Common Sensor Platform Station Requirements

EarthScope Consortium, Inc.
May 17th, 2024

Revision History

Date	Version	Author(s)	Change
5/17/2024	1.0	MO, KA, NB, GE, WG, WJ, DM, JS, MS, KW, EW	Creation

Table of Contents

Overview

EarthScope's Common Sensor Platform (CSP) project aims to standardize geophysical instrumentation stations into a scalable, modular design applicable across multiple sensor types. At the CSP's inception in April 2022, the following objectives were identified:

- Maximize Principal Investigator (PI) scientific goals and data quality by improving station reliability and in-situ condition reporting.
- Capitalize on the broad engineering expertise at EarthScope to promote design uniformity.
- Optimize engineering operations by maximizing field operation efficiency, reducing redundant operations/procedures, and increasing efficiencies in component production and stocks.
- Cultivate a collegial, creative, and open-source engineering culture through standardizing systems, engineering processes and practices, and normalizing regular design reviews and technical exchange meetings.

Document Purpose and Scope

This document addresses requirements pertaining to the core CSP station design and will be used to produce further documentation, including the CSP Technical Design Document (TDD) and a set of guidelines for component selection. It will also inform future station engineering versions.

The following items are out of scope:

- Station designs that do not meet scientific project objectives or are outside of the scope of sponsored-sanctioned activities.
- Use cases that represent one or more of the following conditions:
    - Portable, or short-duration, stations*
    - Sites in geographic locations posing unique environments, such as volcanic craters or sites with unsteady ground material.
    - Power systems that draw in excess of 150W.
    - Any other constraint that requires a custom design.
- Information denoting requirements for field personnel safety, travel, or training.
- Specifications for station components. Requirements inform design specifications, which may change over time as new technologies are adopted and these are, in turn, captured in the TDD.

*Portable stations and custom designs may meet any number of requirements listed in this document, however, they shall not drive nor otherwise influence the CSP station requirements or engineering design.

This document shall be revised as needed to reflect any changes in technology, enterprise scope, and operations as they pertain to the CSP.

Assumptions / Constraints

The following assumptions and constraints are acknowledged:

- For the sake of this document and of a CSP station design, it is assumed a project's scientific goals can be achieved with existing, or easily acquired, technology.
- It is assumed that adequate funding for the project and station construction and installation have been obtained.
- Station costs are dictated by agency or sponsor funding, as well as site and project-specific logistics and requirements.
- Best practices, protocols, and procedures as they relate to the testing and evaluation of instrumentation or equipment are defined by the Testing & Evaluation engineering subunits within the Instrumentation Engineering group at EarthScope.

Document Conventions

Mandatory: "Must" and "Shall" represent the core functionality and must be included in the design or solution.

Desirable: "Should" designates a feature or functionality that is recommended. Effort should be applied to meet this requirement; however, it is not mandatory.

Optional: "May" indicates conditions or functionalities that are permissible and may be accepted into the design once all mandatory requirements are met and as resources allow.

Technical and Functional Requirements

1. Sensors and Sensing Systems

A sensor is a device or component that detects changes in its environment and converts them into signals or data that can be interpreted or used by other systems. Sensing Systems are defined as the sensor and data logger/digitizer. This section describes the requirements as they pertain to the autonomous operation of sensors and sensing systems within a CSP station.

1.1. Instrumentation shall meet PI/Project/Program requirements for accuracy and deliver required metadata elements.

1.1.1. Deliverables from sites are as follows:

1.1.1.1. Raw data ("lowest-level practical output") from sensors; for example, GNSS, seismic, strain, tilt, meteorological, magnetotelluric instruments, geodetic imaging, and other emerging technologies (i.e. DAS).

1.1.1.2. Metadata elements that may be produced by the sensor system, intermediate processing, or by external tools.

        1.1.2. Deliverables shall be uploaded to open source Facility archives to grant public access after any and all data moratoria have been completed according to funding agency requirements.
            1.1.2.1. In some cases, the responsibility for making deliverables accessible to the public falls onto the Principal Investigator (PI).
            1.1.2.2. Commercial data streams may have restricted access.

1.2. New instrumentation shall be evaluated using standard methods as defined by Standard Operation Procedures (SOP) prior to acquisition and adoption into the equipment pool.
    1.2.1. New instrumentation must meet science requirements. This may include on-site processing for some types of equipment.
    1.2.2. New instrumentation must meet functional and logistical requirements.
    1.2.3. New instrumentation should be evaluated for compatibility with the CSP Core Station design.

1.3. Sensor connectors and other materials (including cables).
    1.3.1. Sensors and cables shall meet environmental requirements, such as environmental exposure, as specified in Section 7.
    1.3.2. Vendors should provide information on environmental testing procedures and data, provided an NDA is in place.

1.4. Broadband electronics must be isolated from electronic interference induced by power supplies, solar regulators, network switching, and other electronics as they require clean power.

2. Data Acquisition Systems

Data acquisition units receive input from a sensor and may digitize, process, and/or store data locally at the station. Selection shall be prioritized for reliable long-term data storage for ease of communication with instrumentation or sensor, for functionality in configuring acquisition parameters, to minimize power consumption, to allow for common metadata elements to be recorded, and to provide State of Health (SOH) information.

2.1. All sites should have the capacity to store data to meet science requirements in the event of a communication failure. The minimum recommended capacity of data storage will be determined by instrumentation choice and by project scope and requirements.
    2.1.1. Some stations may be configured to store data locally and may only telemeter SOH information.
    2.1.2. Sites that may be logistically challenging to access, or that produce data at higher-than-typical rates, may require additional storage capacity. System memory should be expandable when required.
    2.1.3. Customizable data products may reduce storage requirements.

2.2. New technologies shall be evaluated on a regular basis in order to mitigate end of life limitations and identify appropriate replacement systems.

2.3. New data acquisition units must be compatible with existing data collection systems.
   2.3.1. MiniSEED-compatible acquisition systems:
      2.3.1.1. Must have the ability to support SEEDLink if realtime data telemetry is desired.
      2.3.1.2. Priority should be given to systems that plan to be compatible with future technologies, such as miniSEED v3 and Seedllink v4.
   2.3.2. GNSS stations:
      2.3.2.1. Equipment that uses a manufacturer's proprietary format should be capable of being decoded to standardized data formats, such as RINEX. Data decoding should take place on the receiver rather than at the Data Center.
      2.3.2.2. A manufacturer's proprietary format should be fully documented.
      2.3.2.3. For streaming data, BINEX format may be required.
      2.3.2.4. Other streaming data formats may be necessary for custom data requests and applications.
      2.3.2.5. Receivers must support logging rates and streaming based on science requirements.
2.4. Data acquisition systems and data flow should be designed to accommodate changing science requirements, such as the addition of secondary instrumentation.
2.5. Real-time acquisition systems should transfer geophysical data and state-of-health parameters to a central Data Collection Center (DCC).
2.6. Standalone or assembled data volumes shall be ingested through various means.
2.7. Equipment should be configurable through a standard communication port.
   2.7.1. Standard communications are defined in the Glossary.
2.8. On-site processing hardware may be desired for certain applications.
   2.8.1. Processing hardware should be low-power (<2W) and allow custom software to be installed.

3. Station Networking

Station Networking refers to all internal communications within a station; for example, from a datalogger to a communications device.

3.1. Stations should use the lowest power device (i.e. switch/router) that meets networking needs and environmental conditions.
3.2. If needed, managed routers should meet security best practices as advised by IT and should be compatible with the project's communication requirements (i.e. VPN).
   3.2.1. A document outlining best practices is forthcoming and will be linked to this document in future versions.

3.3. Devices must require vendor-provided configuration software or built-in user interfaces that are compatible with multiple operating systems, such as web-based interfaces.

4. Telemetry and Data Transport

Telemetry and data transport at a station involve the processes and technologies used to remotely collect, transmit, and manage data from the station to external processing centers, ensuring continuous and accurate monitoring and analysis.

4.1. The project needs will determine the following communication systems metrics from which specifications will be determined: bandwidth, data volumes, and maximum acceptable data latency between the station and data archive.

4.2. The station communication system must be designed to meet the project's data telemetry requirements, as defined by Section 4.1, and remain within project budgets.

4.2.1. Data transmission options may include manual download, limited SOH broadcast, daily automated downloads, and high rate and real-time telemetry.

4.3. Communication devices shall meet site power budget.

4.4. Antennas shall be placed within the manufacturer's recommended distance from the communication device so as to avoid RF signal loss over the overall cable length.

4.4.1. If the antenna must be placed at a greater distance from the modem specification or provided cable length, the coax cable for the site must be replaced with an alternate cable that minimizes signal loss.

4.5. Communications devices and antennas will be placed in such a way and at a proper distance to avoid interference with instrumentation and other components.

4.6. Communication devices must provide network and state of health monitoring abilities (e.g. Simple Network Management Protocol (SNMP)).

4.7. Platforms should be designed in a way that easily accommodates additional types of communication as needed (eg cell phone data networks, wifi, etc). Individual stations may have specific requirements that differ from the norm or standard.

4.8. New Equipment Evaluation:

4.8.1. Vendors shall provide technical specifications and operational and configuration documentation for any communications systems prior to delivery.

4.8.2. Any communications system shall be internally evaluated to ensure the devices meet the vendor specifications and any additional requirements as defined by the project requirements.

4.9. Communication systems will be designed to facilitate ease of setup in the field.

4.9.1. Setup time should be minimized. See Section 8 for Installation requirements.

4.10. Communications systems should be configured to allow field staff or representatives to check if communications are operating properly, preferably while at the site, or at least remotely.

4.11. Secured access to communications will be controlled to save bandwidth and prevent accidental configuration changes, data loss, and hacking.

4.12. Communications systems will meet known IT security standards as required by the host agency or government (i.e NIST).

4.12.1. The latest model should be selected to mitigate any end of life issues and consequent lack of security updates.

4.13. Communications systems shall meet any additional funding agency or host organization requirements, such as any limitations regarding the country of origin or manufacture, prohibited frequency bands, etc.

4.14. Backup configurations for communication equipment should either be downloaded automatically through a network management system or downloaded manually when changes are made remotely or onsite.

4.14.1. Configurations shall be stored in the EarthScope document management system.

4.15. A secondary mechanism for retrieving or repairing station communications shall be implemented for those technologies that allow it (e.g. AirLink Management Service (ALMS) for cell modems) and for those projects that require it.

4.16. There should be enough margin to account for future demands for more data or higher sampling rates and possible reduction in link quality or available bandwidth.

4.16.1. The bandwidth should allow for data to be downloaded in a reasonable timeframe after extended communication outages. The time frame shall be determined by specific project or site needs.

5. Station Power

Power systems supply sources of energy to provide the necessary electricity to all equipment and components, ensuring operation and data collection are achieved according to project objectives. A basic power system includes power storage (batteries), generation, and distribution systems. Conversion systems, for example, converting AC power to DC power, may be used as necessary.

5.1. Power systems shall meet the project’s timeframe occupation requirements as defined by the project scope, including any seasonal variations that may affect the power budget.

5.2. The Core Station should be designed to use 12V DC power systems only.

5.2.1. Some sites may have access to AC power systems and the design may be adapted to operate on AC power.

5.2.2. Power systems shall be adapted to provide the operating voltage for any sensors that require an exception to the 12V standard.

5.2.3. Inrush or surge of amperage must be adequately accounted for in power system design and componentry selection.

5.3. Power systems should be designed and selected to meet station or project power consumption requirements. Per 2023 estimate, power consumption range for EarthScope Consortium stations falls into three general categories:

- 1W - 40W - 93% of existing stations
- 40W - 100W - 6% of existing stations
- > 100W - 1% of existing stations

5.4. The Core Station power input must be designed for photovoltaic (PV) power, the default power generation technology. The power system must have the ability to be expanded or easily adapted to incorporate additional or different types of power generation, such as wind, thermoelectric generator (TEG), fuel cells, etc.

5.4.1. Depending upon sensor requirements, a power conditioning system may need to be incorporated into the power system design to minimize interference and noise.

5.5. Stations will be designed in order to maximize power efficiency.

5.5.1. Components with low parasitic draw should be prioritized.

5.6. Power systems should be designed with low voltage disconnect (LVD) ability in order to protect batteries and instruments.

5.6.1. LVD systems should be configured so as to avoid inflicting damage onto other components of the system (SD cards, comms, etc).

5.7. Power systems should be designed with a high voltage disconnect (HVD) if there is risk of unregulated excess power to the load distribution.

5.8. Power system integration testing must be carried out before deployment following all applicable SOPs.

5.9. Charge Controller Specifications:

5.9.1. Modern Commercial Off The Shelf (COTS) devices must be used.

5.9.2. Prior to deployment, each charge controller model must be tested for RF Noise and be temperature performance challenged (extreme cold/heat).

5.9.3. Charge controllers should have the lowest possible parasitic draw.

5.9.4. Charge controllers should use MPPT charging algorithms; non-MPPT charge controllers are acceptable where needed (i.e. quiet seismic installations).

5.9.5. Charge controllers with programmable settings for LVD are preferred.

5.9.6. Charge controllers and the corresponding charging profile must be matched to the battery type.

5.10. PV Panel Specifications:

5.10.1. Modern COTS PV panels should be used.

5.10.2. Panels should be rated or otherwise modified/ruggedized to withstand local environmental conditions including:

- Wind load resistance.
- Snow load.

- Impact resistance (eg hardened protective coating).
- Corrosion resistance and water resistance.
- Ice and rime build up.

5.10.3. Panels should have a minimum 20% efficiency.

5.10.4. Panels should be compatible with existing mounting systems.

5.10.5. The use of panel wiring connectors (e.g. WeatherPak, 3-pin Barrel, 2-pin MilSpec) are preferred, but not required. Bare wire connections are appropriate when contained within a weatherproof enclosure or junction box.

5.11. Batteries Specifications:

5.11.1. Batteries must meet requirements of the project operating environment.

5.11.1.1. Battery temperature de-rating should be chosen to maximize battery performance at extreme temperatures.

5.11.2. Lead acid and/or lithium batteries should be used. Other types may be considered.

5.11.3. Batteries should be optimized for use with solar systems (i.e. deep cycle AGM battery).

5.11.4. Primary (and Secondary, if present) cells must adequately provide power for the design life of the system, or for the scheduled replacement interval as defined by project requirements.

5.12. Terminal Block and Circuit Breaker Specifications:

5.12.1. Wire gauge and terminal block wire gauge size will meet power system requirements.

5.12.2. Over-current protection circuit breakers must meet power system requirements.

5.12.3. Blocking Diodes may be placed in the backpanel terminal block to isolate each panel circuit.

5.13. Data collection should be prioritized over data telemetry in power draw-down situations.

6. State of Health (SOH)

An Earthscope enterprise level SOH monitoring system is currently under development. The relevant requirements will be integrated into this document when that project is released. For the time being, we recognize that SOH monitoring requirements must reflect project needs with regards to scope, budget, and duration.

7. Station Infrastructure

The station infrastructure includes the essential mechanical and physical structures required to ensure the station's operation.

7.1. Station designs shall prioritize utilizing cross-compatible components common across usage cases.

7.2. Stations shall be designed to reduce human error using techniques such as connections with labeling, color coding, keyed and/or unique connectors, etc.

7.3. Vandalism: Stations deployed in areas known to be vulnerable to vandalism or theft will be designed to include security features or deterrents such as fencing, locks, ruggedized or reinforced features, etc.

7.4. Wildlife: Sites must be designed in such a way to account for local ecosystem sensitivities and prevent interference from local flora and fauna. Practices such as using ruggedized elements and minimizing wildlife attraction will be prioritized. A full assessment of wildlife impacts should be carried out prior to station installation, notably during the permitting process.

- 7.4.1. Impact on wildlife: Stations shall minimize their impact on wildlife habitats by avoiding breeding/nesting grounds and migration corridors, by avoiding the creation of physical barriers or hazards, and by isolating toxic components.
- 7.4.2. Damage incurred by wildlife: Enclosures and components should be chosen to limit this risk. These may include protections such as ruggedized enclosures that are bite-proof or bear-resistant, meshing that is rodent and insect resistant, etc.

7.5. Sensor/Data logger Thermal insulation: the manufacturer's recommendations shall be followed.

7.6. Stations shall be designed in order to meet the following environmental requirements:

- 7.6.1. Stations should meet all of the following baseline environmental conditions:
  - 7.6.1.1. Operating temperature range: Site components shall be operational between the temperatures of -40C to 65C.
  - 7.6.1.2. UV radiation and sunlight exposure: All exposed components, such as enclosures, mechanical support structures, cables, etc., must be able to withstand UV radiation and maintain mechanical integrity for a minimum of 3 years.
  - 7.6.1.3. Wind load: station design should withstand winds up to 90 knots (167 kph, 100 mph).
  - 7.6.1.4. Stations shall be water resistant.
- 7.6.2. Stations will be designed to reduce or eliminate electrostatic buildup and discharge (ESD).
  - 7.6.2.1. Sensor Grounding should be per manufacturer's specifications.
  - 7.6.2.2. Power system should be grounded using best practices, including:
    - 7.6.2.2.1. The use of a common “system” ground bus located inside the enclosure.
    - 7.6.2.2.2. A lightning arrestor wired to the common ground bus attached to the enclosure exterior.
    - 7.6.2.2.3. The use of inline lightning arrestors on sensor and communications cabling

7.6.2.2.4. The system ground must be connected to an external ground. For remote stations, a driven copper rod and standard copper wire secured with appropriate hardware (lugs) no more than 5 feet outside the station footprint is typically required. For stations on AC power or located in buildings, the system ground must be locally grounded.

7.6.3. Sites shall be designed in order to withstand the specific demands of their unique environments:

7.6.3.1. Tropical, high-humidity, and marine environments**:**

7.6.3.1.1. Saltwater and/or fresh water corrosion: components should be selected and/or treated to resist salt- and fresh- water corrosion.

7.6.3.1.2. Mold and/or other organic growth: materials shall be selected to prevent the growth of organic matter such as mold.

7.6.3.1.3. Swelling: materials shall be selected to prevent swelling due to moisture absorption.

7.6.3.2. Arid or low-humidity environments:

7.6.3.2.1. UV exposure: Additional protections may be incorporated into the station design to further reduce UV exposure and/or damage.

7.6.3.2.2. Heat dissipation: Sites should be designed to prevent internal equipment from exceeding their temperature ratings.

7.6.3.2.3. Temperature fluctuations: designs shall incorporate accommodations to allow for material thermal expansion and contraction.

7.6.3.2.4. Shrinking/desiccation: the selection of materials shall consider the effect of desiccation.

7.6.3.2.5. Hurricanes and/or high-winds: designs may be altered to prevent or diminish damage incurred by high winds, tropical storms, etc.

7.6.3.3. Polar environments**:** Stations installed in polar environments shall include polar-specific design elements, including:

7.6.3.3.1. UV exposure: Additional protections may be incorporated into the station design to further reduce UV exposure and/or damage.

7.6.3.3.2. Ice and snow: Stations must be designed to incorporate resistance to ice build up, including shedding, spindrift by eliminating entry points on enclosures, and damage induced by freeze-thaw cycles, including water-resistance.

7.6.3.3.3. Extreme cold temperatures: Heat-capturing devices such as heating pads should be considered to help convert any extra battery charge into heat to counteract effects of cold temperatures on the performance of electronics and batteries. Thermal insulation shall be used inside enclosures to protect batteries and instrumentation.

7.6.3.3.4. Ruggedized or military specified elements shall be chosen over other standards as the budget and design allows.

7.6.3.4. Alpine or high-elevation environments:

7.6.3.4.1. UV exposure: Additional protections may be incorporated into the station design to further reduce UV exposure and/or damage.

7.6.3.4.2. Thermal cycling: Site components shall be able to withstand significant and rapid temperature fluctuations.

7.6.3.4.3. Low pressure: Site components shall be able to withstand low atmospheric pressure.

7.6.3.4.3.1. Sensors, pressure-sensing devices, certain electronics, and other equipment that may be influenced by changes in atmospheric pressure shall be thoroughly tested to ensure they remain operational at high altitudes defined to be above 8,000 ft or 2,400m.

7.6.3.5. Additional environmental considerations:

7.6.3.5.1. Volcanic environments: Site components located near volcanic activity must withstand corrosion from volcanic gasses. Project requirements will dictate the threshold levels.

7.6.3.5.2. Pooling water: Some coastal stations and some stations that experience pooling meltwater may require waterproofing or the use of a stainless steel enclosure and hardware.

7.6.3.5.3. Heavy snow-load environments: At locations with heavy (> 3m) cumulative snowfall, exposed components, such as enclosures, mechanical support structures, etc., must be designed to withstand significant loading.

8. Installation Effort

The installation effort represents the comprehensive range of activities required to set up the station to ensure accurate data collection and system reliability.

8.1. Field Installation:

8.1.1. Sites should be selected to optimize science objectives.

8.1.2. Sites shall be selected for long-term viability and sustainability.

8.1.2.1. Sites shall be analyzed for the capability to collect data over long-term periods where necessary. This may include issues such as ground instability, vegetation growth, and human development.

8.1.2.2. Station locations should be chosen to ensure security of the station and minimize the potential of vandalism.

8.1.3. Installations should be designed and built using techniques and materials that meet the environment's conditions.

8.1.4. Station shall be designed to minimize field assembly time, difficulty, and number of required field personnel while satisfying 8.1.2.

8.1.4.1. Stations should be designed so as to minimize the handling of physically small components during field assembly.

8.1.5. Components shall be of manageable weights and bulk for field personnel to safely carry, transport, or otherwise move.

8.1.6. Stations should be designed so as to minimize both the number and complexity of tools required for manufacturing and field deployment.

8.1.7. Stations shall be designed to achieve ease of training. Field personnel unfamiliar with these systems should be able to learn to deploy these stations with relative ease.

8.1.8. Critical station components should be tested prior to field deployment to ensure they are operational prior to installation when appropriate.

8.2. Component Transport to Site and Logistics:

8.2.1. All domestic and necessary foreign shipping regulations will be followed.

8.2.2. Stations should be designed to reduce potential shipping restrictions when possible.

8.2.3. When possible, the standard station design should limit the use of hazardous materials.

8.2.4. Packaging:

8.2.4.1. Oversized packaging should be minimized.

8.2.4.2. Loose or small void-fill packing materials (i.e packing peanuts) shall be avoided.

8.2.4.3. Station components should be packed to optimize subsystem and installation grouping. Consider on-site order of operations.

8.2.4.4. Stations should be designed so that individual components may be transported by available means of transportation in remote locations.

8.2.4.5. Biodegradable packing materials should be prioritized.

8.2.4.6. Packaging material should be reused or properly disposed of in an environmentally responsible manner.

8.2.5. Personnel safety must be prioritized whenever stations and their components are transported.

8.3. Station Decommissioning and Deconstruction:

8.3.1. When stations are decommissioned, sites should be restored as close to the original state as reasonable.

8.4. Installation and setup of communication equipment should be possible by the field team without vendor/contractor assistance.

8.4.1. The system should be designed in such a way to allow for a link test locally or with a remote party during installation.

9. Operations & Maintenance

Operations and Maintenance (O&M) involves the ongoing activities and processes necessary to ensure that a geophysical station functions efficiently and effectively throughout its lifecycle.

9.1. Stations shall be designed to meet all safety standards and requirements per federal, state, and local regulations.

9.2. Station Visits:

9.2.1. Stations should be designed to minimize in-person maintenance efforts.

9.2.1.1. There can be an exception where it is more cost effective and/or the science objective requires in-person visits.

9.2.2. Stations shall be designed so that ease of operations and maintenance training is achieved. Field personnel who are unfamiliar with these systems should be able to learn to maintain these stations with relative ease.

9.2.3. Parts or components that are prone to replacement should be designed or integrated into the station design to minimize the effort and personnel needed to exchange these parts during maintenance visits.

9.3. Station Documentation:

9.3.1. Site logs must be maintained and may include the following:

9.3.1.1. Initial (reconnaissance/construction/installation) documentation.

9.3.1.2. Ongoing operations (both in-person visit and remote servicing) documentation.

9.3.1.2.1. All firmware changes shall be documented. The firmware shall be archived in a document management system.

9.3.1.3. Decommissioning documentation.

9.3.2. Photo documentation should be maintained in order to track station/site changes and to provide visual information on lay-out, surroundings, and other geographic information.

9.3.3. Information on site access and site contacts must be documented and maintained in a document management system.

9.4. Equipment and Instrumentation

9.4.1. All instruments shall be tracked in an inventory system.

9.4.2. Equipment should be tracked in an inventory system according sponsor-reporting requirements and any additional project-specific needs.

9.4.3. Facility Operations:

9.4.3.1. A supply of essential components should be maintained..

9.4.3.2. Instrumentation must be tested to meet operational standards unless testing may risk the integrity of the instrument.

9.4.4. Shipments must follow domestic and foreign shipping regulations.

10. Permitting

Many stations require a permit to be obtained in order to meet legal requirements and approvals from relevant authorities to establish and operate the station. Permits ensure compliance with environmental, land use, and regulatory requirements.

10.1. Where required, agreements for station/sites shall be obtained, maintained, and easily retrievable.

10.2. All agreement stipulations shall be followed and met in the station design.

11. Additional Requirements

11.1. Environmental Regulatory Considerations:

11.1.1. Sites must meet all environmental regulations for the location at which they are installed, as well as for any in-transit locations.

11.1.2. Sites, stations, networks, and/or projects must comply with agency reporting and permitting requirements.

11.1.3. Stations must not discharge pollutants into the environment.

11.1.4. Stations will be designed with minimal environmental impact to the site location and will be designed using non-permanent features as much as possible.

11.1.5. Stations will be designed in such a way to minimize noise (vibrational, RFI, and environmental).

11.1.6. Consideration should be given to fire danger from dry vegetation.

11.2. Cost:

11.2.1. Station costs shall not exceed agency or sponsor funding, and shall adhere to site- and project-specific logistics and requirements.

11.2.2. Stations will be designed to minimize cost.

11.2.2.1. Minimizing bulk and weight will be prioritized so as to reduce transportation costs.

Appendix A - Glossary

Term	Definition
AC	Alternating Current.
AGM	Absorbed Glass Mat: a type of battery technology.
Core Station	The CSP Core Station represents the most commonly used element in each of the station subsystem groups, except for the communications subsystem, which only features modular elements. See Communication Systems.
COTS	Commercial-Off-The-Shelf: commercially available off-the-shelf products are packaged, or ready-made hardware or software, which are adapted aftermarket to the needs of the purchasing organization, rather than the commissioning of custom-made, or proprietary, solutions.
DC	Direct Current.
Equipment	For the sake of this document, equipment is defined as any items that are used to build a station.
GNSS	Global Navigation Satellite Systems: Global geopositioning satellite constellations, spread between several orbital planes, that are used for determining position, navigation, and time relative to objects on the Earth's surface. This currently includes: Chinese BeiDou Navigation Satellite System, European Union Galileo, Russian Global Navigation Satellite System (GLONASS), and U.S. Global Positioning System (GPS).
Instrumentation	Used interchangeably with “Sensing System”.
LVD	Low-Voltage Disconnect.
NIST	National Institute of Standards and Technology.
PV	Photovoltaic.
Sensing Systems	Sensing Systems are defined as the sensor and data logger/digitizer.
Sensor	A sensor is a device or component that detects changes in its environment and converts them into signals or data that can be interpreted or used by other systems.
Site	A geographic area of scientific interest where one or more stations are located.

State of Health	A set of metrics describing the condition of an element or system.
Station	A collection of instruments and equipment used for one scientific purpose.
Metadata	Metadata refers to descriptive or structural information that provides context about a particular piece of data. It describes the characteristics, attributes, and properties of data, making it easier to organize, search, retrieve, and manage information.
TDD	Technical Design Document: an engineering document that describes in minute detail the design or specific parts of an engineering product.
VPN	Virtual Private Network - a mechanism for creating a secure connection between a computing device and a computer network, or between two networks, using an insecure communication medium such as the public Internet.