Ministry of Earth Sciences (MoES)
Government of India
REACHOUT
PAMC-Technology

Expression of Interest – Indigenous development of equipment

The primary mandate of the MoES is to provide the nation with the best possible services for weather, climate, ocean, coastal and natural hazards, sustainable harnessing of ocean resources, and exploration of the Polar regions. This is being done through nurturing Research and Development (R&D) in MoES autonomous, R&D laboratories in and academic institutions in the country.

2. These institutions utilise various equipment/ instruments that broadly deal with the observations like weather parameters, detection of earthquakes, measuring receding ice in polar regions, oceanic currents and marine biodiversity. Majority of the equipment/ instruments are procured from abroad at very high cost and hence number of instruments availability far below the requirement. Foreign companies have the advantage of being first and develop such equipment on a mass scale as required by other similar institutions globally. However, alternate options for developing such equipment/ instruments within India may save the time and money, enabling capacity build up in the country in the spirit of Make in India.

3. Among various schemes of this Ministry, Research, Education, Training and Outreach (REACHOUT) promotes technology development and necessitates the indigenous development of equipment attributing to the vision of *Make-in-India*. The Ministry of Earth Sciences invites Expression of Interest (EOI) (format in Annexure I) from Universities, Research/ Academic institutions, as well as governmental/ non-governmental organisations in the country for focused design and development in the following three specific equipment:

i. Micropulse-LIDAR (specifications in Annexure II)
ii. Seismometer (specifications in Annexure III)
iii. Accelerometer (specifications in Annexure IV)

4. The PIs may portray their specific interest in the technology development for any one or more of the equipment (apart from the above) through the EOI as per the guidelines. The EOIs received will be examined and evaluated by Experts and accordingly shortlisted ones will be informed to submit detailed project proposals. Modifications in the specifications of the equipment will not be encouraged, but may be allowed if mentioned explicitly in the EOI and felt justified by the evaluation committee.

5. As per the MoES norms:

i. The equipment developed by the supported proposals will be transferred to the MoES for real-time use/applications before the closure of the project tenure.
ii. All equipment/assets procured form MoES funds shall be maintained in the stock Register and no asset/equipment etc., shall be diverted and/or disposed off without prior approval of the competent authority of the MoES

6. Guidelines and deadlines:

i. The duration of the project could be for **18 months.**
ii. Page Limit of EOI: **5 pages**
iii. Please submit your EOI through email at pamc.trb@gmail.com in the format mentioned in **Annexure I**
iv. The last date for receiving the EOI: **1st May, 2024.**
v. For any further queries, please contact:
    a. Dr. M. Ashokan, Scientist D, Ministry of Earth Sciences (ashokan.m@gov.in)
vi. Kindly note: Only those PI(s) who communicate their EOI within the above-mentioned deadline will be considered for invitation for a full proposal. However, sending the EOI does not guarantee acceptance of the project proposal by the Ministry.

Annexure I

1. Details of Principal Investigator (PI) and Co-PI (Name, Designation, Affiliation)
2. Thrust Area and equipment
3. Title of the project
4. Keywords
5. Project Details which include the following:
    i. State of knowledge (both at national and international level) (< 500 words)
    ii. Objectives
    iii. Experience of PI/Co-PI in the subject of the proposal
    iv. Working demonstrations
    v. Manufacturing capabilities (Make in India)
    vi. Servicing/ warranty facilities
    vii. Deliverables
    viii. Methodology (< 500 words)
    ix. Period of work proposed with tentative timeline

NOTE: Proposal to be submitted in Arial font with font size 11 and 1.5 spacing.

Annexure II

i. Micro Pulse LIDAR

1. **Transmitter:**
   a. Laser wavelength: 532 nm (with options for adding multiple wavelengths)
   b. Laser type: Nd:YAG
   c. Pulse energy: 6-10 μJ (typical); suitable to detect upto 20 km or better
   d. laser pulse width: ~10 ns (typical)

2. **Receiver:**
   a. Telescope type: Schmit-Cassegrain
   b. Diameter of telescope: 20 cm (typical) (larger may increase the collection efficiency)
   c. Field of view (FOV): 0.5 mrad (typical)
   d. Interference filter bandwidth: FWHM 3 nm (typical)
   e. Polarization measurement: Horizontal and vertical

3. **Detectors:**
   Si-APD single photon counting modules, discriminator and Photomultiplier tubes or similar (high sensitivity)

4. **Data Acquisition System:** Multi Channel Scaler (MCS) or Transient recorder

5. **Detectable Range:** Up to 20 km or more

6. **Range resolution:** Data from 100 m at every 15/30/ 75/150 m (user defined)

7. **Controls, Data processing and Display:**
   a. Measurement Control : Automatic, Programmable and remote control
   b. Computer and display : PC/Laptop, 32" LED display
   c. Operating environment : Windows and Linux (if possible)
   d. Software : Instrument Control, System Alignment and setting-up procedure, Lidar data acquisition, storage, analysis, Database for data storage
   e. Computer Interface : USB
   f. Data Transfer : LAN Ethernet
   g. Standard Data Products : Raw signal, backscatter coefficients, extinction coefficient, backscattering ratio, depolarization ratio
   h. Operating voltage : 230 ±20V AC, 50 Hz (backup options like batteries)
   i. Ambient Temperature range : 10 to 50 °C or higher range if possible to encompass extreme weather conditions
   j. Ambient Humidity range : up to 100%

8. **Enclosure:** Rugged weatherproof enclosure for outdoor use and robust to counter varied temperature conditions. Preferably transportable.

9. **Operation:** Should be suitable to operate 24 hours

10. **Warranty:** One year warranty

11. **Other parameters that may require mentioning:**
    a. output data format
    b. signal conditioning before transferring to the computer
    c. computer network protocols
    d. requirements of continuous acquisition software
    e. processing and display software

Annexure III

ii. Specifications of Accelerometer (Strong motion sensor)

The accelerometer is a widely used sensor, installed in National Seismological Observatories for earthquake monitoring, Earthquake Early Warning Systems, and structural health monitoring for high-rise buildings and bridges, dam safety monitoring etc. Its applications go beyond those of a broadband seismometer. The tentative specifications of accelerometer sensor, required by these users, are given below:

1	Transducer	Tri-axial, Mechanical Force balance transducer in a single sealed module with output for one vertical (Z) and two horizontal components (N-S and E-W) orthogonal to each other.
2	Frequency response	Flat response (within +/- 3dB) to ground acceleration, at least in the range of DC to 100 Hz or better.
3	Dynamic range	≥130 dB @1Hz
4	Output voltage from the sensor	Analog varying voltage up to ±20V DC, compatible with a wide range of data acquisition systems and ensuring high-quality signal integrity over long cable runs. This output voltage range is compatible with commonly used data acquisition systems and doesn't require additional signal conditioning.
5	Full Scale Range	At least ±2g, (or ±4g is also acceptable)
6	Damping	0.7 of critical.
7	Linearity	Less than 1% of full scale.
8	Cross-axis sensitivity	Less than 1% of full scale
9	Calibration facility	Calibration coil within the sensor to apply step, sine and impulse pulse to assess the working performance of the sensor from time to time
10	Noise Response	Noise response should be less than 0.001% of full scale for the entire frequency band.
11	Indicators	Should have an indicator mark on its body to indicate the direction of relative orientation of the sensor.
12	Humidity and operating temperature range	0 to 100 % RH, and 0° to 50°C.
13	Power requirement	< 2 watts at 12V DC. However, the sensor is powered through 12V DC supply from the digitizer or data acquisition system (DAS), so that additional battery exclusively for the operation of the sensor may not be required.
14	Housing	The triaxial sensors should be mounted in a single water-proof and vacuum-tight enclosure.

iii. BROADBAND SEISMOMETER

1.1.1	Type	Triaxial electronic force balance broadband velocity transducer in a single sealed module with output for one vertical (Z) and two horizontal components (N-S and E-W) orthogonal to each other.
1.1.2	Frequency Response	Flat (within ± 3dB) to ground velocity, at least in the range 120 sec or better to 50 Hz.
1.1.3	Dynamic range	Minimum / At least 150 dB
1.1.4	Output voltage	±20 V
1.1.5	Damping	0.7 critical
1.1.6	Sensitivity	Minimum 1000 v/m/s
1.1.7	Linearity	+/- 1% of full scale.> 100 dB
1.1.8	Clip Level	10 mm/s or better up to 5Hz
1.1.9	Mass centering	Automatic or on external command locally or from remote
1.1.10	Calibration Facility	Calibration facility from Data Acquisition System (DAS)
1.1.11	Frequency response curve and system information	Frequency response curve of the unit along with information regarding transfer function including poles and zeros should be provided as per the serial number of the sensor
1.1.12	Electronic self-noise	Must be below the USGS Low Noise Model over 150 sec to 10 Hz range
1.1.13	Indicator	a) Should have an indicator for leveling the transducer. b) Should have an indicator mark on its body to indicate the direction of relative orientation of the seismometer.
1.1.14	Operating Temperature	-20° to 75°C
1.1.15	Humidity tolerance	Up to 100 % RH
1.1.16	Power Requirement	Less than 1.5 watts at 9-24V DC derived from the DAS
1.1.17	Housing	All the components should be permanently mounted in single stainless steel or cast aluminum casing, water tight, vacuum tight enclosure.
1.1.18	Mass Locking	Automatic Mass Locking facility during transportation
1.1.19	Connectors	Water proof and rust proof
1.1.20	Cable	Low-loss shielded cable of at least 5 meters with end connectors.
1.1.21	Thermal insulation cover	An PVC air-tight thermal insulation cover should be provided from OEM.
1.1.22	Supporting Document	The Bidder should provide detailed technical documentation of the sensor supplied

Strong Motion Sensor (Accelerometer)

1.2.1	Type	Tri-axial, Mechanical Force balance transducer in a single sealed module with output for one vertical (Z) and two horizontal components (N-S and E-W) orthogonal to each other.
1.2.2	Frequency response	Flat response (within +/- 3dB) to ground acceleration in the range of DC to 400 Hz.

1.2.3	Dynamic range	At least 150 dB
1.2.4	Full Scale output voltage	Up to ±20V
1.2.5	Full Scale Range	±0.5g to ±2g (or better) user selectable through DAS,
1.2.6	Damping	0.7 of critical.
1.2.7	Linearity	Less than 1% of full scale
1.2.8	Clip level	Greater than full scale range
1.2.9	Cross-axis sensitivity	Less than 0.1% of full scale
1.2.10	Mass centering	Automatic
1.2.11	Calibration facility	Calibration procedure from the Data Acquisition System to check the working performance of the sensor, free period, damping etc. locally and from CRS should be provided.
1.2.12	Frequency response curve and system information	Frequency response curve of the unit along with information regarding transfer function including poles and zeros should be provided.
1.2.13	Noise Response	Noise response should be less than 0.001% of full scale for frequency band of DC to 400Hz or better.
1.2.14	Indicators	a) Should have an indicator for levelling the transducer. b) Should have an indicator mark on its body to indicate the direction of relative orientation of the sensor.
1.2.15	Humidity and operating temperature range	Up to 100% RH, and -10° to 75°C
1.2.16	Power requirement	< 1.2 watt at 9-30V DC.
1.2.17	Housing	The tri-axial sensors should be mounted in a single water-proof and vacuum-tight enclosure.
1.2.18	Mass locking and safety mechanism	Must contain a robust locking and safety mechanism during transportation.
1.2.19	Connectors	a) All connectors should be water-proof and rust-proof. b) All nuts and bolts should be provided for installation/anchoring the sensor on the seismic pillar
1.2.20	Cable	Low-loss shielded cable of at least 5 meters with end connectors.
1.2.21	Supporting Document	The Bidder should provide detailed technical documentation of the sensor supplied

Data Acquisition System

1.3.1	Number of Channels	Six channels (3 for weak motion sensors and 3 for strong motion sensor) in a single house.
1.3.2	Dynamic range	At Least 135dB or more measured at 100 sps
1.3.3	ADC resolution	24 bit independent digitizer for each channel
1.3.4	Input Range	Should match the sensor outputs
1.3.5	Common Mode Rejection	Greater than 70 dB
1.3.6	Channel to channel skew	a) Zero- Simultaneous sampling of all channels. b) Immune to electro magnetic interference.
1.3.7	System noise	Not more than 2-3 counts of 24 bit system

1.3.8	Sampling rate	a) User- selectable 10,20,50,100 and 500 sps per channel in different streams both in continuous and trigger modes simultaneously as per user requirements. b) Provision to select different sampling rates for weak motion and strong motion channels. c) Provision to record the data for weak motion on continuous mode and strong motion on user set threshold trigger ratio
1.3.9	Filter	Linear phase digital FIR filter.
1.3.10	RAM	At least 128 MB RAM or better
1.3.11	Storage Type	Industrial grade SD card memory card of 32 GB or more to record the weak and strong motion data in ring-buffer configuration.
1.3.12	Recording Format	Standard seismological format compatible with Windows/ UNIX with proven compression technique. It should be easily convertible to SEED, SEISAN, ASCII formats etc.
1.3.13	GPS Timing System	a) UTC timed with digitally controlled precision VCXO clock phase locked to GPS b) Timing accuracy less than 0.1mSec when GPS is locked c) Free running TCXO accuracy of 1 ppm over wide temperature range. d) GPS receiver electronic circuit should be inside the DAS with Antenna exposed to outer side e) Antenna thick cable length should be 15 mts or more. f) Antenna should be enclosed in water tight and can work effectively in extreme climatic conditions. g) Antenna mounting rod and its accessories. h) The antenna cable should withstand harsh weather conditions.
1.3.14	Sensor control	a) Sensor calibration facility for both BB seismometer and Accelerometer b) Sensor mass position monitoring for BB seismometer. c) Sensor mass centering on command for BB seismometer.
1.3.15	State of Health Channel	Provision for checking state of health information like sensor mass position, temperature voltage, condition of GPS time lock etc. locally and remotely.
1.3.16	Status Indicator	Status indicators for power, data acquisition, SOH, GPS lock etc. should be provided.
1.3.17	Gain	Hardware gain selection through DAS for 0.5, 1, 2 and 4
1.3.18	Data acquisition Mode	Both continuous and trigger mode
1.3.19	Trigger	User selectable, independently for each channel at different sampling rate based on triggering criteria as STA/LTA level etc.
1.3.20	Communication	a) In built communication interface circuitry for provision of remote data acquisition and State-of-Health in near real time mode through V-SAT. b) Suitable interface for computer/ laptop for parameter setting and data downloading.
1.3.21	Transmission setting	Should have facility to select transmission to remote location in following options: a) continuous mode transmission for BB data b) continuous or trigger mode transmission of SMA data as per user configuration

1.3.22	VSAT connectivity	a) Ethernet port (10/100 Base-T) supporting TCP/IP and UDP/IP, Multicast b) Compression of data before transferring to VSAT. c) Continuous and trigger both. (6 channels) d) Duplex communication between field and central recording station at Dehradun e) Extensive error correction f) Support for off-the-shelf communication equipment
1.3.23	Power Supply	a) Supply voltage 9-24Volts through solar panel activated maintenance free batteries. b) Power consumption of DAS less than 3W at 9-24V DC recording 6 channels at 100 SPS including the GPS continues mode and ethernet enable mode. c) Low battery voltage protection d) DAS shall resume data acquisition and transmission automatically when the power is restored. e) DC-DC converter should be installed with all the DAS
1.3.24	Operating temperature and humidity range	a) Operating Temperature -20 deg to 60 deg C b) Humidity up to 100% RH
1.3.25	Environment	All the indoor units should work in typical tropical environment conditions and should work without air conditioning.
1.3.26	Housing	a) GPS and DAS modules should be enclosed in a weather- and shock-proof sealed enclosures with lightening protection. b) Earthing is to be provided to digitizer, if necessary, for trouble free operation.
1.3.27	DAS Firmware capabilities	The firmware/software in DAS should support the following: a) Real time ground motion data acquisition (weak motion and acceleration data) in DAS including GPS data and State of Health monitoring, b) Transmission of recorded data to central station in near real time using VSAT communication facilities in continuous or trigger mode or both as per user selected criteria. c) Restoration of automatic data acquisition in DAS on assumption of power in case of power failure.
1.3.28	Solar Power & Battery	The bidder should recommend the requirement of the battery, solar panel, charge controller, technical details of the cable, etc., to procure locally from India.