ANNEX I

ITEM 01 - TECHNICAL SPECIFICATIONS FOR PDS

The Data Collection Platforms (DCP) are composed of a data logger and electronic sensors to measure hydrological conditions. Additionally, they include a data transmitter via the GOES satellite, a photovoltaic power supply system, and a protection system against lightning strikes.

The distribution of the sensors, power supply, and telemetry system required for the automatic stations is indicated in Table No. 01:

The four (4) DCPs must include:

- Data collection platform for processing and storage.
- Satellite communication system via GOES: transmitter and Yagi antenna
- Power system: Battery, charge controller, and solar panel
- Measurement system: river level sensor and precipitation sensor
- Mounting system: Folding mast and protective and/or fixing supports
- Electrical protection system: Lightning rod and surge protection devices (SPD)

The batch of these four (4) DCPs will be composed as follows:

Table 1 - Description, Quantity, Unit, and Maximum Acceptable Values - Item 01

ITEM	SUB ÍTEM	DESCRIPTION	UNIT	Stations	UNIT PRICE (R$)	TOTAL PRICE (R$)
1	1.1	Data Collection Platform (PCD) registrar	4	Atalaya, Inambari, Los Amigos and Limonal		
	1.2	Precipitation Sensor (Tipping Bucket)	4	Atalaya, Inambari, Los Amigos and Limonal		
	1.3	Water Level Sensor (Float Type)	1	Limonal		
	1.4	Water Level Sensor (Radar Type)	3	Atalaya, Puente Inambari, Limonal.		
	1.5	Yagi Antenna	4	Atalaya, Inambari, Los Amigos and Limonal		

	1.6	6 m Folding Mast with Winch	4	Atalaya, Inambari, Los Amigos and Limonal		
	1.7	GOES Satellite Transmitter	4	Atalaya, Inambari, Los Amigos and Limonal		
	1.8	Charge Controller	4	Atalaya, Inambari, Los Amigos and Limonal		
	1.9	30-Watt Solar Panel	4	Atalaya, Inambari, Los Amigos and Limonal		
	1.10	Battery	4	Atalaya, Inambari, Los Amigos and Limonal		
	1.11	Lightning Rod and Surge Protection Devices (DPS)	4	Atalaya, Inambari, Los Amigos and Limonal		

ADDITIONAL ITEMS (1.10 to 1.24)

To ensure medium- and long-term maintenance of the DCPs, the following additional spare items must be provided:

Sub Item	**Description**	**Specifications (identical to those provided through sub-items 1.1 to 1.9)**	**Quantity**	**UNIT PRICE (R$)**	**TOTAL PRICE - R$**
1.10	Modem GOES	GOES Spare Modems with Data Communication Cable between the Modem and the Data Logger	1		
1.11	GOES-GPS Connection Cable	Data communication cable between the modem and the GPS antenna of the DCP enclosure, with installed connectors (N-type for the GPS antenna and connector for the GOES modem).	2		

1.12	GOES Modem to Yagi Antenna Connection Cable	Data communication cable between the modem and the Yagi antenna of the DCP enclosure, with installed connectors (N-type for the Yagi antenna and connector for the GOES modem).	3		
1.13	*Datalogger*	*Spare Data Loggers including all terminals for connecting the wiring to all possible ports.*	1		
1.14	GOES Antenna	GOES Yagi Antenna with a mounting bracket for attachment to the DCP support bar and the cable.	2		

Sub Item	**Description**	**Specifications (identical to those provided through sub-items 1.1 to 1.9)**	**Quantity**	**UNIT PRICE - R$**	**TOTAL PRICE - R$**
		communication with the "N" type connector installed.			
1.15	GPS Antenna	GPS Antenna “outdoor”, with a mounting bracket for attachment to the DCP support bar and communication cable with Type N connector installed.	1		
1.16	"U" Type Clamp	Stainless steel "U" clamps with 3/8" threading, provided with two 3/8" stainless steel nuts and two washers of the same material.	2		
1.17	SPD	Lightning Rod and Surge Protection Devices- SPD	4		
1.18	Charge Controller	Sealed type charge controller with external support or adapter for mounting on DIN35mm rail	2		
1.19	Fuse Terminal	Fuse terminal for 35 mm DIN rail for the connection bar.	4		
1.20	4-Pin Female Military Connector	4-pin female military Type"MS" Class "E", “F” or "R" reference models: MS3106E14S, MS3106F14S or MS3106R14S	3		
1.21	3-Pin Female Military Connector	4-pin female military Type"MS" Class "E", “F” or "R"" reference models: MS3106E14S, MS3106F14S or MS3106R14S	3		
1.22	Connector N	GOES Antenna Connector, N-type for RG-213 cables.	3		

1.23	Connector N	GPS Antenna Connector type N for RGC58 cables	3		
1.24	Hydrophobic membrane	Hydrophobic membrane of the Gore-Tex type with a mounting support for installation in the protection/conditioning enclosure (DCP).	3		

SUB ITEM	Description	Specifications (identical to those provided through sub-items 1.1 to 1.9)	Quantity	UNIT PRICE - R$	TOTAL PRICE - R$
1.25	Precipitation Sensor - Tipping Bucket	As specified in the relevant section of this document	1		
1.26	Float Type Water Level Sensor	As specified in the relevant section of this document	1		
1.27	Radar Type Water Level Sensor	As specified in the relevant section of this document	1		
1.28	Yagi Antenna	As specified in the relevant section of this document	1		
1.29	30-Watt Solar Panel	As specified in the relevant section of this document	1		
1.30	Battery	As specified in the relevant section of this document	1		

Installation Location: The geographic coordinates for the installation of the 4 automatic weather stations (PCDs) are detailed in the following table:

Name of the Stations	Department	Province	Basin	Coordinates		
				Latitude	Longitude	ltitude (msnm)
Limonal	Madre de Dios	Manu	Manu	12°13'59.00"S	70°56'22.00"W	323
Atalaya	Cusco	Paucartambo	Madre de Dios	12°53'26.00"S	71°21'38.00"W	555
Puente Inambari	Madre de Dios	Manu	Inambari	13°11'10.00"S	70°23'06.00"W	464
Los Amigos	Madre de Dios	Tambopata	Madre de Dios	12°34'36.07"S	70° 04'10.71"W	180

1.1. AUTOMATIC DATA COLLECTION PLATFORM

1.1.1. DCP PROTECTIVE CASING

This section presents the minimum functional requirements for the automatic stations, including hardware functions and operating environment. The design must be modular to allow for the replacement of modules and components of the DCP without the need for special tools.

All sensors and peripherals must be fully compatible with the DCP. The data logger must meet at least the following specifications:

Each DCP enclosure must include 1 data logger, 1 charge controller, 1 barometric sensor, battery, GOES satellite transmitter, and protection fuses.

The casing should be in a rectangular format, feature a front door, and include a system with 2 (two) sets of keys/locks, along with a minimum of 2 (two) hinges for securing the access door, thereby ensuring the security of internal components.

Locks for all PCD casings should include keys with the identical pattern as those in the existing DCP casings within the NETWORK. Additionally, they should have an external cover for protection against rain and adverse weather conditions.

The ACTO will provide the successful bidder with the current key to reproduce the pattern.

The DCP enclosure must have the following characteristics: robust with high durability protection (NEMA 4X) against ultraviolet rays; sealed against environmental conditions; waterproof and resistant to water flows; resistant to excess humidity; dustproof and insect-proof, with white powder-coated electrostatic paint.

It should allow easy access to DCP components, including the datalogger, charge regulator, battery(s), sensor interface, and modems. It should enable battery removal without the need to remove other DCP components. The GOES satellite transmitter, Datalogger, Charge Controller, and Surge Protection Devices - SPD, should be easily removable with common tools (screwdrivers/phillips/allen) for subsequent replacement.

The housing should have a "gutter" type system along the entire front to prevent rainwater from entering the PCD’s interior. Also, the door should have an injected and reinforced rubber seal inside.

It should feature a side system facilitating opening and closing to accommodate a notebook-type microcomputer for on-site configuration and data

download from the DCP; type NEMA 4X, resilience to sun and weather, complemented by a white electrostatic powder coating.

The DCP enclosure must be protected from direct sunlight with a shield made of fiberglass, stainless steel, or other materials resistant to sunlight and weather, with a white electrostatic powder coating.

The shield must cover both sides, back, and top of the case, allowing air to pass between the box surface and the shield so there must be a minimum distance of 2 centimeter between the shield and the side and top parts of the box, and approximately 1 centimeter on the back. The shield must protrude at least 8 centimeters from the front top of the case.

A retractable system should be installed on the side of the shield to support the notebook during the operation and maintenance of the DCP.

At least two hydrophobic valves of the GORE-TEX® membrane type should be installed on the bottom of the casing to allow for the equalization of internal-external pressure without allowing water in the bottom of the box.

To prevent the SCP housing from deformation during fixation to the support, this point must be reinforced.

The connections to be installed on the casing's exterior are:

a) One (1) 3-pin male military-type connector for rain sensor;

b) One (1) 4-pin male military-type connector for water level sensor (pressure) (RS-485 communication protocol);

c) One (1) 4-pin male military-type connector for water level sensor (radar) (RS-485 communication protocol);

d) One (1) 4-pin male military-type connector to communicate the water quality probe or bubble water level sensor (SDI-12 communication protocol);

e) One (1) 3-pin male military-type connector for the solar panel;

f) One (1) N-type connector for the GPS antenna;

g) One (1) N-type connector for the GOES transmission antenna; and

h) One (1) 4-pin male datalogger-computer communication connector;

The connections identified above must be compulsorily installed at the lower part of the casing, utilizing metallic military connectors (Type "MS", Class "E",

"F" or "R").

These connectors should be referenced as:

- MS3106E14S
- MS3106F14S or MS3106R14S,
  (*) GOES and GPS antennas must use N-type connectors.

Each type of connection (except for the N type) should have dedicated connectors, clearly labeled on the casing to avoid any incorrect connection of DCP components.

All external connectors should include a screwable nylon or stainless-steel protective cover to safeguard unused connections at the beginning.

The 4 (four) connections of the hydrological sensors (rain sensor, water level sensor (pressure), RS-485, water level sensor (radar) RS-485, and SDI-12 bubble water level sensor) must be protected against potential currents induced by electrical discharges in Surge Protection Devices (SPD), "clamper or similar" type, for DIN35mm rails, individual (1 SPD for each hydrological sensor).

For protection of GPS and GOES antennas, the chosen method should involve a coupling spark gap, varistors, diodes, or similar devices.

The conditions envisaged for the operation of the equipment inside the DCP boxes must meet the following requirements:

a) An operational **temperature range** of -40 ºC to +60 ºC, measured internally within the casing; and
b) Relative air humidity for operation ranging from 0 to 100%, assessed within the casing.
c) Wind: speed No less than 60 m/s
d) Rainfall: No less than 1000 mm/h
e) Atmospheric Pressure: 500 hPa to 1100 hPa
f) Protection Against EMI and ESD Standard
g) Emissions: CISPR22 class B (EN55022) or equivalent standard
h) RF Field Immunity: IEC61000-4-3 or equivalent standard
i) EFT Immunity: IEC61000-4-4 or equivalent standard
j) ESD Immunity: IEC61000-4-2 or equivalent standard
k) Surge Protection: IEC61000-4-5 or equivalent standard
l) Conducted RF Immunity: IEC61000-4-6 or equivalent standard
m) All internal components of the DCP box must be able to endure the specified environmental conditions:

- Temperature: -10 ºC to +60 ºC;
- Relative Humidity: 0% a 100%.

All internal wiring connections should feature insulated terminals

compatible with the connection type (e.g., needle/pin, eyelet, fork, etc.) and must be clearly labeled with laminated adhesive tape indicating the connection type (e.g., VDC+5, VDC+12, RS485-A, SDI12+, etc.), allowing visualization in the power and connection diagram linking the datalogger and connectors.

The power and electrical connection diagram between the datalogger and connectors should be supplied in one (1) unit in the form of a laminated paper. This diagram, housed in an acrylic "document holder," should be easily accessible or replaceable within the access door of the casing.

1.1.2. CONNECTION DIAGRAMS OF THE CASING

Below is the standardization of military connectors by communication protocol type:

Solar Panel – 3 Pins

A	(+)
B	(-)
C	

Rain Gauge (Pulse) - 3 pins

A	1
B	2
C	

SDI-12 – 4 Pins

A	Data
B	(+)
C	(-)
D	nc

RS-485 – 4 Pins

A	A
B	(+)
C	(-)
D	B

1.1.3. DATALOGGER

A) Sensor Interfaces

The datalogger should be low-power, have non-volatile internal memory, and at least the following communication channels:

a) 1 standard SDI-12 serial channel (native);

b) 1 standard RS-485 serial channel (native);

c) 1 standard RS-232 serial channel (native);

d) 1 communication channel with a computer formatted with the Windows 10 operating system or higher.

The standard SDI-12, RS-485, and RS-232 serial interfaces of the datalogger described above must be provided through a dedicated connection integrated into the datalogger, not through external converters. Solutions allowing the multiplication of the native serial interfaces of the SDI-12, RS-485, and RS-232 datalogger will be accepted, provided they are integrated into the datalogger and not through external converters.

The communication port between the computer and the datalogger should allow the execution of external commands for: firmware update; programming routines for data collection, storage, and transmission of data and relevant information (e.g., hydrometeorological data, DCP and sensor configuration parameters in operation); sensor configuration (e.g., offset or multiplier); download and upload of DCP configuration parameters, and download of stored data and information.

The essential set of connections for the datalogger includes:

a) 1 (one) input for the rain sensor;

b) 1 (one) RS-485 input for water level sensor (pressure or radar);

c) 1 (one) input for bubble water level sensor or multiparametric water quality probe (SDI-12);

d) 1 (one) input for the barometric pressure sensor;

e) 1 (one) input for the door opening sensor;

f) 1 (one) channel for 12Vdc power supply;

g) 1 (one) input for the GOES data transmitter; and

h) 1 (one) input for the datalogger-computer communication.

If analog inputs are utilized in the datalogger, they must undergo conversion into digital format with a minimum resolution of 16 bits. Electric signals received from the sensors will be automatically transformed into their corresponding units (engineering units).

Each input of the data logger must be protected against transient phenomena using varistors, optical couplers, or other similar types of protection.

The datalogger must meet the minimum requirements for data acquisition speed, digital encoding, and storage, considering the sensors specified in this document.

The operational program and data loaded into the datalogger will be stored in a non-volatile internal flash memory, ensuring that data and the program remain unchanged in case of power failure.

The memory should possess adequate capacity to store data collected by all sensors for a minimum duration of one (1) year, with a data acquisition frequency of 5 minutes, in addition to recording rain events every 10 seconds, reaching a minimum limit of 3500 mm during that period.

In the event of a power failure, the internal clock of the datalogger should continue to operate, displaying a maximum variation of 60 seconds per month, enabling updates through the GPS antenna of the GOES modem.

The datalogger should efficiently manage internal memory, ensuring that, when reaching full capacity, new records replace the oldest ones, thereby preserving data integrity.

Should there be a power interruption or during the replacement of the battery(ies), the datalogger ought to be capable of resuming all functions upon power restoration, without losing data or prior configurations

The datalogger must be capable of monitoring, storing, and transmitting data related to water level information, rainfall information, internal temperature of the DCP, minimum battery voltage, sensor displacement, barometric pressure value, latitude, longitude obtained through the GPS antenna of the GOES modem, datalogger serial number, and identification of the installed software. The datalogger's serial number will be obtained automatically for subsequent transmission by reading this information from the device itself, without human intervention. The identification of the operating program can be manually entered at the time of programming, with a minimum of 4 (four) numeric characters, for subsequent transmission.

B) Serial Communication

✓ **Serial Input/Output Lines**

- ✓ Each system must include a Programming Port (RS232 Serial Port or USB) to allow a laptop to connect to the Data Logger. Through this interface, the user can perform initialization, software uploads, configuration file uploads, data downloads, and monitor the unit's operation.
- ✓ Once connected, full access to all programming functions will be available, such as sensor definitions, processes, calculations, communication operations, and presentation/download of stored data, as well as system operation monitoring.
- ✓ Operation from the programming port must not interfere with the automatic functions of data acquisition, data logging, and data transmission (telemetry). Access to this maintenance port will be possible through a pre-equipped connector. The cable for this connection will be included in the delivery and must be at least 1 meter long.
- ✓ The user will be able to configure the interfaces in terms of baud rate (the number of times per second that a communication signal changes state), number of data bits and stop bits, parity, and checksum. The data transmission speed must be at least 9600 bps or higher.
- ✓ The serial interface ports will have a modular design (e.g., connectable modules) to ensure that new channels and communication designs can be installed in the future without requiring modifications to the Data Logger or other cards.
- ✓ The supplier must provide software compatible with Windows 10 or later, compatible with the data logger, which allows reading, retrieving, archiving, visualizing data, initializing, and monitoring the Data Logger through the programming port.

C) Real-Time Clock (RTC)

✓ The Data Logger will integrate a time base system protected against power outages at the station.

✓ The time base will generate complete local and UTC time systems that

synchronize the autonomous operation of the station. The UTC will be calculated using an Offset UTC variable, which can be adjusted by the user.

✓ To allow for alarm generation and real-time message exchange, the clock deviation must be less than or equal to twenty (20) seconds per month.

✓ The Real-Time Clock (RTC) must be adjustable by the following methods:

- Locally via commands from the Data Logger
- Remotely via commands executed through a modem or cellular system (if this accessory is added in the future)
- Using signals from the GPS system (Global Positioning System) connected to the GOES satellite transmitter (if this accessory is added in the future)

D) Local Access to the Data Logger

✓ It is desirable for the data logger to have a local display device with a keyboard.

✓ The display device with a keyboard or local screen should access:

- Measured and calculated values by the Data Logger (instantaneous and/or historical)
- Specific settings for the station such as Offset and gain parameters (sensor multiplier)

✓ The display device with a keyboard or touchscreen should be able to properly display data in outdoor light conditions. The Data Logger will allow the programming of an access password.

✓ The Data Logger will permit the installation of configuration files from an external memory device, such as SD, µSD, CF cards, or portable USB memory, using transfer routines via the display device with a keyboard, as well as data recovery from the Data Logger to the external memory.

E) Data Transmission

The data stored in the data logger must be transmitted via the GOES (Geostationary Operational Environmental Satellite) communication modem, following the communication requirements described for the GOES modem, at 15-minute intervals.

F) Data Logger Software

✓ **General Requirements**

- The Data Logger will perform all functions of data acquisition, processing, transmission, and archiving 24/7 without operator intervention, including system self-verification and diagnostics.

- The software will provide all necessary functionality for a simple and efficient interface with commercially available

sensors.

- The Data Logger will allow firmware updates.
- The software loaded onto the system will be installed in non-volatile memory. In the event of a power interruption, the program and system parameters will remain intact.
- Reconfigurations and/or updates will be loadable. New software or configuration files can be loaded onto the system via the serial port, and also remotely if bidirectional telemetry is available.
- A watchdog timer will be used to perform an automatic system restart in the event of a hardware failure or an unrecoverable data acquisition error.
- The configuration software will run on Windows 10 or newer.

G) Data Acquisition

✓ **The Data Logger will support different data acquisition modes:**

- ✓ Scheduled Acquisition.
- ✓ Data acquisition from the central station, upon user request.
- ✓ Acquisition when an alarm condition occurs.

- Data acquisition frequency can be configured individually for each sensor. The frequency can be adjusted between 1 second and 24 hours in 1-second increments.

H) Data Logging

- ✓ The data logger must have internal flash memory for storing configuration programs and operating systems of four (4) MB or more.
- ✓ It must have internal memory for storing recorded data of two (2) MB or more.
- ✓ Parameters to be logged and intervals will be user-configurable.
- ✓ Once memory is full, new data will overwrite the oldest data.
- ✓ The system must allow reading of Compact Flash, USB, SD, or removable memory cards to expand data storage capacity.
- ✓ The removable memory card should have a capacity of 32 GB or more.
- ✓ The memory card should be easily removable and replaceable without special tools.
- ✓ Data should be recorded in a format readable on any PC without requiring a special reader device; otherwise, such a reader device must be included.

I) Terminal Software

- ✓ The PCD will be delivered with user-friendly terminal software. The software must be compatible with Windows 10 or later and with the data logger.
- ✓ The software will be menu-based and will automate routine functions such as collecting data files from the system memory, converting recorded data files to a format suitable for further analysis using standard commercial software packages, and downloading new configuration files to the system.

J) PC-Based Configuration Program

- ✓ The system will come with PC-based configuration software to allow easy configuration and modification of all system parameters and operation.
- ✓ The software must be compatible with Windows 10 or later and with the data logger.
- ✓ The software will be menu-based and will use pre-prepared templates.

- ✓ The PC-based configuration software will include, at a minimum, the following functions:
  - Selection of standard sensors from the sensor library, including specific sensor parameters and default values.
  - Users can configure new sensor definitions and add them to the existing configuration library.
  - Definition of measurement intervals between 1 second and 24 hours in 1-second increments, individually for each sensor.
  - Definition of calibration coefficients, power supply parameters, and data validation parameters specific to the sensors.
  - Selection of calculation formulas and unit conversions from the pre-existing library.
  - Definition of multiple independent logging groups with user-defined parameters and logging intervals between 1 second and 24 hours in 1-second increments. Logging to separate daily files for easy download.
  - Free formats for generated messages may include data and ASCII text in any user-configurable combination.
  - The interval for creating data messages will be a user-defined parameter, between 1 second and 24 hours.
  - Messages will be sent automatically when the alarm threshold is exceeded.

- User-configurable alarm function for monitored parameters, alarm criteria, and actions to be taken when an alarm condition is detected

K) Protection Cabinet or Enclosure

✓ **Weather Protection**

- ✓ The PCD components, including the Data Logger, sensor interfaces, telemetry transmitters, battery, and its regulator, will be installed inside a sealed enclosure resistant to weather conditions and protected against rain, high humidity levels, dust, and insects. The enclosure will meet NEMA-4X or IP-55 standards at a minimum.
- ✓ Electrical connections on the outside of this protective enclosure will be made via waterproof connectors, with one connector for each sensor or sensor pair.
- ✓ All ports will be clearly labeled with their function.
- ✓ The equipment enclosure will be made from corrosion-resistant and UV-resistant material.
- ✓ For the connection of the GOES satellite Yagi antenna cable, N-type connectors resistant to corrosion must be used.
- ✓ The enclosure will be equipped with the necessary mounting accessories for a metal mast.
- ✓ All internal wiring in the enclosure must be done using cable conduits. Loose wires or cables inside the enclosure are not permitted.
- ✓ The equipment enclosure must have a secure grounding contact at its bottom that serves as a common point for static grounding and/or transient or permanent overvoltage protection.
- ✓ The Automatic Station will be protected against damage caused by overvoltage induced by lightning on all sensor input lines, power supply lines, and communication lines. The transient protection design will be modular to facilitate the replacement of the protective device without the need for special tools.

1.1.4. MEASUREMENT SYSTEM: SENSORS

Required Measurement Parameters and Function

The measurement functions of each sensor can be:

- ✓ Instantaneous Data
- ✓ Average Data
- ✓ Accumulated Data
- ✓ Maximum Data
- ✓ Minimum Data
- ✓ Data from a user-specified calculation

General Requirements for All Sensors

- The sensors must be interchangeable, with each type of sensor enabled to operate in all stations according to its configuration.
- The adjustment constants for a sensor can be incorporated into the system when a sensor is installed.
- The constants will include, but are not limited to, the following considerations:
    - Sensor calibration constants: Offset and slope.
    - Data validation parameters from the sensors.
- All sensors shall have a robust, high-quality construction with materials resistant to corrosion and UV exposure, including but not limited to stainless steel, anodized aluminum, and high-impact plastic.
- The mounts, bases, and metal fasteners shall be robust and made of materials resistant to corrosion and UV exposure, including but not limited to stainless steel, anodized aluminum, or hot-dip galvanized iron.
- All sensors will be operated independently by the automatic station so that the failure of one or more sensors does not affect the operation of the remaining sensors.
- Sensor cables must have factory labeling indicating adequate flexibility in extreme temperatures, be waterproof, and UV-resistant; they must also have optimal dimensions to fulfill their function. Methods to protect cables from external interference should also be considered.
- All sensors must come with a factory calibration certificate. These documents will be delivered during the receipt of goods; additionally, some sensors will include certificates from laboratories accredited under ISO 17025 as indicated in points 2, 3, and 4 of these terms of reference.
- All sensors must be able to operate at altitudes greater than or equal to 3500 meters above sea level or their equivalent in isobaric level.
- Digital sensors with processors must be versatile, including the necessary software for their configuration and integration into data loggers, according to user needs.
- Digital sensors that perform their own Analog/Digital (A/D) conversion must consider the minimum conversion resolution of the Data Logger or better.

1.1.5. TELEMETRY SYSTEM: COMMUNICATION

Automatic stations must be capable of interacting reciprocally with various modern telemetry systems and must have the ability to operate with at least two different telemetry systems simultaneously and independently.

Telemetry via Satellite Communication

- **General Requirements**

  - ✓ To optimize access and telemetry costs, it is advisable that the automatic station be able to communicate with several satellite telemetry systems.
  - ✓ The satellite transmission system must include an antenna, cables, and surge suppressors. The transmitter must be installed in the same equipment box as the main equipment. It should also receive its power supply from the same solar panel/electric grid system.
  - ✓ To reduce data transmission costs, the software should include an optional data compression module to reduce the number of bytes sent, especially when satellite transmitters are used.

Satellite Transmission via GOES

- ✓ To transmit data via the GOES satellite, the automatic station must be equipped with a high-speed data transmission transmitter. The transmitter must be approved by the National Environmental Satellite, Data, and Information Services (NESDIS) in accordance with the current version of high-speed data transmission.
- ✓ The transmitter must support both random and self-timed modes.
- ✓ The transmitter channels and data transmission rates of 300 and 1200 bps must be configurable parameters that can automatically adjust the system according to user-configured transmission schedules, allowing transmission at 300 and 1200 bps.
- ✓ To ensure accurate timing, the transmitter must be equipped with an integrated GPS receiver. This same receiver will also be used to synchronize the PCD clock..
- ✓ In order to minimize the energy consumption of the Automatic Station, the power consumption of the transmitter should not exceed 4 amperes in the 300-bps transmission mode.
- ✓ The transmitter can be programmed for hourly transmissions, including corresponding hourly data and redundant data from one hour.
- ✓ Transmission will be in pseudo-binary format.
- ✓ The transmitter will operate in the frequency range specified by NESDIS in Memorandum No. 40, from 401.7 to 402.1 MHz.
- ✓ The transmitter must include protection against open circuit and short circuit of the transmitter's output signal.
- ✓ The transmitter must have the following characteristics:

  Data format: ASCII and Pseudo-binary
  Transmission Power at 300 bps: 10 W or less
  Status Indicators: Multi-function indicators

Communication Ports: RS232 ports

- ✓ The manufacturer will explicitly indicate the distribution of the hydrometeorological parameters in the frames generated by the automatic stations, sent by the GOES satellite transmitters, and received by SENAMHI and the National Water Authority.
- ✓ The transmitted data will be in an open format and will not be considered proprietary or in floating-point format. Decimal data will be converted to integers, and during decoding at the ground station, the corresponding decimals will be retrieved by multiplying with the factor 10^-n, where n is the number of decimals for each data. The transmitted data frame must respect the sequential order of the data.

- ✓ It should be noted that using the GOES satellite transmitter requires the assignment of an 8-digit identification number (GOES ID), which is managed by the National Environmental Satellite, Data, and Information Services of NOAA (NESDIS-NOAA). Therefore, it is necessary to request this number well in advance from the Directorate of Observation Networks and Data (DRD).

Yagi Transmission Antenna

- ✓ The crossed Yagi antenna must be lightweight and weather-resistant, designed to operate in the frequency range of 401.7 – 402.1 MHz
- ✓ The antenna's gain should be 10 dB or better.
- ✓ The standing wave ratio (SWR) should be 1.5 or higher.
- ✓ The antenna must be equipped with a suppressor to protect the GOES transmitter from lightning-induced overvoltage.
- ✓ The Yagi antenna should have the following characteristics:

  Type: Crossed Yagi
  Central Frequency: 401.8 MHz
  Impedance: 50 ohms
  Gain: 10 dB or better
  Maximum Wind: 100 knots
  Support: Antenna base adjustable in azimuth and elevation
- ✓ Must include RG-8 coaxial cable necessary to install the antenna at a height of 10 m, with its respective connectors.

Transient Filters

- ✓ The UHF output generated by the transmitter must pass through a filter that meets the following characteristics:

  Impedance: 50 ohms

Frequency:	300 to 500 MHz
RF Power:	125 – 375 Watts
Voltage Drop:	600 V

1.1.6. FRONT DOOR OPENING SENSOR

Sensor positioned to detect the opening of the front door of the casing and transmit the signal to the datalogger.

1.1.7. CONNECTOR AND SURGE SUPPRESSOR BAR

The casing must have a connection bar properly identified with labels according to the type of connection and fixed on a 35mm DIN rail.

The power lines (positive pole) of the sensor battery utilizing RS-485 and SDI-12 protocols, should be equipped with a replaceable fuse of compatible amperage with the system, offering supplementary safeguarding for both the sensors and the data logger.

These fuses should be systematically arranged and conveniently accessible inside the DCP enclosure for routine inspection and replacement.

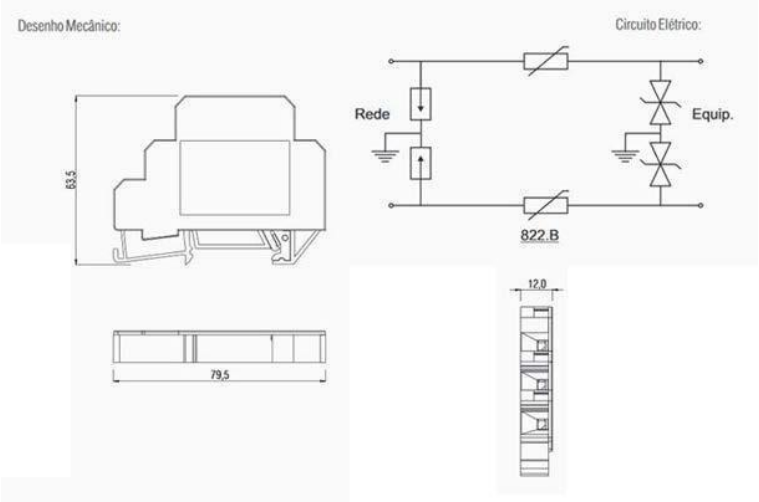
The connections from the pressure transducer, bubbler, and radar sensor to the datalogger must be shielded against electrical surges through the application of SPD devices.

These devices are required to feature electrical connections facilitated by screw terminals, enclosed within a flame-retardant injected plastic casing. The SPD must have the following minimum technical specifications:

Response time on the order of nanoseconds with a maximum peak current of 10kA.

a) High current drainage capacity.
b) Capacity to operate repeatedly without requiring replacement or reconnection.
c) Quickly attachable to rails for easy replacement.
d) Equipped with a flame-retardant casing.
e) Approximately sized: 79 x 63.5 x 12mm (L x W x H), with an approximate weight of 42g.
f) Connected through screw terminals and easily secured on 35mm DIN rails.
g) Models with at least two stages of cascade protection - Gas Discharge Tube (GDT) and Silicon Avalanche Diode (SAD), coordinated through series impedance, providing effective and extremely fast protection.

h) Provides protection in common and differential modes.
i) Class III SPD device installed near the equipment to be protected.
j) IP20 protection rating.
k) Flame-retardant plastic casing.
l) Capable of functioning multiple times without the need for replacement or reconnection.



Illustrative figure: Reference model: Clamper 822.B or a similar model available in the market.

1.1.7.1. **BATERIES**

Batteries must be rechargeable, sealed, maintenance-free, with a gas vent, and capable of supplying power to the DCP for at least 15 (fifteen) days without any recharge, ensuring uninterrupted operation in locations or periods with low insolation.

Additionally, the system must have a single battery with a capacity of at least 26Ah at 12 VDC. Two or more batteries in parallel will not be accepted.

The batteries must have a manufacturing date later than 2023, except for the sample battery.

All supports, connectors, cables, and adapters necessary for the proper installation of all DCP components and sensors in the field must be supplied.

1.1.7.2. **26AH BATTERY HOLDER**

The battery holder will be positioned inside the DCP, facilitating the easy replacement of the battery without requiring disassembly of the internal components.

1.1.7.3. DCP FIXATION SYSTEM

The system for securing the DCP to the support bar should comprise two (2) U-shaped stainless steel reinforcement bar clamps with a 3/8" thread, provided with the DCP containment box. Each clamp must include two 3/8" stainless steel nuts and two washers of the same material, enabling attachment to rods with an external diameter of 6.2 cm.

1.1.7.4. ACCESORIES FOR DCP BOXES

To safeguard the military connectors from corrosion, moisture, and poor connections, a supply of 50g of dielectric silicone grease per DCP box is required. Furthermore, this grease will serve to protect the rubber seal on the DCP door, preventing it from drying out.

Additionally, a kit containing 5 extra fuses should be provided for each connection.

1.1.8. SOLAR PANEL

The solar panel must be capable of recharging the battery(s) and simultaneously providing the required energy for the continuous operation of the DCP. This includes accounting for the consumption of the datalogger and charge controller for sensor operation, rain and water level measurements, and remote data transmission, considering 15-minute intervals for the GOES system.

The solar panels must meet the following minimum requirements:

i) Individual solar panel module of at least 30 watts.
j) The solar panel connection cable should include an external protective cover made of Polyamide, Polypropylene, Polyurethane, Polyolefin, Polyethylene, or Nylon, with high durability protection against ultraviolet rays, molded or similar, and robust.
k) The cable should come equipped with the installed 3-pin female military connector (Type "MS," Class "E," "F," or "R," Reference MS3106E14S, MS3106F14S, or MS3106R14S), featuring heat-shrink material at the ends for the connection between the Solar Panel and the DCP, with a length of 3 (three) meters
l) The solar panel must be protected against reverse currents using protection diodes or an equivalent system.
m) The solar panel should incorporate an inclination adjustment system.

All the necessary supports, connectors, cables, and adapters for the proper

installation of the solar panel inside the DCP box must be provided.

The Solar Panel fixation system to the DCP bar should consist of at least one (2) stainless steel "U"-type clamp with a 3/8" thread. Each clamp should have two 3/8" stainless steel nuts with two washers of the same material, allowing fixation on rods with an outer diameter of 6.2 cm.

The solar panel connection diagram is illustrated below:

<table>
<tr><td>A</td><td>+)</td></tr>
<tr><td>B</td><td rowspan="2">-)</td></tr>
<tr><td>C</td></tr>
</table>

. **Charge Controller**

The battery charge controller must be equipped with a temperature compensation function and protection against battery overcharge and low voltage disconnection (LVD).

The charge controller should indicate battery status and faults via LEDs and include a display for numerical visualization of voltage (V) and current (mA), as well as LED indications for battery status and faults.

The charge controller must have a negative terminal grounded and be installed independently to allow for quick replacement during maintenance.

The charge controller must have the following characteristics:

- Charging current: greater than or equal to 3 A.
- Regulation voltage: 12 V (load reconnection)
- External design with solid-state technology of the PWM or MPPT type.
- Electrical protections
- Protection against lightning and overvoltage or transients
- Load protected against voltage spikes
- Short circuit or overload caused by solar panels or load
- Reverse polarity

1.1.9. GOES ANTENNA

The antennas used for data transmission through the GOES system must meet the following minimum specifications:

n) The Yagi-type antenna for the GOES modem must be compatible with the specifications described in the document "GOES Data Collection Platform Radio Set (DCPRS) CERTIFICATION STANDARDS at 300

bps and 1200 bps," available at :

https://www.noaasis.noaa.gov/docs/DCPR_CS2_final_June09.pdf

o) The GOES antenna will be Yagi-type, weather-resistant, with a gain between 10 and 11 db.

p) Connection of the GOES antenna cable to the DCP is made with an N-type connector reinforced with heat-shrink tubing or similar to prevent detachment and interference or transmission interruption issues.

q) The antenna connection cable should be RG-213 type, 50 ohms, robust, shielded, protected against UV radiation, and at least 3 (three) meters long with the N-type connector installed.

r) The antenna base should include a physical marker (high or low relief) indicating the elevation angle from 0 to 90 degrees, with marks at least every 5 degrees and digits every 10 degrees.

s) Each antenna should come with a functional test certificate indicating the antenna's serial number and transmission gain.

The antennas must exhibit a transmitted signal strength exceeding 40. This criterion will undergo verification within the SIGNAL field, accessible at https://dcs1.noaa.gov/Account/FieldTest, by accessing the configured GOES ID on the DCP. Antennas registering a transmitted signal strength below 40 will face rejection.

The GOES Antenna fixation system to the DCP bar should consist of at least one (1) stainless steel "U"-type clamp with a 3/8" thread. Each clamp should have two 3/8" stainless steel nuts with two washers of the same material, allowing fixation on rods with an outer diameter of 6.2 cm.

Each GOES antenna must include two N-type connectors (spares for RG-213 type cables).

1.1.10. GPS ANTENNA

The antennas used for GPS data reception for time and date adjustment of the GOES modem must meet the following minimum specifications:

t) The GPS antenna should be exterior-type, weather-resistant, with a robust cover and a female N-type connector on the bottom base.

u) Minimum gain: 27db:

v) Output impedance: 50Ω

w) Minimum protection rating: IP66

x) Operating temperature range: -10 ºC to 80 ºC

y) Each antenna should include a robust RG-58 type cable, protected against UV radiation, 3 meters long, with an N-Male connector at both ends.

z) The cable connections of the GPS antenna with an N-type connector should be reinforced with heat-shrink tubing or similar to prevent connectors from detaching and causing interference or communication interruption.

The GPS Antenna fixation system to the DCP bar should consist of at least one (1) stainless steel "U"-type clamp with a 3/8" thread. Each clamp should have two 3/8" stainless steel nuts with two washers of the same material, allowing fixation on rods with an outer diameter of 6.2 cm.

N-TYPE CONNECTOR TECHNICAL SPECIFICATIONS FOR GOES AND GPS ANTENNAS

The male N-type connectors of GOES and GPS antennas must have a locking system with a nut according to the following figures, ensuring they remain securely fastened to their respective communication cables.

Parts of N-type connectors

Parts of N-type connectors

All N-type connectors must include a centrally soldered pin and reinforcement at the junction with their respective connection cables using "rubber sleeves" and "heat-shrink tubing" for increased strength and durability of these connections.

ANA will subsequently send the connector connection diagram.

1.1. COMMUNICATION CABLES

Two (2) communication cables must be provided for each DCP: one (1) for communication between the DCP and the laptop, and another (1) for communication between the GOES modem and the laptop.

The communication cable between the DCP and the laptop should have a minimum length of 3 (three) meters and feature a female connector of the military type with 4 pins at one of its ends, following the previously provided pattern (metallic military connectors Type "MS," Class "E," "F," or "R," reference models: MS3106E14S, MS3106F14S or MS3106R14S). The other end can be USB or Serial-RS232 female, provided it is accompanied by an additional converter cable Serial-RS232 male - USB.

The communication cable between the GOES modem and the laptop should have a minimum length of 2 (two) meters and include a connector for the GOES modem at one of its ends. The other end can be USB or Serial-RS232 female. This cable should enable the firmware update for the GOES modem.

In both cases, the PDA must communicate with the portable devices through the USB communication port, under the Windows 10 operating system.

Additional data communication solutions between the PDA and the laptop (e.g., Bluetooth, Wi-Fi, etc.) will be evaluated by the technical department of the ANA agency.

1.2. DCP SUPPORT BAR, SOLAR PANEL, AND ANTENNAS

For the DCP support, a 3-meter-long galvanized steel tube with a nominal outer diameter of 2 inches and a minimum wall thickness of 3.2 mm should be provided.

This support should allow the joint installation of the casing, the solar

panel, and the GOES and GPS data transmission antennas with a lateral arrangement on the galvanized tube. It should be resistant enough to ensure the equipment's safety in adverse temperature, humidity, and wind conditions.

Components of the DCP installed on the upper base of the galvanized tube will not be accepted.

It should include a threaded or galvanized steel cap on the upper end or welded to prevent rainwater from accumulating inside the support rod.

A locking system at the bottom of the support bar will be provided for additional fixation to the ground.

All clamps, washers, and nuts required to secure the DCP, solar panel, and GOES and GPS antennas should be identical to each other and made of stainless steel.

1.3. GROUNDING SYSTEM

A grounding system should be provided to discharge static charges accumulated in the DCP structure and provide a stable voltage reference for the equipment, following the standards NBRs 13.571/96, 5426/85, 5456/87, 6006/80, ASTM E 478, UL-467, or other standards ensuring equal or superior quality.

The grounding system planned should have the following minimum characteristics:

1.3.1. Solid copper cable, 3.0 meters in length, and nominal section of 35 mm2 (total of 1 unit per DCP);

1.3.2. Grounding rod composed of a carbon steel core, ABNT 1010 to 1020, coated with at least 0.25 mm of electrolytic copper layer with at least 95% purity, no traces of zinc, 2.4 meters in length by 1/2" in diameter, with a beveled tip (total of 1 unit per DCP);

1.3.3. The rod should not present cracks or displacement of the copper layer when bent at an angle of 30°.

1.3.4. Devices to connect the copper cable to the DCP box and the rod.

1.3.5. Connectors between the grounding rod and the copper cables should be of the "U" type, with an area of 1/2" for the grounding rod, as shown in the image below:

Photo of connectors

The grounding rod should be delivered tied inside the 3-meter galvanized tube used as the support rod for the DCP.

1.4. COMMUNICATION SOFTWARES

The software designed for datalogger programming and sensor/data transmitter configuration should exhibit compatibility with the Microsoft operating system, specifically Windows 10 and newer versions. It is expected to facilitate essential functionalities such as firmware updates, the creation of programming routines for seamless data collection, storage, and transmission (hidrometeorologic data, configuration parameters of PCD and the operating sensors and function status), as well as the configuration and calibration of sensors (ex, offset and gain). Moreover, it should allow users to effortlessly download and upload data from the datalogger's internal memory.

All the necessary means (software, programs, licenses, etc.) for the user to download the data and information stored in the internal memory of the datalogger, as well as the programming routines for data collection, storage, and transmission, must be provided.

In addition to the Windows software version, a licensing provision for each DCP is mandatory if the manufacturer provides a software version compatible with the Windows Mobile operating system or applications tailored for Android or iOS. The Software specifications are outlined below.

The communication software designed for the DCP should streamline tasks such as firmware updates, DCP identification (including name and code), and adjustments to date (day, month, and year) and time (hour, minute, and second). The specific functionalities of the programming, configuration, and data download software are outlined below.

1.4.1. PROGRAMMING DATA COLLECTION AND STORAGE ROUTINES

a) Adjust the frequency and duration of data collection (sampling) independently for each sensor or sensor set.

b) Enable users to define collection rules, such as recording the occurrence of each "tilt" of the rain sensor, adjusting the collection interval for water level data based on observed variations, and recording data from one sensor in correlation with data read by a second sensor.

c) Allow users to adjust water level data from a pressure transducer-type sensor by referencing the water level reading in the rule section (conventional limnimeter station). Additionally, provide the capability to compensate for the influence of atmospheric pressure measured by the barometric sensor.

d) Allow adjustment of water level data from radar and bubble-type sensors with the water level read in the rule section (conventional limnimeter station).

e) Activate or deactivate sensors for data collection.

f) Activate or deactivate sensors for storing collected data.

g) Program the scale and calibration (e.g., offset and gain) of sensors.

h) Allow definition of data storage and transmission format.

i) Allow configuration/programming of the standard SDI-12 and RS-485 serial interface.

j) Facilitate DCP programming by enabling the loading of a file (configuration program) that contains pre-recorded general data, including information on sensors, collection and transmission frequency, data format, and more.

1.4.2. PROGRAMMING OF DATA TRANSMISSION AND STORAGE ROUTINES

a) Facilitate the configuration of transmission parameters for both the GOES modem and GSB modem through the communication software with the DCP, eliminating the necessity of a direct connection to the GOES modem by employing an alternative form of communication.

b) Allow the selection of data to be transmitted (e.g., water level from the pressure transducer, bubble and radar sensors, accumulated rainfall, barometric pressure, etc.).

c) Allow the definition of the transmission word format.

d) Allow the definition of parameters of the operational status of the DCP to be transmitted (e.g., battery charge and internal temperature).

e) Allow the transmission interval (e.g., every 15 minutes, hourly, daily, etc.).

f) Allow to define parameters and verify the transmission status.

g) Enable the transmission of alarms in case predefined events occur.

1.4.3. DOWNLOAD OF DATA AND INFORMATION STORED IN INTERNAL MEMORY

a) Enable the download of hydrometeorological data and information, providing the option to refine the downloaded dataset based on the acquisition date.

b) Allow the download of rainfall event data, accumulated at intervals of 10 seconds or less.

c) Allow the download and upload of DCP and sensor configuration parameters

d) Allow data and information stored in the internal memory to be deleted

e) The download of data spanning 6 months, considering an acquisition frequency of 15 minutes, should not exceed 15 minutes.

1.5. DOCUMENTATION

All blueprints, catalogs, and handbooks must be provided in digital format, in Portuguese, English and Spanish, encompassing every element of the DCP: datalogger, power system, sensors, and grounding system, whether sourced domestically or internationally, obtained from external parties, or crafted by the bidding company.

The technical handbooks the bidding company should provide will comprehensively address all essential details for the accurate programming, calibration, installation, maintenance (preventive and corrective), and operation of all components, spanning the following subjects:

1.5.1. DCP MAINTENANCE HANDBOOK

This handbook is required to, at the very least, incorporate an in-depth technical overview of every DCP component: datalogger, sensors, and power system. It is expected to elucidate the configuration of components and testing points, furnish interconnection diagrams, delineate cable connections linking the datalogger and

sensors, and present a step-by-step troubleshooting guide for identifying and addressing faults.

1.5.2. DCP OPERATION HANDBOOK

This handbook should encompass, at the very least, a comprehensive overview of the DCP, startup sequences, operational guidelines, procedures for configuring the datalogger and GOES modem, a description of potential faults detectable through visual inspection by operators, and other critical details essential for the effective operation and maintenance of the DCP.

1.5.3. DCP PROGRAMMING HANDBOOK

This handbook is required to provide, at the very least, a comprehensive overview of the DCP's programming environment (software, programs, etc.) and the fundamental programming/configuration procedures detailed in the section pertaining to the software.

The aforementioned technical handbooks can be consolidated into a single document, organized into chapters for ease of reference.

WARRANTIES

The equipment's operational and technical support warranty extends for a period of 2 (two) years, commencing from the date of acceptance

The provided technical support should encompass the following activities:

a) In the event of hardware or software defects during the warranty period, the DCP or any accessory may be replaced, subject to proper notice. This replacement is contingent upon the usage of the equipment aligning with the guidelines specified in the operation and maintenance manuals that will be supplied.

b) Structuring and implementation of the operation program in the DCPs' datalogger, defining monitored variables, collection intervals, data processing, and other technical details of interest.

c) Resolution of various operational issues with the DCPs, such as firmware installation or reinstallation, installation, or reinstallation of the operating program, download operations, sensor configuration, etc., which may jeopardize the proper functioning of the automatic station.

The Contracting Party reserves the right to connect the acquired equipment with equipment or products from other manufacturers, provided that such initiative does not result in physical damage to the equipment, and the successful bidder cannot use this as a reason to exempt themselves from the performance warranty stipulated in the contract.

OVERALL CONSIDERATIONS

All requisite certificates validating compliance with the specifications will be systematically presented alongside the commercial proposal. The certificates to be furnished encompass:

a) NESDIS Certificate for the supplied model of the GOES modem.

b) Certificate from the *Ministerio de Transportes y Comunicaciones del Peru* for the supplied model of the GOES modem.

c) Calibration Certificate for the supplied model of the barometric sensor.

d) Certificate of conformity for the functional test of the GOES antenna model, demonstrating transmission gain.

e) Certificate of conformity for the operational test of each supplied barometric sensor.

It is important to note that the subject of the tender (Data Collection Platform - DCP) corresponds to a technological solution composed of the integration of different components. Therefore, the offered price corresponds to the total value of the proposed solution, not to each component separately.

Technical specifications are deemed "equivalent," "similar," or "of better quality," established as quality parameters to support the description of the subject being tendered.

The supplier must provide detailed calculations of the DCP's power consumption (during full operation) in their technical proposal to clearly demonstrate that the supplied power system meets the requirements and conditions in this tender.

Data transmission systems must be complete, including all equipment required for communication with the datalogger and radiofrequency output, antennas, cables, connections, manuals, and the necessary software for system installation, maintenance, operation, and integration with the station.

All supports, connectors, cables, and adapters necessary for the proper installation of all DCP components and sensors in the field must be supplied.

TRANSPORT PACKAGING

As recommended by ACTO, a unit must be sent to Brazil for testing and evaluation by ANA's competent department. The cost of this shipment must be

budgeted by the proposer. The address to which it should be sent is:

ANA - Agência Nacional de Águas e Saneamento Básico. Centro de Instrumentação e Logística. Setor Policial, Área 5, Quadra 3, Bloco "U", Brasília-DF. CEP 70.610-200.

Each DCP must be delivered to the Servicio Nacional de Meteorología e Hidrología de Perú - SENAMHI (*National Service of Meteorology and Hydrology of Peru*) at the following address: Av. Fernando Tupac Amaru G9 A, Urb. Tupac Amaru Distrito de San Sebastián, Cusco, Perú, in a single main volume (sole), containing:

DCP Box; Battery; Solar Panel; GOES and GPS Antennas; Copper cord with connector for grounding rod; and Communication cable.

The packaging of the volume must comply with NBR 5985, meaning double-wall corrugated cardboard (BC) with inner and outer brown layers (640 g/m² - outer Kraft cover), minimum thickness of 6.0 mm ± 0.5 mm.

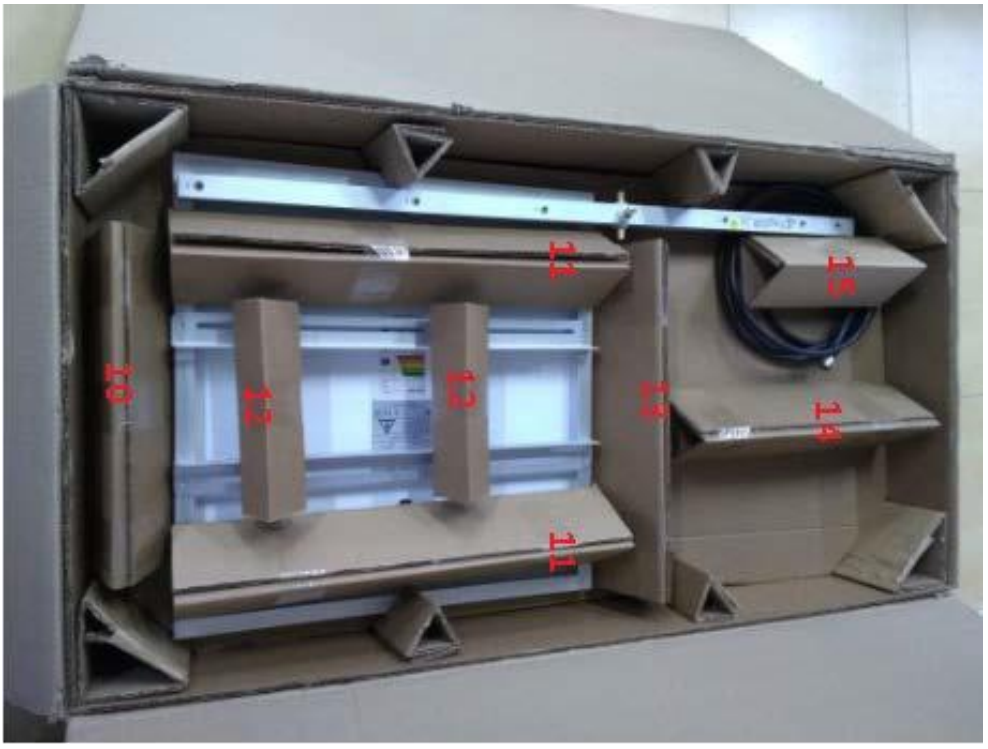
The box closure should have 4 flaps at the top and 4 flaps at the bottom with overlapping.

Inside the package should be strategically placed a minimum of 8 triangular columns made from the same material as the previously described box. The sides of these columns should measure approximately 10 cm and a height sufficient to guarantee separation between the packaging box and the solar panel, as well as other accessories, in order to provide effective protection for the solar panel. Additionally, at least 8 additional triangular columns made of the same material as the box described in the previous paragraph (with sides approximately 10 cm and the same height as the box) must be installed internally, all of which are intended to increase the external structure's resistance. Below are images illustrating the internal structure of the cardboard box with all 16 columns in place.

The side joints of the main packaging must be strongly glued and stapled for protection during transportation. Below is a photograph of the box for the solar panel space.

The photo below illustrates the final closure system, positioned over the solar panel and other accessories, aiming to keep the physical structure of the cardboard box robust and ready for transportation from ACTO to other monitoring entities associated

with the Organization.



Products with packaging quality and resistance below the specified standards will not be accepted.

Sub-items 1.1 to 1.5 will be delivered packaged together (as a unit) in the main package.

Sub-items 1.6 and 1.7: support rods and grounding rods will be delivered separately.

Spare parts described in sub-item 1.10 will be delivered packaged together in separate packaging from the other items.

ITEM 02 - TECHNICAL SPECIFICATIONS OF ELECTROMAGNETIC RADAR WATER LEVEL SENSORS FOR PDS

The water level sensor must be of the "Radar" type and meet the following minimum requirements:

a) Capable of being programmed for reading frequency between every 30 seconds and once per day.

b) Minimum measuring range: 1 to 35m.

c) Uncertainty: ± 10mm over the entire measuring range.

d) Resolution: 5 mm

e) Maximum Total Opening Angle: 12°. 12°.

f) Operating temperature range: -10 °C a + 50 °C.

g) Operating relative humidity range: 0 a 100%.

h) Output signal through the standard RS-485 data communication interface (using the Modbus transfer protocol) and standard SDI-12. The offered sensors must have two types of communication interfaces: RS485 – 4-wire and SDI12 – 3-wire.

i) Power range: 10 to 16 Vdc.

j) Electrical connection: The provision of cable for the connection between the Radar and the DCP is not part of the bidding.

k) Casing material of stainless steel and weather-resistant.

l) The bottom of the antenna must be sealed to prevent insect entry.

m) IP66 or higher protection rating.

n) Maximum Weight: 3.5 kg.

o) The sensor must endure the specified environmental conditions without incurring any damage:

- Temperature: -10 ºC to +60 ºC; and
- Relative Humidity: 0% a 100%.

p) A display or software compatible with the Windows 10 operating system or higher, capable of:

- Communicating with the radar and changing the RS485 or SDI12 address;
- Checking the firmware version of the sensor and the serial number; and

- Checking the radar level and allowing changes to the unit of measurement and other calibration parameters.

q) A metallic support must be provided to fix the Radar, allowing for level adjustment.

r) The radar sensor must operate with the NetDL1000 data loggers from OTT, CR8000 from Campbell, and QML201C from Vaisala without requiring additional resistors or any additional electrical devices inside the military connector. These data loggers will be available to bidders at the ANA headquarters in Brasília/DF for communication validation.

s) All components (meter, cables, accessories) must be fully protected against moisture and be waterproof.

t) The offered Radar must be authorized by the *Ministerio de Transportes y Comunicaciones del Perú* and comply with the technical requirements and regulations established

u) The bidding company must submit a declaration regarding compliance with the technical requirements regulated by the *Ministerio de Transportes y Comunicaciones del Perú* and with the qualification documents.

v) If the radar frequency is subject to certification by *Ministerio de Transportes y Comunicaciones del Perú*, the bidder must provide the Ministry's homologation certificate for the offered radar sensor along with the qualification documents.

w) If the Radar frequency is not subject to certification by *Ministerio de Transportes y Comunicaciones del Perú*, the bidder must submit a declaration that the offered Radar is not subject to certification by Ministry, along with the qualification documents.

x) Other components and accessories required for the correct installation and operation of the equipment in the field, such as software, display (if necessary), cables, converters, etc., must be provided.

y) A 4-pin female metallic military connector (MS3106E14S, MS3106F14S, or MS3106R14S type, complete with its respective pigtail) must be provided for each supplied radar sensor, for the connection between the radar and the DCP.

z) All folders and technical handbooks to validate the requirements of the electromagnetic radar water level sensor must be systematically included with the commercial proposal. Should the sensor operate on the Modbus protocol,

essential data such as Slave Address, communication rate, parity, Start Bit, Stop Bit, Function Code, Check Code, and other details related to Modbus-type sensor question/answer strings should also be furnished.

aa) The electromagnetic radar water level sensors must be delivered, packaged separately, so that the Organization can transport them to the entities responsible for hydrometeorological surveillance. The main packaging must comply with NBR 5985, using corrugated cardboard with BC-type waves, double-walled, with a thickness not less than 5mm density. Products with packaging quality and resistance below the specified standards will not be accepted.

The connection diagram of the radar sensor on the 4-pin military connector should be:

RS-485 – 4 Pins	
A	A
B	(+)
C	(-)
D	B

o

SDI-12 – 4 Pins	
A	Data
B	(+)
C	(-)
D	nc

These are technical specifications of "equivalent" or "similar" nature and "or of better quality," established as quality parameters to facilitate the description of the object being tendered.

ITEM 03 - TECHNICAL SPECIFICATIONS FOR PLUVIAL BUBBLE SENSORS FOR PDS

- This sensor will measure water level variations in places where it is not possible to install piezometric or radar sensors.
- The sensor itself will not be in contact with the water; instead, the hose carrying a constant flow of gas from a compressor will have direct contact. The pressure required for air to pass through the hose will be proportional to the liquid depth.
- The bubble-type level sensor must meet the following specifications:
  - Sensor type: Bubble
  - Flow type or measurement technique: Constant flow
  - Compressor type: Piston
  - Measurement range (pressure range): 0 to 20 meters or greater
  - Accuracy:
    - ≤ 0.05% of reading or less than 1 cm or ≤ 0.02%

of full-scale output.

- Maximum purge pressure: 50 PSI with manual and programmable control option.
- Air flow control: Programmable bubble rate.
- Maximum current consumption: 8 A or less for active compressor at 50 PSI.
- Average current consumption: Less than 20 mA (without purging)
- Display screen: LCD with backlight. Included keypad type: Push buttons or Communication Protocol: RS232 e SDI-12.
- Air Outlet Connector: For 3/8" tubing or hose.
- Enclosure: Fiberglass NEMA4 and/or IP64.
- The bubble-type level sensor must include the following accessories:
- The polyurethane hose should be of a length suitable for the distances between the measurement point and the datalogger.
- Replacement desiccant with spare container included.
- Entry terminal for mounting on a 2" rigid pipe.
- User manual in digital and/or printed format.
- Metal mounting and/or protective support.

ITEM 04 - TECHNICAL SPECIFICATIONS FOR PLUVIOMETRIC BUBBLE SENSORS FOR PDS

a) Type: Type: Tipping-Bucket Rain Gauge (TBRG) comprising a set with a base and a removable collector, both labeled with the brand, model, and the same serial number.

b) The cabinet (collector) should be positioned/mounted adjacent to the base only in a specific orientation. This requires the use of mechanical devices or markings on both the base and collector preventing the wrong assembly of the set.

c) The collector cabinet must be designed with internal dimensions and angles that minimize possibilities of rain splashing beyond the collection container.

d) The cabinet should be equipped with screws or a similar system (made of stainless steel) to level the rain gauge.

e) Sensor with adjustment devices to balance scale volumes, and the scales should come perfectly balanced from the factory.

f) Resolution: 0.20 mm

g) Measurement range: 0 a 300 mm/hour;

h) Operating temperature range: 0 °C a + 50 °C.

i) Uncertainty: 3% for intensities up to 50 mm/hour.

j) Uncertainty: 5% for intensities exceeding 50 mm/hour.

k) Water capture orifice area of the sensor from 300 to 500 cm2; (with a tolerance of less than +/- 1 mm in nominal diameter measurements).

l) The angles (both internal and external) of the rain gauge's (collector) edge should be precisely tuned to minimize the impact of wind turbulence.

m) Includes a reed-switch interrupter.

n) Constructed entirely with corrosion-resistant materials.

o) Use of material (or paint/treatment) with a low coefficient of friction coating to prevent the retention of rain samples.

p) The sensor must include a fixed screen in the collection area, shaped like a tower, which can be removed for cleaning. It is designed to safeguard the entry point of rainwater against the infiltration of insects and other debris.

q) The rain sensor must include conduits or other devices at the bottom for the integral drainage of rainwater, allowing for verification and/or calibration. The sensor should not retain water inside.

r) The rain sensor must have mesh(es) at the discharge hole(s) of the captured water (rain exit point), suitable for preventing the entry of insects.

s) It must be equipped with an additional internal funnel, and it must have a siphon, constructed from stainless steel.

t) The sensor must consist of a "tilting" mechanism entirely made of stainless steel and supported on stainless steel bearings.

u) The sensor must have an internal bubble leveling mechanism.

v) The cable is externally coated with materials such as polyamide,

polypropylene, polyurethane, polyolefin, polyethylene, or nylon. It is electrically shielded and provides high-durability protection against ultraviolet rays. The cable is molded or similarly manufactured, featuring 3-pin female military connectors (Type "MS," Class "E," "F," or "R," with references MS3106E14S, MS3106F14S, or MS3106R14S) installed and accompanied by its corresponding rubber sleeve. Additionally, each rain sensor and the DCP follow the specified diagram, and the cable is further protected with heat-shrink tubing.

w) It should be used for the connection between the rain sensor and the DCP, with a length of 05 (five) meters.

x) The sensor must endure the specified environmental conditions without incurring any damage:

- Temperature: -10 ºC to +60 ºC; and
- Relative Humidity: 0% a 100%.

y) An independent and dedicated support rod for the rain sensor will be provided, crafted from galvanized pipe measuring 1.7 m with a nominal diameter of 1 and 1/2 inches. The pipe features a minimum wall thickness of 3.2 mm and is equipped with a locking system at the base.

z) The rain sensor will be strategically installed, ensuring that the rain capture plane is positioned at least 1.5 m above the ground. Its support will be securely anchored to the ground, free from any interference with other DCP equipment.

aa) All connectors of the rain sensors must be reinforced at the junction with their respective connection cables using "rubber sleeves" or "heat-shrink tubing" to enhance the strength and durability of these connections. The connection diagram for these connectors will be provided by ANA at a later date.

bb) For the correct installation and operation of field equipment, all components and accessories required must be supplied, including a calibration certificate for each rain gauge.

cc) For each rain sensor, the selected supplier must provide a graduated device to verify the calibration of the rain gauge in the field (calibration kit).

dd) The graduated container will feature a volume of approximately 1 liter, equipped with interchangeable holes to adjust the precipitation rate (included), and will feature a base (or other type of accessory) to facilitate attachment to the rain gauge.

ee) The calibration kit requires a mechanism (siphon or equivalent) to maintain a constant water flow during the calibration process.

ff) For each calibration kit, 1 digital pulse counter will be provided (battery-operated or using batteries available in the national market), with a pair of 1m-long cables attached to a pair of approximately 3 cm male electrical terminals for the verification of rain gauge calibration, according to the images shown below..

gg) Except for the support rod of the rain sensor, it is required that all sensors be delivered separately, and packaged for transportation by ANA to the entities responsible for hydrometeorological surveillance.

hh) The main packaging must comply with NBR 5985, using corrugated cardboard with BC-type waves, double-walled, with a thickness not less than 5mm, and high density.

ii) The connection diagram for the Rain Sensor on the 3-pin military connector should be:

Rain Gauge (Pulse) - 3 pins

A	
B	

C	

These are technical specifications of "equivalent" or "similar" nature and "or of better quality," established as quality parameters to facilitate the description of the object being tendered.

ITEM 05- TECHNICAL SPECIFICATIONS FOR DISPLAY-TYPE KEYBOARDS FOR PDS

Minimum General Requirements:

a) Device composed of a keyboard, a display, a protective case, and processing capability allowing manual data input and communication with a data logger using the SDI-12 serial communication protocol.

b) The device must use the SDI-12 communication protocol, a standard for all ANA (Brazil) DCPs, enabling hydrological observers (and trained personnel) to input hydrological data through the attached keyboard.

c) The main applications of the collected information will be:
- Replace the use of automatic sensors in locations where installation is impractical.
- Employ manually input data from observers for comparison with information transmitted by automatic sensors at crucial hydrological control stations.

Minimum requirements for the shielding of the SDI-12 keyboard casing

a) The SDI-12 Keyboard casing must be protected from direct sunlight by a stainless-steel shield, resistant to sunlight and weather, with a white electrostatic powder coating. The shield must cover the sides, back, and top of the case, allowing air to pass between the box surface and the shield so there must be a minimum distance of 1 (one) centimeter between the shield and the side and top parts of the box. The shield must protrude at least 2 (two) centimeters from the front top of the case.

b) All accessories for fixing the shield (clips, clamps, nuts, screws, etc.) must be provided.

c) The set consisting of the shield and the SDI-12 Keyboard case must have a stainless-steel fixing bracket allowing attachment to rods with an outer diameter of 6.2 cm. For each SDI-12 Keyboard, two (2) stainless steel "U" clamps with 1/4" thread, nuts, and stainless-steel washers must be supplied.

d) The shield's external dimensions require approximately (H x W x D): 23 cm x 23 cm x 10 cm.

Minimum requirements for the SDI-12 keyboard casing

a) The device must be securely installed within the casing and protective cover, exhibiting the following features: robust construction, built with stainless steel, possessing high durability against ultraviolet rays, environmentally sealed, resistant to rain and water, humidity, dust, and insect intrusion, and finished with a white electrostatic powder coating.
b) The SDI-12 Keyboard case is required to incorporate a front door, a set of keys/locks, and two hinges for securing the access door, ensuring the safeguarding of internal components.

c) The SDI-12 Keyboard case requires a vented Gore-Tex® or a similar membrane mechanism, effectively minimizing pressure and temperature differentials between the case's interior and exterior while maintaining its sealing properties.

d) All locks on SDI-12 Keyboard cases require keys with identical codes as the ANA SDI-12 Keyboard cases, along with an external cover for protection from rain and adverse weather conditions. The current code will be provided by ANA for duplication.

e) Each SDI-12 Keyboard must be supplied with two keys sharing the same code.

f) The orifice for the keyboard cable passage through the case should be situated at the box's bottom, equipped with a sealing mechanism (cable gland or similar) to ensure compliance with the case's sealing requirements.

g) The external dimensions of the SDI-12 Keyboard Case must be approximately (H x W x D): 16 cm x 16 cm x 8 cm.

Minimum requirements for the SDI-12 keyboard

a) Use the SDI-12 serial communication protocol, version 1.3 or higher, for communication with ANA dataloggers.
b) Be compatible with dataloggers: Vaisala QML-201C, OTT NetDL100, and Campbell CR300.
c) Possess a non-volatile internal memory for storing configurations.
d) Possess a standard RS232 or USB communication port located inside the cover to allow configuration.
e) Consume less than 10 mA in standby mode and less than 100mA in operation.
f) Exhibit a 12-volt DC input voltage sourced from the SDI-12 interface, bearing voltages within the range of 10 to 16 volts DC without causing any harm to

the keyboard.

g) Be made of stainless steel.
h) Adhere to the impedance and transient limits outlined in the SDI-12 communication standard, ensuring that communication with other equipment linked to the same SDI-12 port is not impeded or obstructed.
i) Possess the following operating environmental conditions:
   - Temperature: -5 a +55°C;
   - Relative Humidity: 0% a 100% (non-condensing).
j) Possess the following storage environmental conditions:
   - Temperature: -20 a +70°C;
   - Relative Humidity: 0% a 100% (non-condensing).
k) Possess the following maximum external dimensions (H x W x D): 16 cm x 16 cm x 8 cm.
l) Possess e sealing with IP65 protection standard.
m) Possess a 16-key membrane manufactured according to NBR 13173 recommendations from August 2012.
n) Possess keys: "0 to 9", "●", "+/-", "turn off", "abort", "enter", "function".
o) Possess minimum key dimensions: 10mm x 10mm.
p) Possess a minimum distance between key centers: 15 mm
q) Possess a maximum contact time of 5 ms.
r) Possess a minimum durability of 500,000 cycles per key.
s) The external dimensions of the SDI-12 Keyboard Case must be approximately (H x W x D): 13 cm x 13 cm x 2 cm.

Minimum requirements for the SDI-12 keyboard Display

a) Alphanumeric LCD display with 02 lines, each comprising at least 12 digits and 16 segments or 35 points.
b) Minimum character dimensions of 03 mm width and 6 mm height.
c) Backlight for enhanced visibility in outdoor environments.

Minimum Requirements for the Cables and Connectors of the SDI-12 Keypad

a) Attached to the casing, with a sealing mechanism (cable gland or similar) ensuring compliance with the sealing requirements of the IP65 protection standard.
b) Standard 4-pin female military connector, Class "E" or "F" (reference models:
c) MS3106E14S or MS3106F14S).

Minimum Requirements for the Communication and Configuration Software of the SDI-12 Keypad

a) The device must be configurable from an external application compatible with the Windows 10 operating system or higher.

b) This application must be provided to ANA with a perpetual license, without restrictions.

c) The source code of the Windows application and the firmware controlling the device must be provided to ANA, allowing for modifications and updates.

Minimum requirements for the SDI-12 keyboard

a) Allow the entry of at least 10 different variables, selectable from the "function" key.
b) Each selected variable must have an alphanumeric label displayed on the top line of the screen.

c) Allow the input of decimal numbers.
d) Allow the input of negative numbers with a selectable sign using a "+/-" key.
e) The entered value and the "+/-" sign should appear on the bottom line of the screen.
f) Store the values entered via the keypad, allowing their subsequent reading by the datalogger, at predefined time intervals in the datalogger. Once this operation is completed, the keypad will return to standby mode.
g) To conserve energy, the display screen will automatically power off, and the device will transition to standby mode after a preconfigured period of inactivity on the keypad. It will reactivate upon pressing any key.

h) Configurations will be stored in a non-volatile internal memory, ensuring they remain unchanged in case of a power outage.
i) Stored values should be deleted:
   - Stored values should be deleted either after the datalogger has read the values stored in the keypad, or
   - after the pre-established time on the keypad has elapsed.

j) It should be configurable through an external application compatible with the Windows 10 operating system.
k) Configuration from a laptop requires the device to include not only the SDI-12 interface for communication with the Datalogger but also a standard RS232 or USB communication port.
l) Minimum configuration functions:

- SDI-12 address selection from 0 to 9.
- Allowing the input of up to 10 parameters (variables).
- Allowing the input of up to 10 parameters (variables) in the main flow and up to
- 8 control parameters (0 or 1) in the alternate flow.
- Allowing the selection of the order of parameters.
- Allowing the insertion of an alias (name) for each parameter for display on the first line of the screen.
- Possessing the function to reset the factory settings (via the application).
- Configuring the serial communication pattern (communication speed, number of bits, parity, stop bit, and flow control).
- Configuring the screen turn-off time.

m) Configuring the time after which the device will erase the entered keyboard data.

Minimum Standard Programming Requirements for the SDI-12 Keypad

a) The following functions must be assigned to special keys (Abort, Delete, and Function):

- "Abort" key: Discards the data of the entered variables (before the end of the standard flow), and the standard flow must restart.
- "Delete" key: Deletes one character at a time, from left to right on the line.
- "Function" key followed by a number: Cancels the ongoing operation and directs to the variable corresponding to the selected number. In the example of the previous standard flow, pressing the "Function" key and the number 1 directs the keypad to the elevation variable.

b) Here is the primary sequence for defining parameter 02. Elevation corresponds to variable 01, and precipitation corresponds to variable 02. This default sequence should be set as the factory default.

- 1- Press any key to exit standby mode and enter operation mode, illuminating the screen.
- 2- The screen shows the message "Elevation-cm" on the top line of the screen and the empty bottom line.
- 3- The user enters the elevation value (e.g., 4587) and presses the "Enter" key.
- 4- The screen shows the message "Rain-mm" on the top line of the screen and the empty bottom line.
- 5- The user enters the elevation value (e.g., 15.7) and presses the "Enter" key.

- 6 - The display shows the message "END" and stores the data in memory.
- 7 - The display will enter sleep mode after 30 seconds.
- 8 - The entered data must remain in the device's memory for a fixed period (configurable) or until further input. Values will be automatically erased after this configurable interval.

c) Alternate flow programming should involve the technician inserting up to 8 control parameters during the device's maintenance visit. The following provides a background description of the alternate flow with 3 parameters that should be preconfigured as factory defaults: maintenance, elevation adjustment, and rain gauge calibration.

- 1- Pressing the <Function> key followed by the number 000 and the <Function> key will display the message "Maintenance?" centered on the top line and "1-YES 2-NO" centered on the bottom line. The user should press the <1> key to confirm that the station maintenance has been performed or <2> to cancel the operation and return to the beginning of the main flow cycle.
- 2- If the answer is YES, the screen will display the message "Elevation adjustment?" centered on the top line and "1-YES 2-NO" centered on the bottom line.
  The user should press the <1> key to report that the elevation adjustment was performed or <2> to report that the elevation was not adjusted.
- 3- The screen will display the message "Rain gauge calibration?" centered on the top line and "1-YES 2-NO" centered on the bottom line. The user should press the <1> key to report that the rain gauge was calibrated or <2> to report that the rain gauge calibration was not performed.
- 4- Binary values 0 and 1 should be associated with the responses NO and YES, respectively. The numbers corresponding to the responses should be grouped to form an 8-digit binary variable, ordered from right to left, filling empty positions with 0.

Illustrative figures and photographs of the SDI-12 keyboard, packaging, and shield.

a) The following images show the SDI-12 keyboard, the casing, and the protective shield.

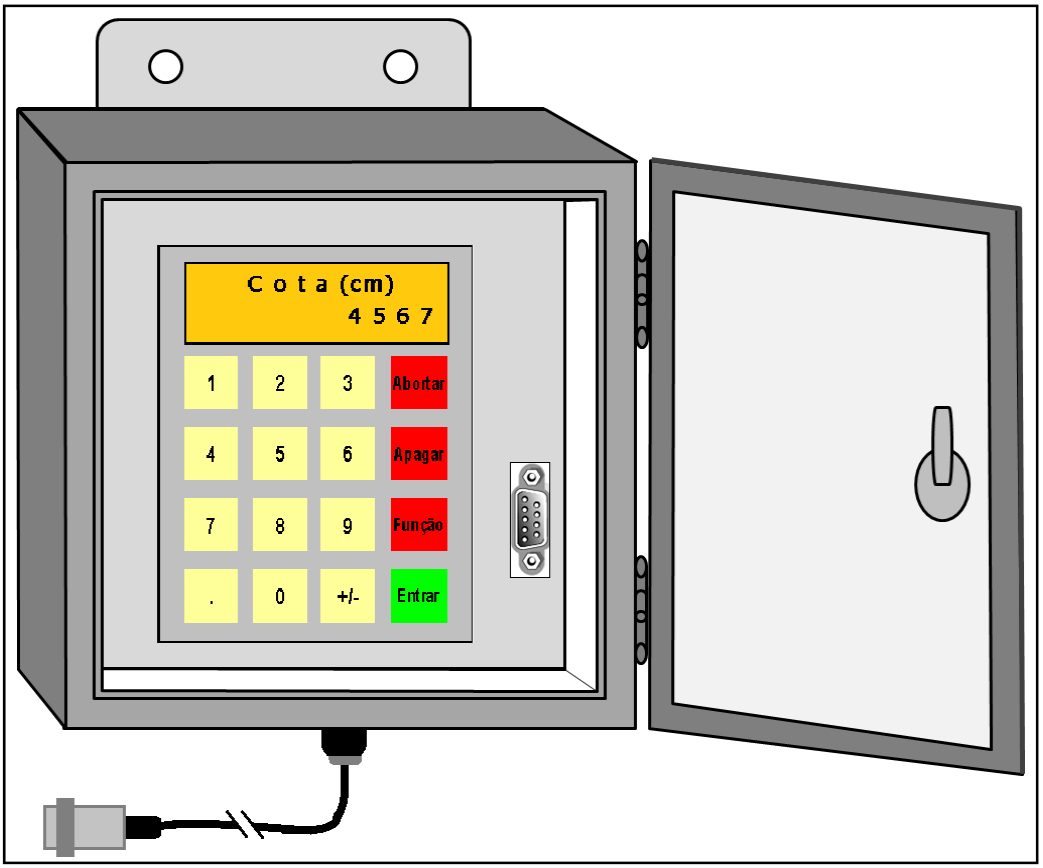


Figure 1 – Layout of SDI-12 keyboard

Figure 2 – Image of the front part opened

Figure 3 –Image of the bottom part

Figure 4 –Image of front part closed

Figure 5 – Internal image of the casing door

ADDITIONAL ASPECTS

I. Installation

- After the delivery of the goods, the installation of the 4 PCDs must be carried out at the designated locations. These sites may be adjusted if necessary, in coordination between the contractor, ACTO and SENAMHI.
- All accessories for installing all PCD components must be included, including cables, hoses, pipes, supports, connectors, etc.
- A grounding system (one per station) with a minimum capacity of 8 ohms must be implemented, including all materials for this purpose. The grounding system will be connected to the lightning down conductor.

II. Reception of the Stations

Delivery Location

- The contractor will be responsible for transporting the goods to the designated locations where the PCDs will be installed. The contractor will cover all costs related to transportation and insurance during transport and storage until all goods have been dispatched from the warehouse to the installation sites.
- Verification of the equipment upon receipt will involve ensuring that both the hardware and software components of the automatic stations match the specified models and brands, following a protocol that the supplier must outline in their work plan, schedule, and Occupational Health and Safety (OHS) plan. This protocol must be reviewed and approved by the supervising authority (or its equivalent) before the commencement of any work.

Physical Verification

Physical verification of the equipment will be conducted through visual inspection to ensure that the acquisition includes all items with the specified physical configuration, considering the following aspects:

- The quantity in numbers.
- Physical characteristics of the equipment (dimensions, NEMA4/IP56 protection, manufacturing materials, installation accessories, offered brand/model, etc.

Functional Tests of the Automatic Stations

Operational Verification: The supplier must provide a list of specialized personnel responsible for conducting the functional tests in the warehouse.

The data collection system must be tested in the warehouse, including the testing of each sensor to verify proper operation. Additionally, the solar panel and charge controller must be tested together with the batteries to ensure they are functioning correctly.

III. Data Visualization

As part of the installation, the contractor must provide WEB-HOSTING services for the visualization of data transmitted by GOES satellites. This service must be included for a minimum

period of 2 years and should be accessible from any PC with internet access. The company must provide access credentials (USERNAME and password) with the following minimum functionalities:

- Capacity to view data from automatic stations transmitting via commercial GOES / UMTS / GPRS communication systems
- Capacity to analyze/decode messages from relevant automatic stations.
- Capacity to control and validate data to ensure maximum reliability of recorded data across the entire network of automatic stations.
- Capacity to connect to NOAA/NESDIS servers and automatically download data from automatic stations transmitting to GOES satellites, with large-scale visualization of statistics from the stations.
- Capacity to export data in various formats (at least Excel and CSV.
- Capacity to analyze and visualize data with graphical analysis (e.g., maximums, minimums over periods of days, months, years) and numerical data visualization.
- Capacity to select standard sensors from the sensor library, configuring specific sensor parameters and default values.

1. INSTALLATION OF EQUIPMENT IN THE FIELD

The final installation of the equipment must be completed within a 30-calendar-day period. This process should be organized by the contractor in two phases, which are aligned with the date of receipt of the goods. The Contractor will begin the following activities no later than 10 days after the contract is signed and will have a maximum of 80 days to complete them, after which a report on the first stage of installation will be provided:

- Leveling of the terrain.
- Construction of the PCD infrastructure.
- Construction of a security system (7-meter posts with barbed wire).
- Construction of an electrical grounding system.
- Installation of a lightning rod system.
- Installation of limnimetric rules (water level gauges).

In a second phase, following a satisfactory inspection of the stations in the warehouse and no later than 90 days after the contract is signed, the following activities will be carried out over a 30-day period:

- Installation of the equipment described in these terms of reference.
- Installation of GOES satellite transmission.
- Installation of a YAGI transmission antenna.
- Installation of a protective enclosure (cabinet for weather protection).
- Installation of the power supply system: Solar panel, charge controller, and batteries.

1. Permits for Work Execution

The Client will be responsible for obtaining the necessary permits in a timely manner before the commencement of work, such as construction licenses and other approvals related to the areas where the stations will be installed.

2. Station Preparation and Installation

The Contractor will coordinate in advance with ACTO, SENAMHI, and the Cusco Regional Office to begin the preparation and installation work. The Contractor will also handle the transportation of materials and equipment to the designated installation site, ensuring that all necessary supplies for the installation are accounted for.

The contractor will prepare and install each PCD, covering all expenses involved in this activity. This includes the construction of the grounding well and installation of the grounding system (SPDA), as well as concrete infrastructure for each station. If necessary, any additional construction required to make the Automatic Stations fully operational will also be included.

3. Detailed Engineering and Plans

The detailed engineering will specify each subsystem, component, or part that makes up the project, referencing all the automatic stations and precisely defining their execution. As part of this process, detailed plans must be provided at the start of the work, along with final versions to be submitted upon project completion as part of the contractor's deliverables.

4. Construction of Station Infrastructure:

- The construction of the station infrastructure must include concrete foundations and perimeter fences made of steel to ensure the security of the station components, in accordance with the specifications provided. The ACTO must approve the contractor proposed structures that should meet these requirements.
- The design of the mast or pole for the installation of the automatic system, as well as the structural details, will be the responsibility of the contractor.
- The structural design of the stations must ensure that they do not retain rainwater. Additionally, the contractor must validate and construct an elevated platform for each station, if required.
- The contractor will install the automatic stations within a perimeter fence at the predefined locations. Prior coordination with ACTO the contractor should prepare the areas where the Automatic Stations will be installed, ensuring access to all areas where the stations will be located, clearing the area where each Automatic Station will be installed.
- Reference plans are shown in this section of the document; however, the final construction plans must be developed and submitted by the contractor before work begins. These plans will be reviewed and approved by the supervising entity (or its equivalent). The contractor is responsible for managing and financing all necessary permits, licenses, or procedures

required for the proper installation and operation of the stations, with the process being accompanied by the entity for accreditation purposes.

- The contractor must install each station in compliance with the SENAMHI installation protocol, which will be provided in digital format upon request by the contractor. Keyconsiderations include:
  - The bases of the guy wires must be separated at a 120° angle.
  - The cabinet containing the datalogger must be positioned at a height that allows easy access for a person to operate the internal equipment.
  - The solar panel should be oriented to the north, maximizing exposure from east to west, with an inclination angle of less than 30 degrees.
  - Mandatory installation tasks include all on-site preparations such as excavating for the foundation around the perimeter fence base, digging and ducting pipelines for sensor connection cables, and extending them to the hydrological station.
  - All logistics, including transportation of personnel, equipment, and machinery, must be considered for proper installation.
  - The commissioning of the entire system includes the implementation of all station components, including mechanical, electronic, and monitoring software, which must be compatible with the SENAMHI network of stations that transmit to the GOES Meteorological Satellite.
  - All stations must be correctly installed and fully operational, ensuring that they transmit data completely and accurately. Data reception, quality control, and visualization will be verified.

The contractor must provide a software platform for automatically downloading data from the NOAA server, which is transmitted via the GOES satellite, ensuring the correct reception and encoding of data for reliable use.

The contractor will submit to ACTO and SENAMHI an installation report and a technical datasheet for the station (including a detailed inventory) to finalize acceptance and approval. Compliance with the installation and operation verification protocol for an Automatic Station will also be verified.

The contractor will be responsible for the equipment until the automatic station is installed, fully operational, and has received the official approval from the entity.

The contractor must submit a work plan within 30 days of contract signing. This plan should include all activities, such as equipment delivery, installation, training, warranty, technical support, specialists, and coordination contact information.

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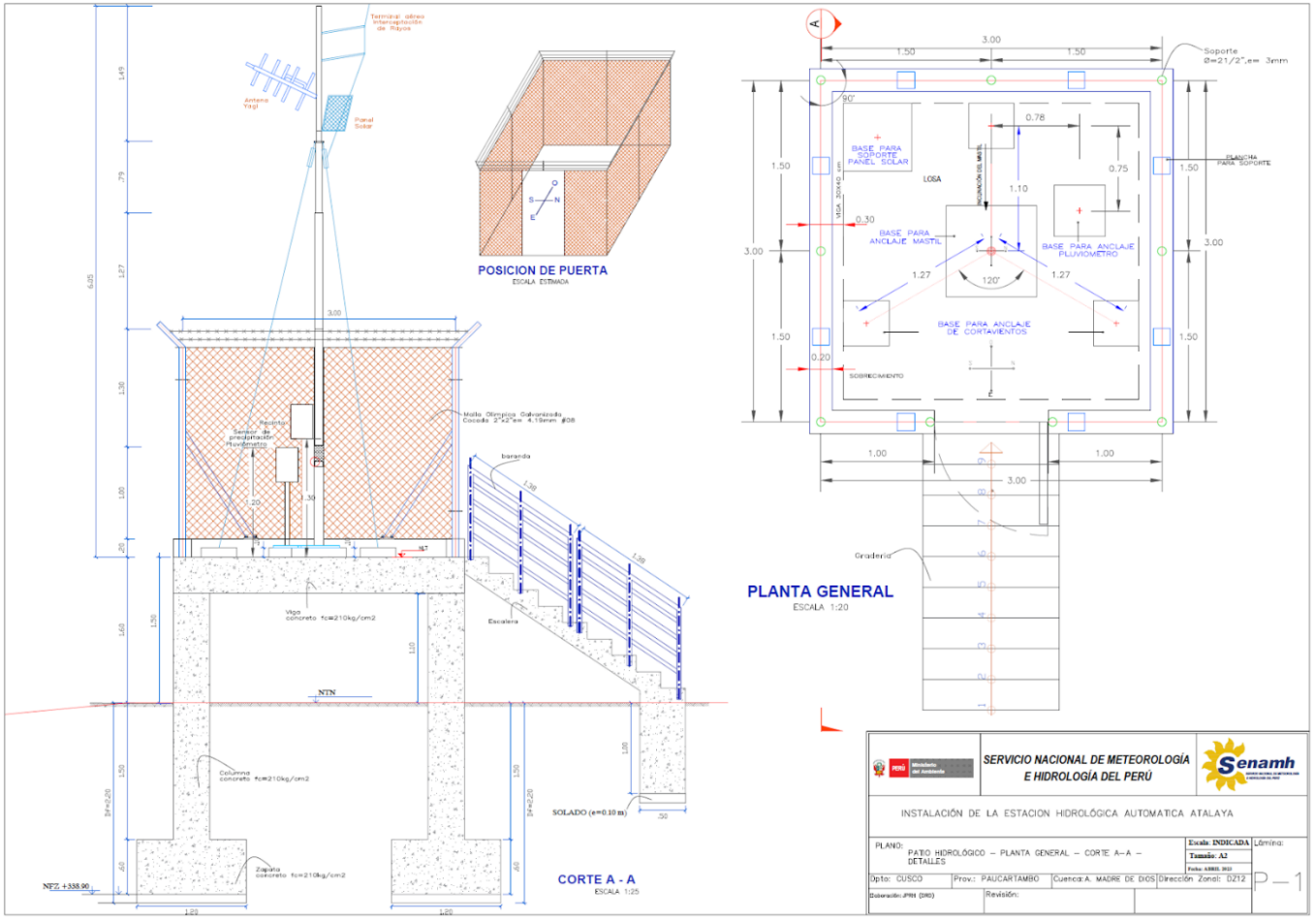
Amazon Cooperation Treaty Organization
SP - Permanent Secretariat

De Organisatie van de Overeenkomst voor Amazonische Samenwerking
SP - Permanent Secretariaat



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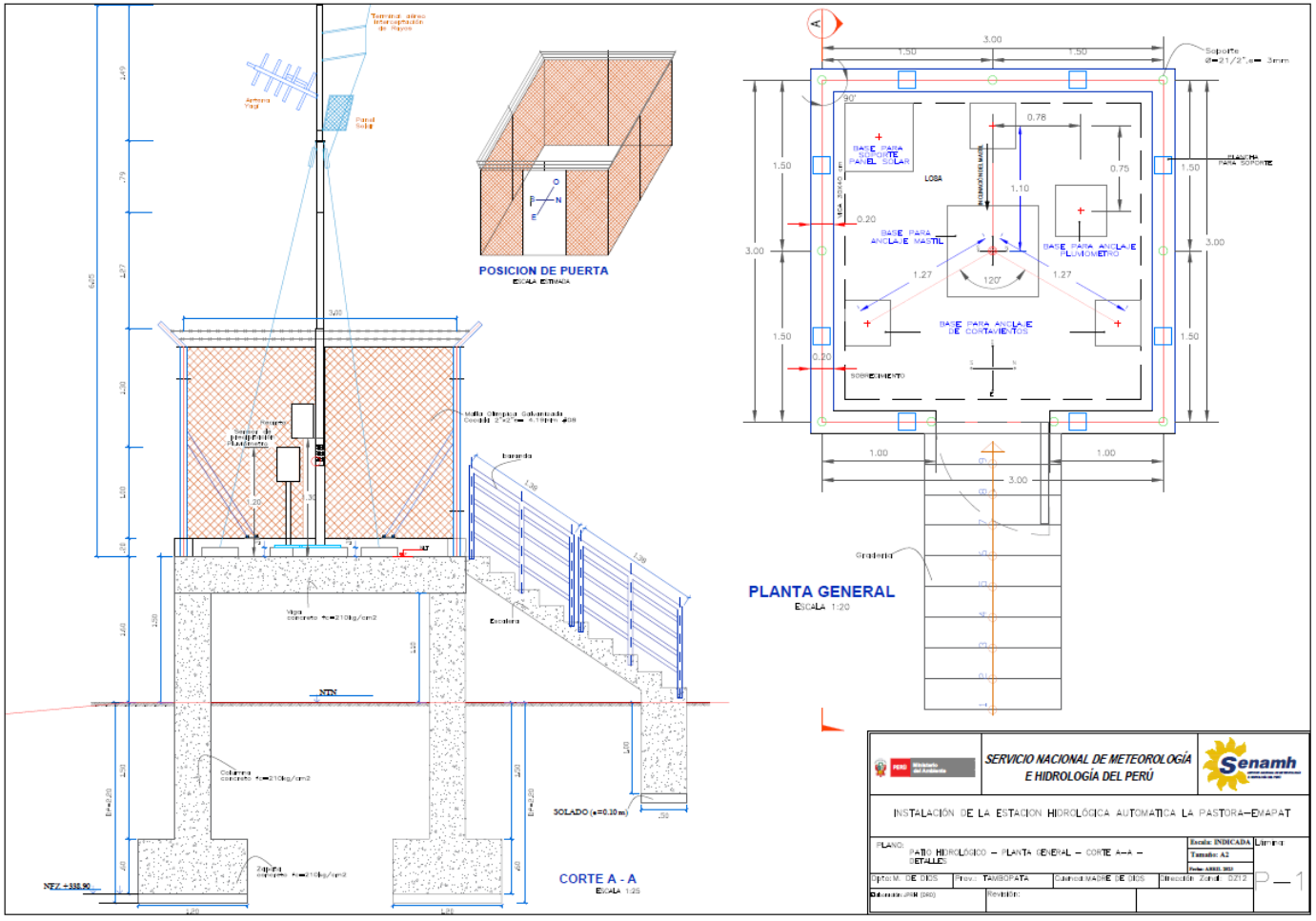

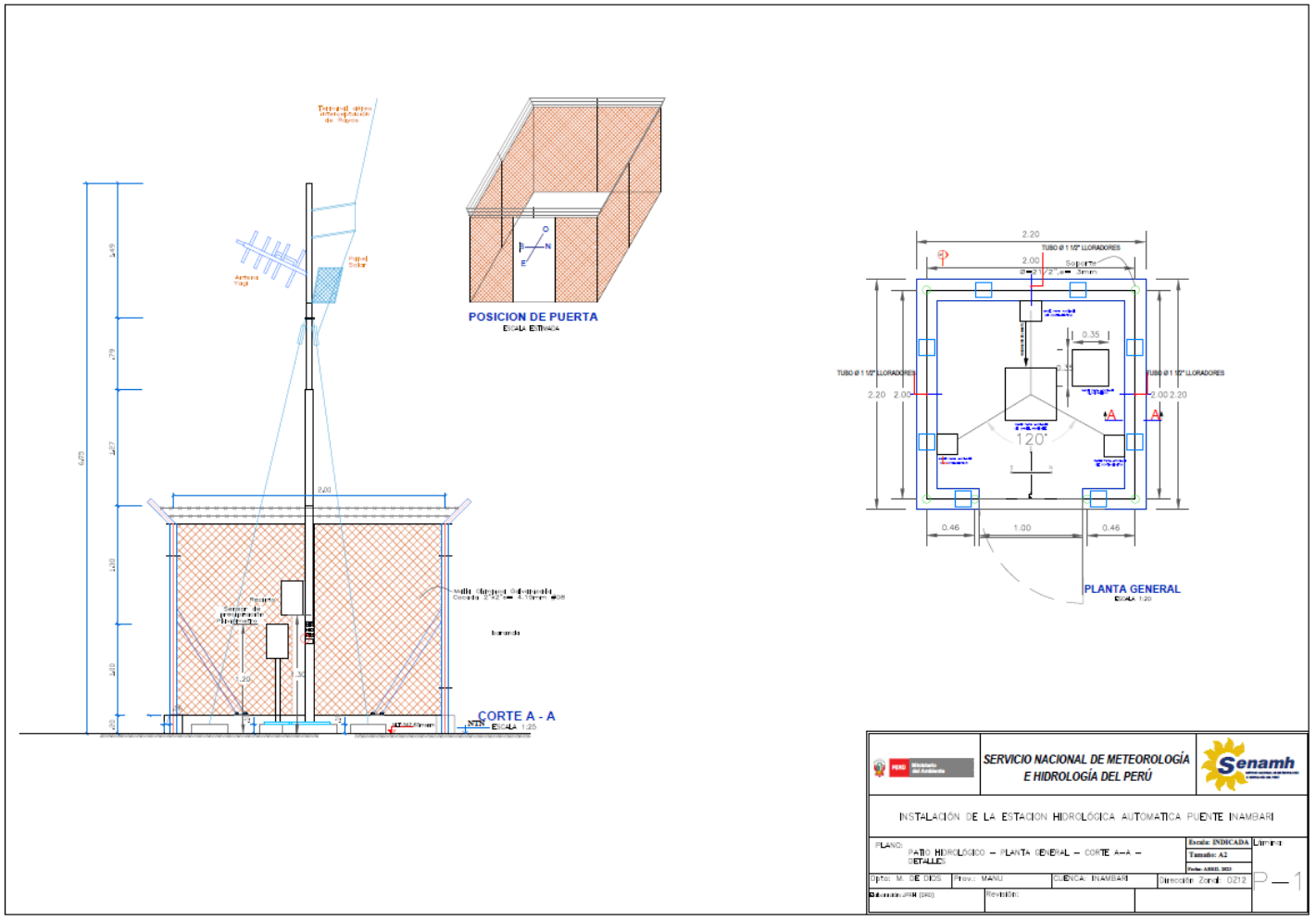
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ESCALA 1:25
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Tamaño: A2
Dpto: M. DE DIOS
Prov.: MANU
CUENCA: INAMBARI
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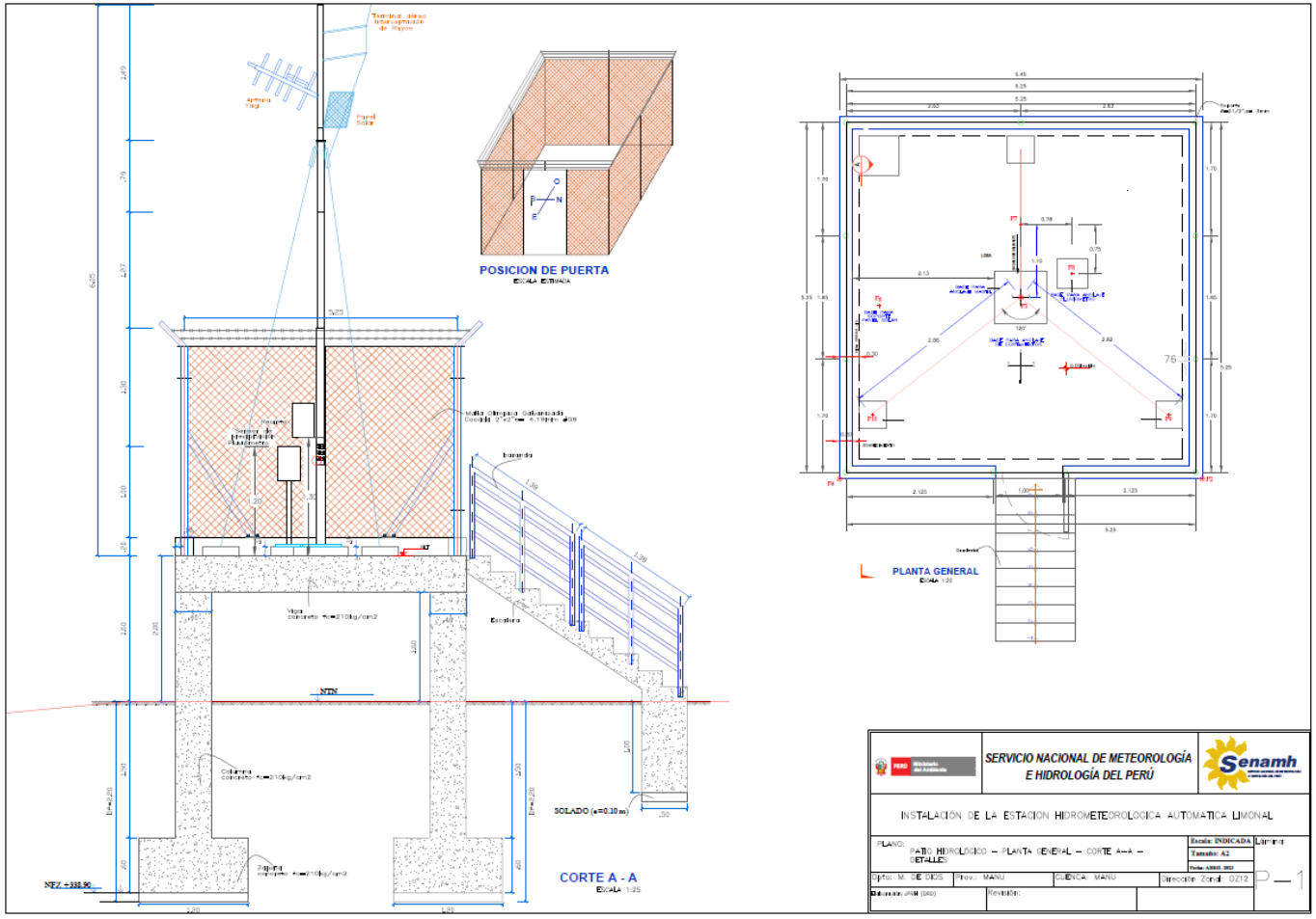
Revisión: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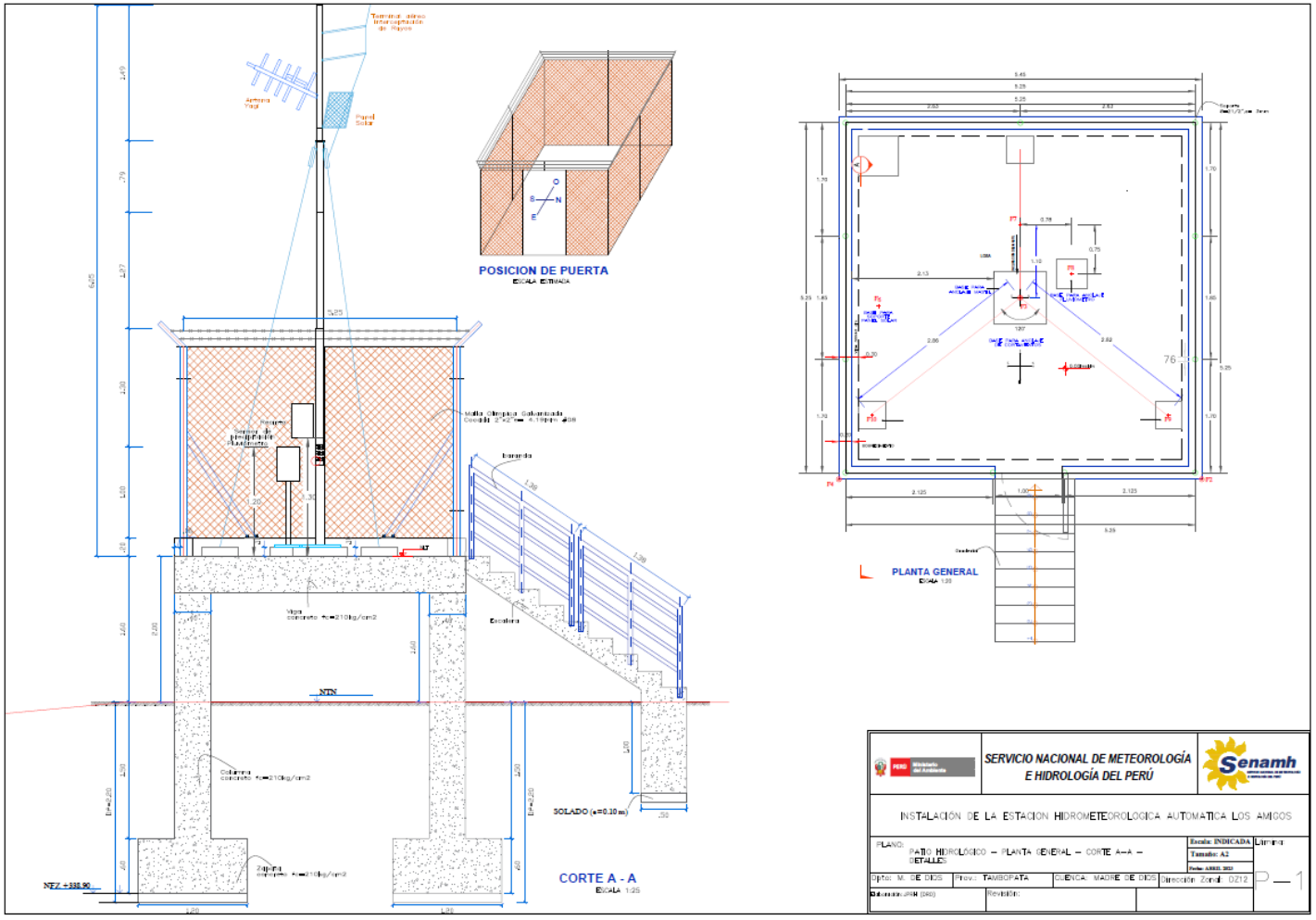


5. Construction of electrical grounding system

The construction of the electrical grounding system must include two grounding systems with resistances of 8 ohms and 10 ohms or less, maintenance-free, for the automatic station instrumentation and the lightning protection system.
A grounding certificate signed by a licensed Electrical Engineer. Materials used for grounding construction include:
Copper rod: 5/8" x 2.4 meters, and/or 50mm² copper cable, and/or a combination. Exothermic welding, conductive cement, sodium bentonite, and agricultural soil. Polypropylene inspection box.
Copper equipotential bar with minimum dimensions of 13 cm x 4 cm x 4 cm.

6. Lightning Protection System

The lightning protection system must include:

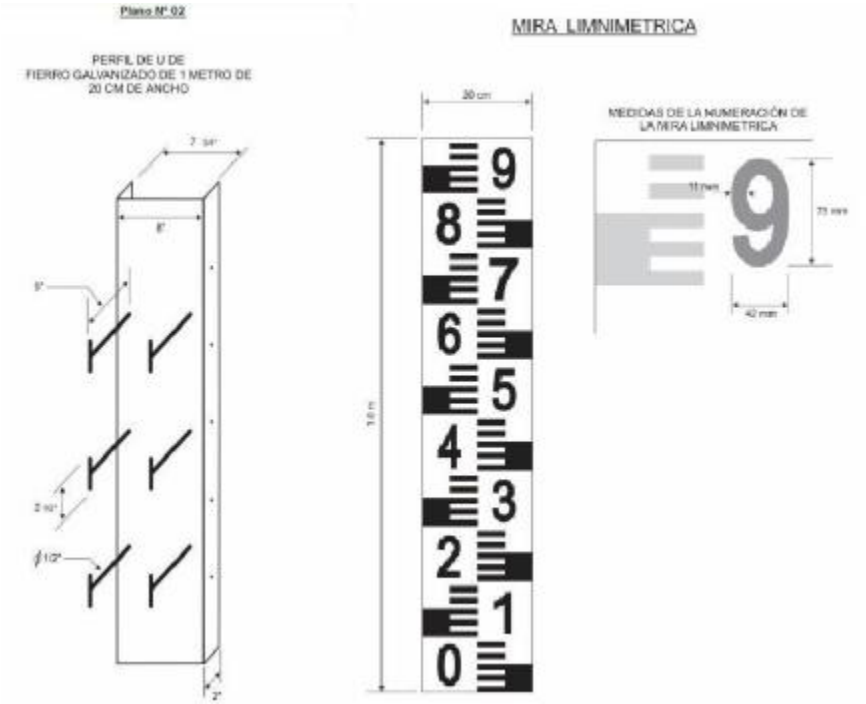
- A Franklin-type aerial terminal, at least 80 cm long, installed at a height that exceeds 0.50 meters above the top of the mast. This should include a covered copper cable for the down conductor, properly insulated from the mast, with a kit of insulator supports for installation on the mast. At the end of the cable, it should connect with the grounding conductor buried in the ground at the grounding system.

7. Limnimetric Rules:

- All stations must include the supply and installation of limnimetric rules with all components, ensuring consistency with the rules used in the SENAMHI network. Details are as follows:
- All limnimetric rules must be attached to structures built for this purpose, existing structures, or bridge piers as applicable, ensuring they are visible and verifiable.
- Dimensions: Length: 100 cm, Width: 20 cm, Thickness: 0.7 cm (with a tolerance of ±1%)
- Material: Cast aluminum or cast iron.
- Graduation: 0 a 100 cm.
- Maximum error: The total length of each of the mentioned limnimetric rules is 100 cm. The maximum error, resulting from the manufacturing process (gravity casting), is 1%, which corresponds to 1 cm, and this error is distributed proportionally along the entire length of the scale.
- Numbering and scale in raised relief of 4 mm, with divisions every 1 cm. The stroke width of the number along its entire length will be 11 mm, with the number height being 75 mm and 42 mm wide (margin of error 2%). The painting must be done with epoxy paint on both the base and the finish, with a white background and black numbering scale. It will include 10 countersunk holes of ¼ inch in diameter and 10 self-tapping screws of 3/16 inch in diameter x 1½ inches in length.
- Wooden Battens of 45 mm thickness x 190 mm width x 1 meter length (error margin of 1%).
- The wooden battens should be positioned 1 cm below the top of the metal "U" profile wings, so that the limnimetric rule is protected by the metal profile.

- The Metal "U" Profile with dimensions: 1 meter or 2 meters long x 50 mm height x 200 mm width x 1/8" thickness (error margin of 1%). Includes 5 countersunk holes per side for 1/8" bolts to secure the wooden battens, with 10 self-tapping screws of 3/16" diameter x 1½" length.

- For installation it should be considered metal supports adapted to properly fix the limnimetric rule components.
- A minimum of 2 rules per site should be installed based on river conditions and historical maximum levels.



8. VERIFICATION OF INSTALLATION

Physical Verification

It consists of verifying the entire installation and commissioning of each PCD station, which will be evaluated and validated for gradual acceptance. This includes the functional verification of sensors, dataloggers, transmission systems, power supply, and data visualization on the monitoring software platform. The representative of the entity and the supplier will sign a Term of Receipt for each station using an installation and operation verification protocol, which must be included in the work plan.

Functional Tests of the Automatic Stations (ADD FIELD TESTS)

After the station has been installed in the field, the functional tests must rigorously approve all technical and operational characteristics, both individually and collectively (hardware and software).

When applicable to the system being tested, these tests must include at minimum the following aspects:

- Verification of all required operational functionality of the system.
- Verification of the configured system software.
- Verification of the correct acquisition, processing, and storage of data from the sensors.
- Verification of data transmission via GOES.
- Verification of data reception via GOES and GPRS on the SENAMHI server.
- Verification of all user interface functions.

The contractor must perform functional tests on 100% of the required automatic stations.

The contractor must perform these functional tests in the presence of personnel designated by the UGP, who will verify the procedures carried out and the correct operation of the equipment, as well as the consistency of the data obtained during the test period.

At the end of the functional tests, the contractor will present the automatic station test protocol to the personnel designated by ACTO.

9. CAPACITY BUILDING AND TRAINING GENERAL TRAINING REQUIREMENTS:

- The supplier is required to provide training for up to 20 individuals designated by the Client. This training will be conducted in a suitable environment arranged by the supplier and approved by the entity, as well as at the station installation sites. The training should be both theoretical and practical-demonstrative for all selected participants.
- The instructor will present their scheduled work plan and execution timeline. The training period will be at least 24 hours.
- The training will include keeping the automatic stations operational.
- The training should cover the hardware and software components related to the automatic stations.
- The training will be conducted by personnel accredited by the manufacturer-integrator, who must present documentation proving their training and experience.
- The training sessions will be held at a location designated by the entity and also in the field where the stations are located.
- The training should be conducted in such a way that technical personnel acquire the skills, knowledge, and technical criteria necessary for the proper operation of the stations. It should focus on the following activities:
    - Description of the offered sensors: operating principle, technical characteristics, calibration methods, and maintenance.
    - Description of the PCD, technical characteristics, connection, description of the connection distribution, description of the memory distribution, permitted communication types.
    - Description of the configuration, programming of configuration files (upload and download).
    - Alarm programming.

- Description of transmission or communication functions.
- Fault diagnosis.
- Preventive Maintenance.
- Corrective Maintenance.
- Sensor calibration (sensor enabling).
- Equipment configuration.
- Data reception.
- Data collection with a PC.
- Data visualization in the field.
- Time and date adjustment.
- Name change, PCD ID.
- Access to operational verification data.
- Communication type configuration.

10. MAINTENANCE OF HYDROMETRIC STATIONS

The PCDs to be installed will undergo maintenance every six (06) months following the signing of the service installation acceptance report, over a period of one (01) year.
To ensure the PCDs remain fully operational, the supplier must have qualified local experts for preventive maintenance campaigns every six months, as well as corrective maintenance in case of any failures. This maintenance will cover all four (04) stations to be installed. The supplier must also certify, along with the offer, at least two specialists (engineer or bachelor's degree holder) who have undergone at least 40 hours of manufacturer-certified training in the installation and maintenance of stations with GOES and GPRS satellite transmission. Additionally, these specialists must have at least two years of experience in the installation or maintenance of hydrological or meteorological stations with GOES and GPRS transmission.

11. TECHNICAL SUPPORT

The supplier will provide both local and remote technical support, as needed, to ensure the station remains operational.

The supplier must demonstrate technical capability to efficiently provide local support during the warranty period and as part of ongoing maintenance. With their offer, they must include a list of phone numbers, email addresses, and locations of local laboratory/office facilities to facilitate communication for any requests or complaints during the warranty, technical support, and maintenance periods.

Additionally, the supplier must consider the scope of technical interventions within their offer, taking into account at least the following:

- Provide attention within a maximum of 48 hours after requests from the end customer or SENAMHI or technicians in charge from the entity who require technical assistance for any queries or issues presented. (on-site and/or remote).

- Resolve within a maximum of 72 hours any issue of failure or malfunction of any component of any of the stations, which should include the repair or replacement of any hardware component or mechanical elements, ensuring proper functioning; therefore, they must ensure the availability of spare parts to meet this objective efficiently. (on-site and/or remote).
- All interventions that are part of the technical support must include all costs of travel, personnel, and materials at the supplier/contractor's expense, without any additional cost.

12. GUARANTEE OF PERMANENT CUSTOMER TECHNICAL SUPPORT

The supplier must maintain a Technical Support Department accredited by the manufacturer, ensuring continuous availability to provide on-site technical assistance for the maintenance, repair, and configuration of the client's stations, without additional charges, throughout the equipment warranty period. If issues arise with the configuration or operation of the station(s) in the field during the equipment warranty period, the technical support team must promptly assist field personnel in resolving the problem. In case of complex issues, the support should furnish the required information for an immediate preliminary assessment, followed by a final evaluation or solution within a maximum period of 15 days.

13. ADDITIONAL TERMS

Supply of Spare Parts: The company must guarantee the supply of spare parts and maintenance for at least two years and/or in a manner similar to the operational warranty.

Supply of Parts or Equipment: The supplier must ensure the supply of the necessary parts or equipment for the proper functioning of the station during the aforementioned technical warranty period.

Repair of Equipment and Service Location: Technical assistance services for the maintenance and operation of the equipment must be carried out at the company's facilities or at locations expressly authorized by the company, free of charge during the warranty period.