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MATERIALS MANAGEMENT DIVISION
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Technical Specifications for the procurement of Eddy covariance tower

Sensors and specifications:

1. **Open Path CO_2/H_2O gas Analyzer**

- Should be capable of measuring at 10 and 20 Hz frequency (programmable by software)
- Accuracy: Within 1% of measurement
- RMS error for CO_2: Less than 0.2 PPM at 20 Hz
- RMS error for H_2O: Less than 0.007 mmol mol^{-1} at 20 Hz
- Minimum range of measurement: CO_2: 0 to 1000 µmol mol^{-1} and H2O: 0 to 50 mmol mol^{-1}
- Measurement drift
    - Zero Drift values within ±0.05 PPM per degree Celsius for H_2O and ±0.3 PPM per degree Celsius for CO_2
    - Gain drift within ±0.3% of reading per degree Celsius for H_2O ±0.1% of reading per degree Celsius for CO_2

Should include the calibration kit for the open path gas analyzer

2. Precision digital 3D Sonic Anemometer and thermometer

Variable	Range	Resolution	Accuracy
Wind Speed	0 to 60 ms^{-1}	0.01 ms^{-1}	RMS less than 1.5%
Wind Direction	0–359 Degrees	0.1°	1°
Sonic Temperature	–35 °C to 60 °C	0.01 °C	-

Should have an internal measuring frequency of more than 25 Hz.

3. Air temperature and Relative humidity sensor with heat shield

Variable	Range	Resolution	Accuracy
Air temperature	–20 °C to 60 °C	0.01 °C	±0.1 °C
Relative Humidity	0–100 % RH	0.1 %	±1 % RH (between 0–90% RH range) at 25 °C temperature

4. Four component net radiometer

Should be able to measure and output incoming and outgoing components of the shortwave and longwave radiation components. The pyranometer and the pyrgeometer (for measuring the shortwave and longwave components respectively) should meet the specifications given below:

Characteristic	Pyranometer	Pyrgeometer
Spectral range	0.3 to 2.5 µm	5 to 40 µm
Measurement range	0 to 2000 W m^{-2}	–200 to 200 W m^{-2}
Uncertainty	< 5% of daily total	< 10% of daily total
Deviation from calibrated responsivity (non-linearity)	<1%	<1%
Maximum change of sensitivity per year	< 1%	< 1%
Sensitivity	< 20 µV per W m^{-2}	< 15 µV per W m^{-2}

The Net radiometer should have a heating and ventilation unit to prevent dew deposition on the pyrgeometer.

5. Self-calibrating soil heat flux plates – 3 nos.

Sensitivity: 50 µV per W m^{-2}

Temperature range: –25 °C to +65 °C

Accuracy: Maximum ±5 % of true value

6. Tipping bucket rain gauge

Resolution: 0.1 mm

Accuracy: with 1% with rainfall up to 50 mm per hour

7. Probes for measuring the soil moisture and soil temperature – 3 nos.

Preferred method of measurement: Coaxial impedance dielectric sensor. However, any other standard and proven principle such as TDR, FDR are also acceptable.

Accuracy of soil moisture measurement: < ± 3%

Accuracy of temperature measurement: ±0.1 °C

8. Quantum Sensor for measuring the photosynthetically active radiation

Spectral range: 400 to 700 nm (±4 nm)

Response time: < 1µs

The measurement should be stable with a change less than 2% per year.

9. Data logger (Hereinafter refrred as data collection platform, DCP) for the fast and slow response sensors. The DCP should be able to store all the high frequency EC

data without any day loss. It should be possible to retrieve all the data from the DCP using a memory card/USB Stick or through connection with a laptop.

1. The Data Collection Platform (DCP) should incorporate the latest state-of-the-art technology and must consume very low power. Since the equipment will have to operate under stringent weather conditions, the system should be rugged and sealed to avoid ingress of moisture.
2. The complete details of the current set up of the DCP should be provided. The loading of setup/program will be demonstrated with Laptop separately. The user manual should spell out the settings. A separate copy of the set up program (if any) should be provided on a CD or Pen drive.
3. The design of the DCP should be modular and the replacement of the modules should be easy and user friendly.
4. The DCP should have least tuning parts (preferably none) and should provide consistent performance for at least two years.
5. The complete Technical Demonstration should be provided.
6. User manual for the station will also be provided by the firm which will include the setup/program details, calibration constants, wiring diagram of the concerned sensors, and any other station specific details.

10. All the sensors must have corresponding mounting brackets, crossbars, cables and fixtures required to fix the sensors to the tower structure and connect the sensors with the power source and the data logger.

<u>Other components:</u>

- Solar panels and battery with charge controller for power supply to all the sensors.
- GSM communication modem to remotely transmit the data continuously to a server located at IIT Bombay.
- A 7m tall tower structure to hold the sensors. It should be possible to change the height of the EC sensors continuously from 2 m to 7 m height as and when needed.
- Suitable software to collect the stored data (raw data from all the sensors) and process the data into turbulent and radiative fluxes. The Software should also be able to gap fill the processed fluxes using multiple approaches.

<u>Delivery/installation and maintenance</u>

- The instruments should be delivered to the Department of Civil Engineering at IIT Bombay by the vendor.
- The instruments will then be transported to the field site by IIT Bombay.
- The vendor should install the tower structure and all the sensors and demonstrate the sensor working and data collection. In addition, the vendor should ensure that the data is transmitted through the GSM module and received remotely at the server at IIT Bombay.

- The vendor should provide annual maintenance of the sensors (3 years) and provide re-calibration if some sensors drift away from their normal performance
- The vendor should provide training to 2 researchers on the principles of eddy covariance measurements, data collection and data processing.

Eligibility for vendor:

- The vendor should be an authorised distributor and maintenance provider certified by the manufacturers of the different sensors placed in the EC tower.
- The sensors (both fast and slow response sensors) should be from manufacturer(s) who have demonstrated the reliability and accuracy of the sensors through deployment in at least 5 sites belonging to any of the global flux network such as AmeriFlux, Fluxnet, TERENO observatory in Germany, AsiaFlux etc. across the globe.
- The vendor should have demonstrated installation and maintenance of EC systems in at least 3 sites in India and maintaining them for at least 1 year. A support letter from PI of any of the EC tower will be required.