

**Department of Science and Technology
Philippine Atmospheric, Geophysical and Astronomical
Services Administration**

**TERMS OF REFERENCE
for
Supply, Delivery, Installation, Testing, Training and Commissioning of
Expansion of Nationwide Network of Compact High Frequency Radars
for Remote Sensing Observation of Coastal Currents Circulation
Including Integration of all HFDR**

A. OVERVIEW

The Philippines has an insistent need of a coastal currents circulation observation network. In recent years High Frequency (HF) radars have become a very handy land based- platform for making wide-area coastal ocean measurements. Nowadays, more and more countries are adopting the compact HF radar technology, including many in the Southeast Asian region.

Meanwhile, in the Philippines sea disaster events have piled up, including storm surge and ship accidents ranging from sinking due to typhoon-driven powerful waves to fisher folk lost at even coastal shores due to monsoon surges. The country has become overly cautious because of such disasters, such that even in areas where typhoon signal number one is raised, some 500 km away or more from the center of the storm, ships are not allowed to sail, much to the detriment of our economy; not to mention the humanitarian cost of caring for thousands of refugees whose evacuation may have been needed. Even rescue operations may not be intelligently evaluated for lack of ocean current data.

Part of the problem is the inability of the country to comprehensively observe ocean current circulation and storm response. Expanding PAGASA's network of compact HF radar network with long-range coverage will help address the greater part of the solutions to these problems.

This project shall be known as the HIGH FREQUENCY RADAR (HFR) NETWORK EXPANSION PROJECT. It aims to expand the existing HFR coastal network by supplying, delivering, installing and commissioning a new set of HFR stations and training PAGASA personnel on integrating the new stations into the existing network.

B. APPROVED BUDGET FOR THE CONTRACT (ABC)

The Approved Budget for the Contract is **One Hundred Seventy Million Pesos (Php 170,000,000.00)** inclusive of Value Added Tax (VAT), custom duties, and other applicable government taxes.

C. QUALIFICATION OF THE BIDDER

(Please refer to Section II. Instructions to Bidders, the Bid Data Sheet and Checklist of Eligibility and Technical Requirements of the Bidding Documents)

In addition, thereto, the prospective bidder must have the following:

1. The manufacturer of the HF Radar units to be supplied must have at least ten years of experience manufacturing and deploying systems, similar to those manufactured for this project, on national scales. The manufacturer must have existing local installations.
2. Bidder's Experience and Capability:
 - 2.1 The bidder must have completed contract(s) that are similar in nature and scope to the Project to be bid within the period of five years from the date of the scheduled opening of bids. Similar project involves provision of a national HF Radar network for public and private agency access.
 - 2.2 For purposes of achieving a shortened down time of the HF Radar units, especially during the warranty period, bidders are expected to provide a team of qualified local technicians **that can sustain 24/7 support system**. Bidders are required to submit curriculum vitae of at least two local technicians including their corresponding training certificates.

Please refer to **Section K: after Sales Support** for a detailed Level of Support that the winning bidder shall provide during the warranty period.

D. DELIVERY PERIOD AND PLACE OF DELIVERY

The winning bidder shall supply, deliver, install at sites and commission the new High Frequency Radars within fifteen (15) months commencing from the date of receipt of the Notice to Proceed (NTP). Preparation and securing of all relevant permits for the acquisition, importation, delivery, installation and operation of the equipment shall be for the account of the winning bidder and to be assisted by PAGASA particularly for the radio station licenses which shall be valid for three (3) years. The location of the proposed five (5) HFDR sites are attached herewith as "Annex A".

E. BID PROPOSAL CONTENTS

1. The prospective bidder shall include in its submissions a drawing of the site design and network diagram.
2. The prospective bidder shall likewise clearly indicate in its bid offer the model number and specifications of the HF Radar units and all other equipment and accessories referred to in **Section F: Technical Specifications** to be supplied, if awarded the contract for the Project.
3. To aid the Procuring Entity in its procurement planning and to ensure a sustainable and continuous operation and maintenance of the HF Radar units, the prospective bidder shall be required to include in its bid proposal a list of recommended spare parts, both serviceable and disposable, with their corresponding prices and guarantee their availability in the market within the next eight years.

The prospective bidder is expected to comply and respond in accordance with the specific instructions to bidders and submit all the documentary requirements under the Checklist of Eligibility, Technical and Financial Requirements. The submission of

Documentary requirements must be properly arranged in order and with label.

The prospective bidder shall respond paragraph by paragraph and shall clearly indicate compliance to all the required specifications (*Please see Section VII. Compliance Matrix*) and shall specify the number of days or schedules within which to complete the delivery of all the goods required (*Please see Section VI. Schedule of Requirements*).

The prospective bidder shall be required also to include in this proposal, original descriptive literatures and un-amended brochures of all equipment/materials to be supplied. If applicable, technical plans, installation drawings / diagrams, configurations, method of installation, list of materials must likewise be provided.

These details will allow the **PAGASA-Bids and Awards Committee** to fully evaluate and determine compliance and responsiveness by the prospective bidders to each specific bidding requirement.

F. TECHNICAL SPECIFICATION

The expansion of the HFR Network will enable PAGASA to make scientific observations via remote sensing of the ocean current dynamics, and use such observations to make subsequent forecasts into the future using numerical weather prediction models. The following sections describe the hardware, software and the final basic products that can be derived and visualized:

Ocean Sensor

- Shore-based oceanographic HF Radar with no components in the water;
- Provides reliable and accurate radial component of the ocean surface current velocity from a single station which can be combined from multiple stations to provide maps of current vectors;
- Provide flexible system concept for observations either projecting towards open ocean or waterways in between islands;
- Provide measurements to offshore ranges that depend on operating frequency, salinity and wave climate. Adequate conceptual consulting on system implementation will be required from manufacturer and is an essential part of this ocean radar project;
- Provide a range resolution depending on the radar bandwidth defined by the frequency allocation;
- Provide wave information;
- Provide accuracy of the following:
 1. Current velocity about 10 cm/s or better
 2. Significant wave height +/- 10% of maximum value
 3. Mean wave direction typically 10.0 deg.
 4. Mean wave period typically +/- 0.6 s

Derived data/information

The systems should have flexibility of user-adjustable integration times for specific applications;

- A single station should be able to provide:
 1. Radial current velocity maps
 2. Significant wave height and period,
 3. Uncertainty values for each radial current velocity vector.
 4. Should be able to transmit raw data to the central site.
- Multiple stations with overlapping coverage should be able to provide:
 1. 2-D Current velocity vectors on a user defined grid

2. Uncertainty values for each 2-D current velocity vector.

Antenna Systems

- An easy to install robust antenna system consisting of a minimal number of antenna masts;
- The transmit and receive antennas should each have capability for up to 360° coverage, or coast-to-coast coverage, limited only by coastline;
- Angular resolution a user-adjustable setting, to as fine as 1°;
- The system should consist of a minimum number of antennas, for maximum ease and flexibility in deployment.
- For frequencies below 11 MHz, the transmit and receive antennas should all be able to fit within a 5-meter x 50-meter space.
- Each antenna mast should have flexible design for mounting by use of either guy ropes or a more secured base for better addressing typhoon-force conditions;
- Hinged base assemblies for convenient antenna mast raising and lowering should be provided;
- The radar system should have a minimum of two antenna calibration methods using external signal or echo sources: one that runs automatically during routine ocean data acquisition and one that can be performed by technicians during radar site visit.

Infrastructure

- Entire installation must include
 - AC line power
 - A backup power system (in case of loss of AC line power) consisting off-grid solution (solar, wind, generator or fuel cell, etc.) including battery supply to operate 24 hours per day.
- Equipment shelter must:
 - Be constructed to Philippine government office standards, including electrical grounding;
 - Protect HFR electronics from outside air, temperature and moisture;
 - Allow for two technicians to work on electronics inside, protected from weather;
- Dimensions: LWH 3.5 x 2.5 x 2.5 meters (recommended)
- Cables shall be protected inside conduit and, where possible, buried
- Antenna mounts on ground shall be reinforced concrete piers poured to a depth rated to withstand winds up to 275 km/h. Antennas mounted on existing structures shall be secured in a fashion that meets local building codes.
- Radar electronics shall have minimized power consumption (<500W average);
- Each unit shall have capability for PAGASA personnel to easily switch power input between 220 VAC and 24 VDC;
- Lightning protection must be integrated in the antenna cabling;
- An uninterrupted power supply (UPS) should be installed to provide a stable input power, secure shut down and storage of all required data;
- A local data storage which can archive up to 6 months of raw data;
- A reliable communication system, to transmit data to the PAGASA Operation Center in Quezon City. The communication system should be capable of connecting to the remote sites and provide remote login for maintenance requirements
- Civil, electrical, cabling and networking works

The winning bidder shall conduct all necessary work in the installations. This

Include application for permits wherein PAGASA shall provide assistance.

- The electrical system shall be 220V/60Hz, single phase.
- Bidders must conduct actual site survey to have accurate information and assessment. The bidders must present certification from local area for the conduct of the inspection and assessment.

Special Features

- Radar electronics chassis should have at least four internal temperature sensors that is viewable remotely;
- The radar system should utilize the FM-I-CW for minimal spacing between transmit and receive antennas, or even combined onto a single mast if frequency is above 11 MHz;
- The radar system should be able to apply an effective rejection of radio interference artifacts;
- Ability for 4 or more radars in close proximity of each other to simultaneously utilize exact frequency band;
- Radio call sign capability should be included in the system that meets International Telecommunication Union (ITU) standards;
- Radio call sign should function so the user does not need to schedule the call sign interval to be at the beginning/end of a signal time-series period needed for Doppler processing (the latter being typically 2 – 17 minutes). It should be able to be anywhere in between.
- Radio call sign should function so that the processing ocean data stream for the radar broadcasting the call sign is not interrupted;
- Radio call sign should function so as other radars in this network operating on the same frequency simultaneously do not need to be shut down during one station's call-sign broadcast;
- A demonstration of real-time multi-static processing shall be provided following installation and calibration.

Control Software

- Radar waveform settings should be easily accessed and editable by PAGASA personnel;
- Relevant system diagnostics should be monitored including station health;
- Automatic warning should be generated and transmitted in case of critical operation situations;
- A frequency management system for all radars to be able to operate simultaneously at same frequency without mutual interference.

Processing Software

- Real-time processing to extract current maps, and wave parameters, programmable with user-adjustable individually optimized integration time for each output type;
- Automatic antenna pattern processing;
- Quality control software tools;
- Each unit shall be expandable via software-only add-on packages to add ship detection & tracking, and/or tsunami detection as a future application.

Software for the Central Station

- Software for the existing Central Station must be upgraded to latest available and configured for the existing HF Radar network
- Central Station should be configured to include additional units acquired in this tender

- In addition to existing functions, the upgraded software must also include the following functions:
 - Web Display and download of combined vector data
 - Matrix or chart view of diagnostics from the HF Radar systems
 - Email warning function when HF Radar systems do not report data
 - Interpolation capability across multiple baselines between HF Radar systems

Data Communication link:

A reliable data communication link is required for the transmission of data as well as the monitoring of system operations. The link shall have the feature for system maintenance and for the conduct of support from the customer in compliance with service level agreement for the updating of software on remote sites, etc.

- Cellular Network using GSM technology
- Router/ modem
- LTE / 4G / 3G / 2G
 - Bandwidth: 512kbps ~ 1Mbps
- Antenna:
 - External 2dBi antenna x 2 for Mobile (detachable)
- Management:
 - DHCP, Port Trigger, Port Forwarding
- WAN Connection:
 - Automatic IP, Static IP, Mobile Broadband
- Ports:
 - SIM Card Slot x 1
 - RJ45 for 10/100/1000/Gigabits BaseT for WAN x 1, RJ45 for 10/100/1000/Gigabits BaseT for LAN x 4

PAGASA Marine Information System

The proposed Marine Information System shall provide at least:

- Integration of all HF radar data including from existing facilities
- Environmental Data Server including computer/server hardware and software. This station shall be installed inside PAGASA's premises and is to be connected to an Internet link.
- Backup/Mirrored data server (including hardware and software). This station shall be installed inside PAGASA's premises and is to be connected to an internet link
- Environmental Data Server and Backup/Mirrored data server shall each have a hard drive storage capability for at least 2 years of raw data files and list option for increased hard drive storage that can last beyond 2 years
- User friendly web-based interface with zoom, pan and scroll features
- Ability to customize the web interface with PAGASA's corporate identity (logos, texts...)
- Easily-manageable restricted user and password protected access controls, so certain personnel/institutions can be authorized for access to more data layers than others
- Multi-Language Interface, including at minimum English and Tagalog
- Ability for 100 persons to be using interactive interface simultaneously through any standard web browser

- Ability to easily display all information using a calendar-based component
- Ability to input/display data from up to 33 HF radar units
- Ability to input/display data from various models of oceanographic HF radar systems
- Ability to display HFR ocean wave data outputs and ocean surface current data outputs. Individual surface currents vector values and wave outputs shall be displayed just by clicking on any point of the surface currents 2D map or HFR wave measurement area
- Ability to plot time series for each HFR surface currents vector
- Ability to plot time series for HFR wave measurements
- Ability to automatically inter-compare different HFR data time series
- Ability to generate animations/movies of HFR surface currents maps
- Shall integrate a tool to run, display and export particle trajectory simulations (both forward and backward) using HFR 2D currents as forcing
- Ability to export and serve HFR data through FTP and Open DAP protocols in different formats (ASCII, NetCDF and KML)
- Ability to generate automatic HF radar system performance reports in PDF format for user selectable time periods (weekly, monthly, yearly...). At least the following information should be included in these reports:
 - Spatial and temporal availability of radial and total HFR surface currents data
 - Forwarded and Reflected power for each of the HFR stations
 - Temperatures at HFR electronic components
 - Voltages at each HFR station
 - Signal to Noise Ratio (SNR) at each HFR station
 - Range and number of surface currents vectors provided by each HFR station
- Ability to display Global wind forecasts provided by NOAA's Global Forecast System (GFS) with a $0.5 \times 0.5^\circ$ horizontal resolution showing:
 - Wind direction
 - Wind speed
- Ability to display outputs from PAGASA's wave model (VAG model) showing:
 - Significant wave height maps
 - Wave direction maps
 - Time-series for significant wave height and direction at each point of the map
- Ability to display outputs of PAGASA's surge model (based on JMA model) showing:
 - Predicted storm surge height maps
 - Time-series for storm surge height at each point of the map
 - Surge hazard maps provided by PAGASA for different scenarios based on predicted storm surge height
- Ability to automatically inter-compare data time series from different instruments and forecast models with the same output parameters (e.g. HFR measured vs. Buoy measured vs. Forecast provided by the wave model for significant wave height)
- Remote server configuration and on-site server physical installation in the Philippines

Milestone Timeline for Implementation of the Marine Information System (MIS)

- Integration of up to 33 HF radars owned by PAGASA should be completed within 6 weeks from program (MIS) inception. All HF radars to be integrated need to be operational and reachable through an Internet link and both the Environmental Data Server and Backup/Mirrored Data Server need to be

installed inside PAGASA's premises and connected to an Internet link prior to this 6-week integration timeline. Any HF radars that are not operational within this six-week period that are added within one year of program inception shall be added within six weeks of their commissioning.

- Addition of PAGASA's wave model + storm surge model should be completed within 16 weeks from program start date, or within 90 days after PAGASA provides all necessary inputs.
 - All field equipment shall be designed to operate in the harsh outdoor tropical environment with operating temperature up to +55°C and humidity levels up to 100%.
 - The field site enclosures are EMC-shielded units designed to protect equipment from interference and which also prevent any unwanted EMC emissions. RVR, visibility sensor, anemometer and Met Garden field sites should have frangible masts to mount the equipment.
 - All field site equipment and sensors are protected from voltage and current surges, short circuits and lightning strikes. They are also earthed and tested on installation to ensure the safety of any engineering personnel working on them. All lightning protection system shall be properly grounded using exothermic bonding for all grounding rods. Minimum grounding impedance should be 1ohm or better. Obstruction lights shall be provided.
 - All field sites are designed to self-start automatically as soon as power is applied, so if power is cut they automatically re-start as soon as possible without requiring manual attention

G. TESTING PROCEDURE

The bidder shall submit a detailed procedure or methodology in the conduct of test procedure and the same shall be fully validated and tested on site. Bench test procedures for alignment for circuits in modules, etc. shall be provided. The procedure shall be such that it can be easily accomplished using standard test equipment and external power supplies. Test procedure should be conducted for data reception at workstations. All parameters shall be assessed and verified by PAGASA representative at site and should be properly documented.

Bench test procedures for HF radar electronics shall also be provided. The procedure shall be accomplished using standard test equipment and external power supplies.

H. FACTORY ACCEPTANCE TESTING

Factory Acceptance Testing (FAT) shall be conducted at the factory site. The purpose of the test is to verify the performance of the system in accordance with the specifications and functional requirements. Any defect or deviation discovered during the factory acceptance test shall be rectified by the winning bidder immediately or within a maximum period of one (1) month from the completion of the test. After such rectification, another testing shall be made to verify the rectification. Perpetual license on all software licenses shall be provided upon completion and acceptance.

The Factory Acceptance Test (FAT) shall be witnessed and accepted by Three (3) PAGASA personnel and shall be conducted within a total of five (5) calendar days.

All related expenses, such as, round trip air fare, transportation, lodging/accommodation and allowable travel expenses based on the prevailing UNDP-DSA rates for each participant shall be shouldered by the winning bidder.

I. FACTORY TRAINING

The winning bidder shall conduct a 5-day Factory Technical Training to be attended by Five (5) qualified technical personnel of PAGASA that will be trained on the software and hardware configuration and set up. All related expenses, such as, but not limited to the training materials, round trip airfare, local transportation, lodging/accommodation and allowable travel expenses based on the prevailing UNDP-DSA rates for each participant shall be borne by the winning bidder.

J. SITE ACCEPTANCE TESTING & ON-SITE TRAINING

A 5-day Operation and Maintenance Training for Twenty-four (24) PAGASA Employees shall be conducted by the winning bidder. Travelling expenses for personnel coming from the field offices shall be borne by the winning bidder. Training courses shall cover operation and maintenance, actual equipment and system software. The objective of the training course comprises lessons on working principles of the equipment and practical hands-on training. The objective of the training course is to familiarize the personnel to the architecture, main components, calibration and features of the system. Training materials and meals shall be provided to the participants by the winning bidder. The winning bidder can provide additional training subjects as deemed necessary and shall form part of the training syllabus.

- System Operations and Maintenance Training
- Meals shall be served during the course of the program. Morning and afternoon coffee breaks and lunch. These will be borne by the winning bidder.
- The winning bidder shall provide the appropriate certificate to the participants.

The winning bidder must secure a certificate of compliance as proof of the trainings conducted. This certificate of compliance shall form part of deliverables prior to the issuance of Certificate of Acceptance and Completion.

K. WARRANTY AND AFTER SALES SUPPORT

System Commissioning shall be conducted at each radar site. The purpose of the test is to verify the performance of the system in accordance with the specifications and functional requirements. The commissioning will review performance across a 5-day period.

The commissioning at the radar sites shall be conducted together with two (2) PAGASA technical personnel. All expenses relevant to the activity shall be shouldered by the winning bidder.

A PAGASA-DOST logo / signage with an appropriate warning message should be

provided for each station.

All workmanship, materials and equipment shall be warranted by the winning bidder for two (2) years. Any materials or equipment that fails to provide satisfactory operation during this warranty period shall be replaced at the winning bidder's expense. While the equipment is undergoing repair, a spare unit will be supplied to PAGASA. Repair of the defective material or equipment shall be permitted provided that the repaired item meets original specifications.

- The contents of the warranty certificate shall include but is not limited to the following:
 - Warranty period of every equipment
 - Responsibilities of all parties
 - Scope of technical assistance specifying different levels of service
 - Contact Details of all technical personnel
- The winning bidder will provide all parts and labor during the warranty period at no additional cost to the customer. Delivery to manufacturer/factory and subsequent re-installation shall be at the expense of the winning bidder.
- Parts of all major equipment must be available in the market for at least a period of 10 years.
- Should provide 24/7 technical support help desk.
- For severe or critical issues on the system, an SLA of 8 hours' response time in two (2) years' term should be available.

L. SYSTEM DOCUMENTATION

The winning bidder shall likewise provide PAGASA with the HF Radar unit installation, (as-built), operations and maintenance manuals both in hard (2 sets) and soft copies (2 sets). Said manuals shall contain among others the theory of operations, calibration, site details and maintenance procedures.

All other hardware and software requirements shall also be turned-over to PAGASA prior to the issuance of the Final Inspection and Acceptance report.

In addition, the winning bidder shall provide a complete list of deliverables and installation materials, such as but not limited to mechanical, electrical, structured cabling, etc.

The documentation must be written in English of durable construction with concise and high quality presentation to include but not limited to the following:

- Technical / Reference Manuals
- As-built Plans in AutoCAD format
- Station Profile including pictures

All documentation for each installation must be in two (2) hard copies and soft copy accompanied in a compact disk/USB media on Microsoft Word for Windows format and delivered to PAGASA.

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