of spare parts after a few years. Since the maintenance of a network of automatic stations is often a grossly underestimated task, it is essential to organize maintenance according to a rational plan that details all the functions and arranges them so as to minimize costs without adversely affecting performance. The modular structure of many modern automatic stations allows maintenance to take place in the field, or at regional and national centers.

It is important to consider the lifetime costs of an AWS rather than simply the initial cost. Generally, the lower the initial cost, the higher the ongoing cost to maintain acceptable data. In the end, this may result in either a higher total cost or long periods with no useful data.

Field maintenance: In general, it is not advisable to repair AWS sensors or other modules in the field because conditions do not favor effective work. Also, because of high staff costs and relatively low equipment costs, it is more cost effective to discard faulty modules rather than to repair them. It is recommended that corrective maintenance in the field, be carried out by specialized technical personnel. The periodic transmission of self-checking diagnostic information by the AWS is a very desirable practice to ensure rapid response to failures.

National center: A national centre requires more skilled technical personnel, who should be capable of detecting and eliminating complex problems in sensors, modules and data transmission means. The equipment necessary for checking and correcting all parts of an AWS should be available and the work should be performed in the centre. Any recurring defects should be referred to designers or suppliers in-charge of correcting the design fault. As software plays a very important role in each AWS and in the central network processing system, personnel with a profound knowledge of the AWS and central network system software are required. The necessary software development and test facilities should be available. Moreover, the national centre should be able to execute all tasks associated with adaptive maintenance. With reference to the quality-control of network data, it is desirable to establish effective liaison procedures between the monitoring service and the appropriate maintenance and calibration service in order to facilitate rapid response to fault or failure reports from the monitoring system.

10. **Calibration**

AWS sensors with electrical outputs, show accuracy drifts in time and, consequently, need regular inspection and calibration. In principle, the calibration interval is determined by the drift specifications given by the manufacturer and the required accuracy. As signal conditioning modules and data-acquisition and transmission equipment also form a part of the measuring chain, their stability and correct operation also have to be controlled or calibrated periodically.

Field inspection: The periodic comparison of AWS sensors with travelling standards at the station is an absolute requirement to monitor the performance of the sensors. Before and after field inspections, the travelling standards and reference sources must be compared with the working standards of the calibration laboratory. The maintenance service must be informed as soon as possible when accuracy deviations are detected.

Laboratory calibration: Instruments at the end of their calibration interval, instruments showing an accuracy deviation beyond allowed limits during a field inspection and instruments repaired by the maintenance service, should return to a calibration laboratory prior to their re-use. Sensors should be calibrated in a conditioned environment (environmental chambers) by means of appropriate working standards. These working standards should be compared and calibrated periodically with secondary standards and be traceable to international standards. Attention should also be paid to the calibration of the different components forming the measuring and telemetry chain, in particular the signal-conditioning modules. This involves appropriate voltage, current, capacitance and resistance standards, transmission test equipment and high-accuracy digital multimeters. Highly accurate instruments or data-acquisition systems are required for calibration. A schedule should be set up to compare periodically the secondary standards of the calibration laboratory with WMO primary standards.

11. Elements of a Metadata Database related to an AWS

A metadata database should provide detailed information necessary for users to gain adequate background knowledge about the station and observational data, together with updates due to changes that occur. Major database elements include the following:

1. Station information
2. Individual instrument information
3. Data processing information
4. Data handling information
5. Data transmission information
6. Quality Check information

12. Importance of third party weather station accreditation and data verification

As explained above, the siting and exposure of stations have an important influence on the performance of the stations and quality of the data. Hence, it is important to verify the weather station location, sensor specifications etc., to ensure the quality of weather data as this data is important for insurance claim settlement. Occasional missing values or recording erroneous data are common in most of the systems, as the automatic methods point out possible erroneous observations; they are unable to estimate the correct observed values. Hence, one should be careful while selecting this data. As the weather data service providers may not accept the fact of poor quality data either due to lack of in-house capabilities to judge the data quality or due to their vested business interest, it is important to verify the whole network physically once in a year and data quality on regular basis through a competitive third party, who uses many different information sources, such as reference stations, neighboring stations, geographic and topographic data, climatological data, model calculations, satellite information, etc. Though it takes extensive and very costly efforts to construct a perfect quality control system, rational and effective manual control can reduce the number of incorrect observations in the data stream.

In order to maintain the sanctity of the process, it's suggested that the accreditation process shall be done a by a competent third party. The party can be chosen through a competitive bidding process, based on the guidelines finalized by the Committee constituted by the Ministry of Agriculture (GoI).

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CHAPTER-III

Vendor requirements for "Automatic Weather Stations and Data Quality Certification" by the third party Agencies

Apart from IMD there are other public and private weather data providers in specific geographical locations which are currently covered under Weather based crop insurance scheme. In order to maintain the quality of out-put and also have uniformity in the process of installation, collection, collation, archiving and retrieving of weather data guideline is being prepared jointly by IMD, AIC and NCMSL.

In order to ensure that the minimum criteria/benchmark which is fit for purpose is met, it is proposed to bring in a process of certification of weather data and AWS by third party agencies. The present document lists out the requirement specification for organizations which can become third party certifying agencies.

Following are the suggested requirements for 'Certifying Agencies'

1. The vendor / competent firm should have a team of experts with below given qualifications;

    i. At least one agro meteorologist with adequate experience in agro-meteorology
    ii. Agro meteorologist or other resource person, who has at least three years of field knowledge on installations of AWSs and their maintenance
    iii. One or more IT experts, with adequate experience and exposure to latest technologies land data transmission systems

iv. Adequate manpower and resources to undertake pan-India data quality and accreditation services as may be required by the weather data providers and the users

2. The vendor / competent firm should have experience / competence / resources in the following areas:

i. Previous experience of handling large weather datasets
ii. Facility to check the quality of the data as per the IMD guidelines:
iii. Proven track record of experience in weather data quality checks:
iv. Expert(s) to develop algorithms for weather data quality checks and / or certification
v. Exposure / experience of other data networks available in the market, including meteorological satellites, and
vi. Exposure / experience of meteorological satellite and experience in handling the weather data from those satellites.

3. Based on the criteria set above, a panel of three to five vendors / competent firms shall be empanelled

4. The vendor / competent firm empanelled shall in no case directly or indirectly be related to or promoted by the weather data provider in the market

5. A vendor / competent firm shall be chosen for a particular activity jointly by the weather data provider and the user agency

6. Professional charges / fees of the certification & accreditation vendor / competent firm shall be borne by the weather data provider.

7. Proposed schedule of certification & accreditation w.r.t. age of the weather station and sensor is as follows:

S.No	Age of the Weather Station and Sensor	Proportion

1	Upto one Year	5% of stations
2	Above One Year and upto two years	10% of stations
3	Above Two Year and upto Three years	15% of stations
4	Above Three Year and upto Four years	20% of stations
5	Above Four years	25% of stations

8. The weather stations for inspection as per the scale mentioned above, shall be representative and chosen by the data user? Sampling criteria can be set which need to be followed.

9. The vendor / competent firm who inspected the weather station for certification & accreditation shall submit the report to both the weather data provider and the data user within three weeks from the inspection.

10. Weather data provider shall strengthen and improve the installation, maintenance and data quality standards as recommended by the certification & accreditation vendor within a reasonable time.

11. Government of India / IMD in consultation with data users may issue further guidelines from time to time, and if necessary

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