TECHNICAL SPECIFICATION

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DVOR/DME SPECIFICATION

1. GENERAL REQUIREMENT

1.1 Two (2) complete systems of DVOR/DME shall be installed to replace the currently used at Trang Airport and Nan Airport.

1.2 The DVOR/DME systems shall be dual transmitters and dual monitors configuration. The DVOR/DME systems shall consist of the following:

1.2.1 Dual DVOR equipment;

1.2.2 Dual DME equipment;

1.2.3 Antenna systems for the above equipment;

1.2.4 Local and remote control status units for the above equipment in 1.2.1 – 1.2.2 shall be equipped at designated control points;

1.3 The system performance and signal quality shall at least complied with the ICAO Annex 10 vol. I Radio Navigation Aids, Sixth Edition, Amendments 85.

1.4 All RF generators shall be synthesizers.

1.5 The proposed equipment shall be the modular design, or an easy plug – in card or modules for quick replacement. It shall be designed for easy maintenance and repair.

1.6 The dual independent transmitters shall be housed in the cabinet (s) and operated as main and standby facilities.

1.7 Maintenance on one equipment shall be accomplished without disturbing the operation of the other.

1.8 The equipment shall be designed in common of modules and printed circuit boards.

1.9 The equipment shall be designed for high–reliability operation. Reliability analysis (MTBF, MTBO etc.) of all assemblies for DVOR/DME shall be submitted.

1.10 The DME equipment shall be designed for co–location with the DVOR system.

1.11 All outdoor material shall be suitably weather protected by appropriate coat or high grade paint in order to withstand severe ambient conditions of outdoor installation due to temperature, humidity, rainfalls, as specified in ICAO Annex 14 at the site.

1.12 Transmission lines, cables and accessories.

1.12.1 All transmission lines, AC power lines and accessories shall be provided.

1.12.2 All buried cables shall be underground–type and installed in HDPE or RSC tubes with diameters wide enough for fitting cables easily.

1.12.3 All transmission lines shall be installed in a different tube separated from that of the AC power lines.

1.12.4 All underground cable work shall be done by the Contractor under AEROTHAI's supervision.

1.12.5 Cable route markers shall be installed at every 10 meters for indicating buried cables. The specification of the cable route markers shall be the same one as in AEROTHAI's construction plan.

1.12.6 Test cables and accessories required for initial set up and maintenance shall be provided.

1.13 Power Supply.

1.13.1 The DVOR/DME and all peripheral devices shall be operated with 220 $\pm$ 10 VAC, 50 Hz $\pm$ 5% single phase.

1.13.2 Uninterrupted Power Supply (UPS) for the DVOR/DME equipment shall be installed at the site. (See Section 8: Uninterrupted Power Supply (UPS))

1.13.3 Surge and lightning arrester with indicators for the stations supply (AC) power shall be installed. The unit shall provide a maintenance free service and bypass the energy from direct lightning strike to the incoming power line without interrupt of supply. Indicator lamp shall be provided to indicate failure of the arrester. Type, model and diagram shall be submitted in the proposal.

1.13.4 At the minimum, surge and lightning arrester specification shall be as follow:

1.13.4.1 Maximum continuous operating voltage (Uc) at least 320 VAC;

1.13.4.2 Voltage protection level (Up) less than 1.5 KV;

1.13.4.3 Maximum discharge current (Imax) (8/20 µs) at least 100 KA

1.14 Operating environment.

1.14.1 Indoor equipment shall be designed for continuous operation under ambient temperature range of 5 °C to 50 °C with a relative humidity of up to 90%.

1.14.2 Outdoor equipment shall be designed for continuous operation under the temperature from 0 °C to 60 °C with up to 100% humidity of rain and more than 60 mph. wind velocity.

1.15 The contractor shall be responsible for improving the grounding system.

2. DOPPLER VHF OMNI RANGE (DVOR) SPECIFICATIONS

2.1 System accuracy.

2.1.1 Azimuth accuracy shall be better than ± 1 degree on ground measurement.

2.1.2 Azimuth stability shall be better than ± 0.5 degree measured at a monitor.

2.2 The Dual DVOR equipment shall comprise, but not limited to:

2.2.1 Dual carrier transmitters;

2.2.2 Dual sideband transmitters;

2.2.3 Dual monitors;

2.2.4 DVOR test generator;

2.2.5 Antenna Switching Unit;

2.2.6 Antenna System;

2.3 Carrier transmitter.

2.3.1	Frequency band	– 111.975 – 117.975 MHz.
2.3.2	Operating frequency	– 116.6 MHz for Trang Airport – 115.7 MHz for Nan Airport
2.3.3	Frequency stability	– ± 0.002% from the operating frequency.
2.3.4	Output power	– at least 50 watts. (adjustable)
2.3.5	Spurious output	– better than 60 dB below carrier.
2.3.6	Carrier Modulation:	
	2.3.6.1 Reference frequency	– 30 Hz ± 0.2%
	2.3.6.2 Modulation depth	– 30% (adjustable)
	2.3.6.3 Identification frequency	– 1020 Hz ± 50 Hz
	2.3.6.4 Identification Modulation depth	– 10% (adjustable)
	2.3.6.5 Speech channel filter	– band pass at the range of 300 to 3,000 Hz within 3 dB relative to the level at 1,000 Hz
	2.3.6.6 Speech modulation depth	– up to 30% (the transmission of speech shall not interfere in any way with basic navigational function.) (adjustable)

2.3.7 The identification unit shall be able to generate any three letters International Morse Code for both DVOR and DME.

2.3.8 Identification code shall be computerized set up.

2.3.9 DME identification shall be generated on every forth DVOR identification cycle.

2.3.10 Protection shall be provided for the RF amplifier from damage caused by open or short circuit of the output.

2.3.11 Thruline wattmeter and plug-in element shall be equipped for all radiating outputs. Type, model and diagram shall be submitted in the proposal.

2.4 Sideband transmitter.

2.4.1 A Double-sideband DVOR system shall be required.

2.4.2 The Sub-carrier modulation mid-frequency shall be 9960 Hz ± 1%.

2.4.3 Phase control circuit shall maintain phase stability between the sidebands and carrier signals.

2.4.4 Thruline wattmeters and plug-in elements shall be equipped for each sideband output. Type, model and diagram shall be submitted in the proposal.

2.5 DVOR Monitor.

2.5.1 The monitor shall initiate an alarm signal and cause the equipment to initiate its shutdown/transfer sequence if one or more of the following conditions occurs:

2.5.1.1 A change in excess of 1 degree of the bearing information transmitted by the DVOR;

2.5.1.2 Reference signal 30 Hz Modulation Depth exceeds ± 2% from the nominal value;

2.5.1.3 Sub-carrier 9960 Hz Modulation Depth exceeds ± 2% from the nominal value;

2.5.1.4 Sub-carrier 9960 Hz Deviation Ratio exceeds 16 ± 1.

2.5.2 The bearing alarm limit shall be adjustable within ± 2 degrees with the step of not more than 0.1 degree.

2.5.3 The Carrier RF level alarm limit shall be adjustable when the Carrier level decreases 10% to 30% from the nominal value.

2.5.4 The Identification alarm shall be provided for the following conditions:

2.5.4.1 Continuous keyed;

2.5.4.2 Loss of Identification for more than 15 second (adjustable).

2.5.5 The monitors shall be configurable such that both monitors are monitoring the operating (on-antenna) or standby (on-dummy) transmitter simultaneously.

2.5.6 When two monitors are monitoring the operating transmitter, the monitors can be configured either in 'AND' mode or 'OR' mode for a changeover or shutdown in the event of failure.

2.5.7 The monitor shall provide a maintenance warning alarm to permit corrective action before an out-of-tolerance condition occurs. The warning indication shall be displayed at the designated control points.

2.5.8 Alarm delay shall be adjustable.

2.5.9 Alarm history shall be provided to identify the parameter that has deviated beyond the alarm limit and caused the alarm.

2.5.10 At least the following transmitter and monitor parameters shall be available for display at the designated control points:

2.5.10.1 The bearing information;

2.5.10.2 Reference signal 30 Hz Modulation Depth;

2.5.10.3 Sub-carrier 9960 Hz Modulation Depth;

2.5.10.4 Sub-carrier 9960 Hz Deviation Ratio;

2.5.10.5 Identification;

2.5.10.6 Forward and reflected power or standing wave ratio.

2.5.11 Control and selection for display of the transmitter and monitor parameters in 2.5.10 shall be done by a personal computer which is permanently located at the site.

2.5.12 The field monitor system (including the monitor antenna, the antenna mast, transmission lines, obstruction lighting) for monitoring the radiated composite signal shall be provided for installation at any azimuth suitable for installation. Type and model shall be submitted in the proposal.

2.5.13 Double LED Obstruction lighting with photo-switch shall be provided for installation with the monitor antenna to comply with the ICAO Annex 14 vol. I, Fourth Edition, Chapter 6. The LED obstruction light specifications shall comply with Federal Aviation Administration (FAA)'s Specification for Obstruction Lighting Equipment (AC 150/5345-43F). Type and model shall be submitted in the proposal.

2.6 DVOR Test Generator.

2.6.1 DVOR test generator shall be able to check and calibrate the monitor to conform with ICAO Annex 10 vol. I Amendments 85.

2.6.2 Type and model of the test generator shall be submitted in the proposal. (in case of separated unit)

2.6.3 Built–in–Test (BIT) or Fault Diagnostics shall be provided for all lowest replaceable units (LRU).

2.6.4 Built–in–Test (BIT) or Fault Diagnostics shall be capable of being initiated locally and remotely.

2.7 DVOR Antenna switching.

2.7.1 The RF power distributor in the antenna switching unit shall be broadband for operation in the range of 108 – 118 MHz.

2.7.2 Surge and lightning arresters shall be provided for all output ports of the distributor.

2.8 DVOR Antenna system.

2.8.1 Each antenna element shall be adjusted to its operating frequency from the factory.

2.8.2 The proposal shall describe the method of sideband feed lines fabrication and any other adjustment procedure.

2.8.3 The Antenna VSWR shall not exceed 1.2 : 1 for carrier and 1.2 : 1 for sideband.

2.8.4 The antenna system shall provide sufficient coverage as required in ICAO Annex 10 vol. I Amendment 85 Paragraph 3.3.4, except for where topographical features dictate.

3. DISTANCE MEASURING EQUIPMENT (DME) SPECIFICATION

3.1 The DME equipment shall comprise:

3.1.1 Dual transponders;

3.1.2 Dual monitors;

3.1.3 Antenna system;

3.2 DME Transponder.

3.2.1 Frequency band – 960 – 1215 MHz.

3.2.2 Operating channel – 113X for Trang Airport.

– 104X for Nan Airport.

3.2.3 Transmitter characteristics

3.2.3.1 The radio frequency of operation shall not vary more than plus or minus 0.002% from the assigned frequency.

3.2.3.2 Pulse shape and spectrum of pulse modulated signal shall meet the requirements for DME/N in ICAO Annex 10 vol. I Amendment 85 Paragraph 3.5.4.1.3.

3.2.3.3 Pulse spacing shall meet the requirements specified in ICAO Annex 10 vol. I Amendment 85 Paragraph 3.5.4.1.4.

3.2.3.4 The peak power of each pulse of any pulse pair shall not differ by more than 1 dB.

3.2.3.5 Peak effective radiation power of the reply pulse shall not be less than 30 dBw.

3.2.3.6 The transponder power amplifier shall provide full output power of not less than 1000 watts to the antenna.

3.2.4 Receiver characteristics

3.2.4.1 The centre frequency of the receiver shall not vary more than plus or minus 0.002% from the assigned frequency.

3.2.4.2 Transponder sensitivity shall meet the requirements specified in ICAO Annex 10 vol. I Amendment 85 Paragraph 3.5.4.2.3.

3.2.4.3 Bandwidth and selectivity shall meet the requirements specified in ICAO Annex 10 vol. I Amendment 85 Paragraph 3.5.4.2.6.

3.2.4.4 CW and echo suppression shall be provided and meet the requirements specified in ICAO Annex 10 vol. I Amendment 85 Paragraph 3.5.4.2.9.

3.2.5 Video.

3.2.5.1 Interrogating pulse spacing error more than ± 2 microseconds shall be rejected.

3.2.5.2 Receiver dead time shall be adjustable for echo suppression as measured after main delay time.

3.2.5.3 Long distance echo suppressor shall be provided by automatic receiver gain reduction according to each echo pulse level.

3.2.5.4 The minimum transmission rate shall be as close as practicable to 700 PPS.

3.2.5.5 The maximum transmission rate shall be at least 4,800 PPS.

3.2.5.6 Identification shall meet the requirements specified in ICAO Annex 10 vol. I Amendment 85 Paragraph 3.5.3.6 for association with the VOR identification.

3.2.5.7 The time delay shall meet the requirements specified for DME/N in ICAO Annex 10 vol. I Amendment 85 Paragraph 3.5.4.4.

3.2.5.8 Reply delay, pulse spacing and pulse width shall be adjustable to the specified values without removing any module from the assembly.

3.2.5.9 Reply delay stability shall be within ± 0.5 microseconds for any interrogation level.

3.3 DME Monitor.

3.3.1 The monitor shall serve two purposes.

3.3.1.1 To ensure that the transponder signal is within the tolerance as specified for DME/N in ICAO Annex 10 vol. I Amendment 85 Paragraph 3.5.4.

3.3.1.2 To be used as a RF signal generator in conjunction with a built-in test unit for calibration, testing and maintenance of the transponder.

3.3.2 The monitor shall initiate an alarm signal if any of the following conditions occurs:

3.3.2.1 Reply delay error exceed 1 microsecond;

3.3.2.2 Transmitting pulse spacing error exceed 1 microsecond;

3.3.2.3 Reply efficiency is less than 70%;

3.3.2.4 Effective radiated power (ERP) decreases below by 3 dB;

3.3.2.5 Transmitting pulse count falls below 700 PPS;

3.3.2.6 Continuous or loss of identification.

3.3.3 The occurrence of primary alarm shall initiate a transfer action while the main transponder is operating (on–antenna) and a shutdown action while the standby transponder is operating (on–antenna). The primary alarms are generated by reply delay error (in 3.3.2.1) or transmitting pulse spacing error (in 3.3.2.2).

3.3.4 The occurrence of secondary alarm shall initiate a transfer action while the main transponder is operating (on–antenna). The secondary alarms are generated by conditions 3.3.2.3 – 3.3.2.6.

3.3.5 The monitors shall be configurable such that both monitors are monitoring the operating (on–antenna) and standby (on–dummy) transponder simultaneously.

3.3.6 When two monitors are monitoring the operating transponder, the monitors can be configured either in 'AND' mode or 'OR' mode for a changeover or shutdown in the event of failure.

3.3.7 Alarm history shall be provided to identify the parameter that has deviated beyond the alarm limit and caused the alarm.

3.3.8 Monitor signal generator output shall be selected so that the channel frequency deviation of $\pm$ 200 KHz and $\pm$ 900 KHz of the transponder receiver can be tested.

3.3.9 Monitor signal generator output level shall be adjustable from –94 dBm to –25 dBm or wider.

3.3.10 Monitor PRF shall be adjustable from 700 to 4,800 PPS.

3.3.11 At least the following transponder and monitor parameters shall be available for display at the designated control points:

3.3.11.1 Reply delay;

3.3.11.2 Reply pulse pair spacing;

3.3.11.3 Reply efficiency;

3.3.11.4 Transmit power;

3.3.11.5 Transmitter pulse count;

3.3.11.6 Identification.

3.3.12 Control and selection for display of the transponder and monitor parameters in 3.3.11 shall be done by a personal computer which is permanently located at the site.

3.4 DME Antenna System.

3.4.1 The antenna shall be an omni-directional antenna type.

3.4.2 The antenna shall be capable of radiating DME signal throughout the DME frequency band (960 – 1,215 MHz) so that changing of the operating frequency needs no re-adjustment of the antenna.

3.4.3 The antenna system shall provide sufficient coverage as required in ICAO Annex 10 vol. I Amendment 85 Paragraph 3.5.3.1.2.1, except for where topographical features dictate.

3.4.4 Double LED Obstruction lighting with photo-switch shall be provided for installation with the antenna system to comply with the ICAO Annex 14 vol. I, Fourth Edition, Chapter 6. The LED obstruction light specifications shall comply with Federal Aviation Administration (FAA)'s Specification for Obstruction Lighting Equipment (AC 150/5345-43F). Type and model shall be submitted in the proposal.

4. DVOR/DME CONTROL AND MONITORING SYSTEM

4.1 DVOR Local Control Unit.

4.1.1 The front-panel control unit with indicators shall be at least capable of

4.1.1.1 Selecting the main equipment from the front-panel switch.

4.1.1.2 Turning on the standby transmitter into dummy loads for testing purposes.

4.1.1.3 Bypassing the monitor.

4.1.1.4 Selecting Remote/Local control.

4.1.1.5 Resetting the alarm.

4.1.1.6 Shutting down the station;

4.1.1.7 Displaying operating status of the equipment

4.1.2 The local control unit shall be able to adjust and display transmitter and monitor parameters via a desktop computer which is permanently located at site.

4.1.3 Two (2) sets of Desktop Computer shall be provided as part of the Local Control Unit for DVOR. The Desktop Computer for DVOR shall be provided separately from the Desktop Computer for DME. Brand and model shall be submitted in the proposal. (See Section 9 : Desktop Computer Specification)

4.1.4 The software for monitoring and controlling the DVOR equipment shall be installed in the desktop computer. The recovery CD for the software shall be provided. The user's license for the software shall be provided for AEROTHAI.

4.2 DME Local Control Unit

4.2.1 The front-panel control unit with indicators shall be at least capable of:

4.2.1.1 Selecting the main equipment from the front-panel switch;

4.2.1.2 Turning on the standby transponder into dummy loads for testing purposes;

4.2.1.3 Bypassing the monitor;

4.2.1.4 Selecting Remote/Local control;

4.2.1.5 Resetting the alarm;

4.2.1.6 Shutting down the station;

4.2.1.7 Displaying the operating status of the equipment.

4.2.2 The local control unit shall be able to adjust and display transponder and monitor parameters via a desktop computer which is permanently located at site.

4.2.3 Two (2) sets of Desktop Computer shall be provided as part of the Local Control Unit for DME. The Desktop Computer for DME shall be provided separately from the Desktop Computer for DVOR. Brand and model shall be submitted in the proposal. (See Section 9 : Desktop Computer Specification)

4.2.4 The software for monitoring and controlling the DME equipment shall be installed in the desktop computer. The recovery CD for the software shall be provided. The user's license for the software shall be provided for AEROTHAI.

4.3 Remote Control and Status Unit (RCSU) at the technician room at ATC tower

4.3.1 RCSU shall have at least the following control and monitoring functions:

4.3.1.1 Turn on/off the selected transmitter/transponder with indicator;

4.3.1.2 Transfer and shutdown with indicator;

4.3.1.3 NORMAL/ALARM indicator and audible alarm;

4.3.1.4 Alarm silence control with indicator;

4.3.1.5 Station alarm reset.

4.3.2 The remote control equipment shall be housed in a cabinet suitable for either desktop or rack mounted installation.

4.3.3 RCSU shall be connected via landline (provided by AEROTHAI) and the outdoor wireless link (5.150–5.850 GHz) (provided by the Contractor).

4.3.4 The wireless link between the DVOR/DME site and the technician room for the RCSU shall be installed. The operating frequency of the wireless link shall be adjustable within the band UHF 5.150–5.850 GHz. The air link shall be at least AES 128 bits encryption.

4.3.5 The selection capability for using the landline or the outdoor wireless link as the main communication link between DVOR/DME equipment and the technician room shall be provided.

4.3.6 Surge and lightning protection shall be provided at both ends of landline and the outdoor wireless link. Type, model and diagram shall be submitted in the proposal.

4.4 Remote Status Unit (RSU) at ATC room

The status indicator with audible alarm suitable for installation in the control tower shall be provided.

The RSU shall have at least the following features:

4.4.2.1 Display the operating status of the DVOR/DME.

4.4.2.2 Visual and audible alarm with an alarm silence control;

4.4.2.3 Turn on/off switch for the RSU.

4.4.3 The unit shall be installed to console for usage of an air traffic controller at the control tower.

4.5 Remote Monitoring and Maintenance (RMM)

4.5.1 The RMM shall monitor and control DVOR/DME equipment from anywhere by public telephone network.

4.5.2 The RMM shall have at least the following functionalities for each equipment:

4.5.2.1 Selecting the main/standby;

4.5.2.2 Turning on the standby transmitter/transponder into dummy loads for testing purposes.

4.5.2.3 Bypassing the monitor.

4.5.2.4 Resetting the alarm.

4.5.2.5 Shutting down the station

4.5.2.6 Adjusting and displaying transmitter/transponder and monitor parameters.

4.5.3 The RMM unit shall be interfaced with a PABX to DVOR/DME site via landline (provided by AEROTHAI) and the outdoor wireless link (5.150–5.850 GHz) (provided by the Contractor).

4.5.4 The communication for the RMM must be separated from that for the RCSU for redundancy. (See Section 12: RCSU and RMM communication Diagram)

4.5.5 The wireless link between the DVOR/DME sites and the technician room for the RMM shall be installed. The operating frequency of the wireless link shall be adjustable within the band UHF 5.150–5.850 GHz by users. The air link shall be at least AES 128 bits encryption.

4.5.6 Surge and lightning protection shall be provided at both ends of the landline and the outdoor wireless link. Type, model and diagram of the surge and lighting protection shall be submitted in the proposal.

4.5.7 RMM shall be performed from a laptop computer and a desktop computer.

4.5.8 Two (2) sets of Desktop Computer shall be provided as part of the RMM located at technician room. Brand and model shall be submitted in the proposal. (See Section 9 : Desktop Computer Specification)

4.5.9 Two (2) sets of Laptop Computer shall be provided as part of the RMM. Brand and model shall be submitted in the proposal.
(See Section 10 : Laptop Computer Specification)

4.5.10 The RMM software for monitoring and controlling the DVOR/DME equipment from anywhere shall be installed in the laptop computer and the desktop computer. The recovery CD for the RMM software shall be provided. The user's license for the software shall be provided for AEROTHAI.

4.5.11 Two (2) sets of Laser color printer for hard copy report of the station status and meter reading shall be provided as part of the RMM located at technician room.

5. DVOR/DME Supplements

5.1 Portable Navigational Signal Analyzer (PNSA)

5.1.1 Two (2) sets of PNSA shall be provided.

5.1.2 PNSA shall be able for using for ground testing of the VOR/ILS (VOR, localizer, glide path, and marker beacon).

5.1.3 The PNSA shall consist of a VOR/ILS receiver, a built-in rechargeable battery, a battery charger (220 VAC 50 Hz), an antenna, an antenna pole and accessories.

5.1.4 The PNSA shall be designed with lightweight (not more than 6 kg) and weatherproof.

5.1.5 PNSA shall be able to analyze VOR/ILS performance in accordance with ICAO Annex 10 vol. I Amendment 85 and Doc 8071 Fourth Edition.

5.1.6 PNSA shall be able to select all VOR/ILS channels.

5.1.7 All VOR/ILS parameters stored in PNSA shall be able to be exported to a computer via RS 232C or USB port.

5.1.8 PNSA shall be able to send real-time measurement data directly to RS 232C or USB port.

5.1.9 Interface Control Document (ICD) with fully explanation for extracting or decoding the real time measurement data shall be provided.

5.1.10 Certified document from the authorized company shall be submitted in the proposal.

5.2 Portable Vector Network Analyzer (PVNA)

One (1) set of Portable Vector Network Analyzer (PVNA) shall be provided.

(See Section 11: Portable Vector Network Analyzer (PVNA) Specification.

5.3 DVOR Spare Parts.

5.3.1 Four (4) sets of DVOR spare parts shall be provided.

5.3.2 One (1) set of DVOR spare parts in 5.3.1 shall consist of one complete unit of each line replaceable module (LRM), printed circuit boards (PCBs), backplanes, RF switches (Coaxial relays, RF distribution units) for DVOR.

5.4 DME Spare Parts.

5.4.1 Four (4) sets of DME spare parts shall be provided.

5.4.2 One (1) set of DME spare parts in 5.4.1 shall consist of one complete unit of each line replaceable module (LRM), printed circuit boards (PCBs), backplanes, RF switches (Coaxial relays, RF distribution units) for DME.

5.5 Wireless Link Equipment Spare Parts.

Four (4) complete sets of Wireless Link Equipment shall be provided as spare parts.

6. TOOL KITS AND SERVICE AIDS

6.1 Special tool kits required for adjustment and maintenance the DVOR/DME equipment at the site shall be provided. A detailed list shall be submitted with the Proposal.

6.2 Extension cables and cards as required for each module/PCB of the DVOR/DME shall be provided for maintenance.

6.3 Test cables, dummy loads, attenuation kits for RF signal adjustment shall be provided

6.4 Installation materials such as external and internal cablings, cable trays, connectors, cable ties, conduits shall be provided.

7. TECHNICAL DOCUMENTS AND TEST REPORTS.

The Contractor shall provide the following documents:

7.1 Six (6) sets, hard copy and CD, of mechanical and electrical DVOR/DME drawings essential for installation, maintenance and repairing of the equipment, including such drawings as are needed to identify the components and cable terminations within the equipment or its subunits;

7.2 Six (6) sets, hard copy and CD, of DVOR/DME installation and equipment instruction manuals, setting out in detail the procedures for operation, routine maintenance, repairing of the equipment, test and alignment procedures, including schematics and inter-cabling diagrams;

7.3 Six (6) sets, hard copy and CD, of DVOR/DME component part lists, including manufacturer part numbers or descriptions of any generic component-level devices (ICs, transistors, capacitors, etc.) in each line replaceable modules (LRMs) so that AEROTHAI can search for the generic devices in the electronic-component market in order to repair the LRMs after the warranty period.

7.4 Two (2) original and Four (4) hard copies of Factory Acceptance Test (FAT) report shall be provided at the factory after FAT.

7.5 Two (2) original and Four (4) hard copies of Functional Unit Test (FUT) report before commissioning flight check shall be provided at the site after the completion of FUT.

7.6 Two (2) original and Four (4) hard copies of Site Acceptance Test (SAT) report shall be provided at site after the completion of the commissioning flight check.

8. UNINTERRUPTED POWER SUPPLY (UPS)

8.1 General Requirements

8.1.1 Two (2) sets of UPS shall be a 10-KVA True On-Line Type with Double Conversion.

8.1.2 On-Line UPS including associated circuits for emergency used for the DVOR/DME equipment shall be capable of providing backup time at least 3 hours.

8.1.3 The battery shall be continuously float charged. The battery charger shall be capable of charging batteries, which are completely discharged.

8.1.4 The UPS provided shall be with protection against overcharging, over current and short-circuit, spill proof, maintenance free and with capability of latching shutdown on overload.

8.1.5 In the event of a main failure, the batteries shall automatically take over without disrupting the operation of the system.

8.1.6 When UPS is failed or an overload is occurred, Static Transfer Switch shall be able to automatically transfer the load supplied by the inverter to the reserve line without any interruption of the system operation

8.1.7 In connection with 8.1.6 requirement, Static Transfer Switch shall be able to automatically transfer the load supplied back to its previous operation without any interruption of the system operation when above occurrences are back to the normal state.

8.1.8 Manual Bypass Switch shall be provided for maintenance purpose. When the manual bypass switch is selected, the system shall be able to operate without any interruption.

8.1.9 The status of UPS shall be displayed at the technical room as well as visual and audible alarm.

8.1.10 Protection shall be provided against damage of semiconductors due to the battery polarity being inadvertently reversed.

8.2 Technical Requirements

8.2.1 Input

8.2.1.1 Voltage	:	220 VAC or 230 VAC ±15% or better
8.2.1.2 Frequency	:	50 Hz ±5% or better
8.2.1.3 Phase	:	Single (2 Wire + Ground)

8.2.2 Output

8.2.2.1 Voltage	:	220 VAC หรือ 230 VAC ±15% or better
8.2.2.2 Frequency	:	50 Hz ±0.5% or better
8.2.2.3 Phase	:	Single (2 Wire + Ground)
8.2.2.4 Wave Form	:	Sine Wave
8.2.2.5 Total Harmonics Distortion	:	≤ 3 % for 100% Linear Load
8.2.2.6 Overall Efficiency	:	≥ 84% at load
8.2.2.7 AC to AC – Crest Factor	:	3:1 or better
8.2.3 Overload Capacity – 120% Load	:	1 Min or better

8.2.4 Environment

8.2.4.1 Ambient Temperature	:	0–40 ºC (Continuous) or better
8.2.4.2 Humidity	:	90% continuously with non–condensing

8.2.5 Audible Noise : ≤ 55 dB(A) at 1 m.

8.2.6 Battery

8.2.6.1 Type : Maintenance Free Sealed Lead Acid

8.2.6.2 Discharge : High Rate Discharge

8.2.6.3 Life Time : ≥ 4 years at 25° C

8.2.6.4 Back Up Time : ≥ 15 Minute at Full Load

8.2.7 Status and Control Indicator shall be able to: (at least but not limited to)

8.2.7.1 Display status and parameters, line input, inverter, output, load on bypass, battery and fault

8.2.7.2 Provide visual and audible alarm when main fail, low battery and overload

8.2.7.3 Enable and disable alarm

8.3 UPS Training.

8.3.1 Training shall be provided for 4 engineers or technicians at site.

8.3.2 The training course shall include theoretical, practical, installation and alignment procedure. The course duration and syllabus shall be submitted.

9. DESKTOP COMPUTER SPECIFICATION

9.1 หน่วยประมวลผลกลาง (CPU) ต้องทำงานที่สัญญาณนาฬิกาไม่น้อยกว่า 2.40 GHz โดยมีเทคโนโลยีแบบ Core i5 หรือมีคุณสมบัติดีกว่า

9.2 หน่วยความจำหลักแบบ DDR3 SDRAM (Memory Bus 1066 MHz) หรือมีคุณสมบัติดีกว่า ขนาดไม่น้อยกว่า 2 GB และสามารถรองรับการขยายหน่วยความจำสูงสุดได้ไม่น้อยกว่า 8 GB

9.3 Harddisk Drive SATA หรือมีคุณสมบัติดีกว่า ขนาดความจุไม่น้อยกว่า 500 GB

9.4 ต้องมี DVD+/-RW Drive หรือมีคุณสมบัติดีกว่า ชนิด Internal Drive จำนวน 1 Drive

9.5 หน่วยควบคุมการแสดงผล (Graphic Controller) สามารถแสดงความละเอียดสูงสุด (Maximum Resolution) ได้ไม่น้อยกว่า 1280 X 1024 จุด

9.6 จอภาพมีขนาดไม่น้อยกว่า 17 นิ้ว

9.7 ส่วนควบคุมการเชื่อมต่อกับระบบเครือข่าย (Network Controller) เป็นอุปกรณ์ที่ติดตั้งอยู่บน Mainboard (Built-in on Board) ซึ่งสนับสนุนความเร็ว 10/100/1000 Mbps โดยมี Interface เป็นแบบ RJ-45

9.8 มีระบบเสียง พร้อมลำโพง

9.9 มีส่วนเชื่อมต่ออุปกรณ์ภายนอก (I/O Interface) แบบ USB 2.0 หรือดีกว่า จำนวนไม่น้อยกว่า 4 ช่องและมี Serial Port อย่างน้อย 1 ช่อง(หรือมีอุปกรณ์แปลง USB เป็น Serial อย่างน้อย 1 ชุด)

9.10 มี Expansion Slot จำนวนไม่น้อยกว่า 1 slot

9.11 Keyboard ใช้หัวเชื่อมต่อแบบ USB โดยตรง จำนวนแป้นพิมพ์รวมกันไม่น้อยกว่า 104 keys โดยมีตัวอักษรทั้งภาษาไทยและอังกฤษอยู่บนแป้นพิมพ์อย่างถาวร

9.12 Mouse เป็นชนิด Optical Mouse ที่มีปุ่ม Scroll Wheel โดยใช้หัวเชื่อมต่อแบบ USB โดยตรง ทั้งนี้จะต้องมี Mouse Pad ที่สามารถใช้งานร่วมกับ Optical Mouse ที่เสนอให้ด้วย

9.13 ตัวเครื่อง, จอภาพ, และ Keyboard ต้องมีเครื่องหมายการค้าเดียวกัน โดยประทับตราเครื่องหมายการค้านั้น ไว้บนอุปกรณ์อย่างถาวรจากโรงงานผู้ผลิต

9.14 เครื่องคอมพิวเตอร์แต่ละเครื่องต้องมีโปรแกรมระบบปฏิบัติการ (Operating System) ซึ่งติดตั้งให้มากับตัวเครื่องเป็นโปรแกรม ซึ่งสามารถใช้งานกับโปรแกรมควบคุมการทำงานของระบบเครื่องช่วยฯ ที่เสนอแผ่นโปรแกรม หรือแผ่น Recovery CD ซึ่งมีลิขสิทธิ์ถูกต้องตามกฎหมาย

9.15 ต้องมีแผ่น Software Driver CD ของเครื่องคอมพิวเตอร์ที่เสนอ

9.16 บริษัทเจ้าของผลิตภัณฑ์ต้องได้รับการรับรองมาตรฐาน ISO 9000 Series

9.17 เครื่องคอมพิวเตอร์รุ่นที่เสนอต้องผ่านการรับรองมาตรฐาน FCC หรือ UL หรือ CSA หรือ ETL เป็นอย่างน้อย

9.18 เครื่องคอมพิวเตอร์ที่เสนอจะต้องผ่านการรับรองมาตรฐาน และ จะต้องมีบริษัท ที่เป็นเจ้าของผลิตภัณฑ์สาขาของบริษัท ที่เป็นเจ้าของผลิตภัณฑ์ หรือมีศูนย์บริการในประเทศไทย

9.19 ต้องรับประกันผลิตภัณฑ์ (อุปกรณ์ทั้งชุด) เป็นไปตามข้อ 14 ของเอกสารประกวดราคาฯ

9.20 ต้องมีโต๊ะสำหรับวางตั้งเครื่องคอมพิวเตอร์ พร้อมเก้าอี้มีพนักพิง ที่ผลิตสำหรับงาน Computer โดยเฉพาะ

10. LAPTOP COMPUTER SPECIFICATION

10.1 หน่วยประมวลผลกลาง (CPU) ต้องทำงานที่สัญญาณนาฬิกาไม่น้อยกว่า 2.40 GHz โดยมีเทคโนโลยีแบบ Core i5 หรือมีคุณสมบัติดีกว่า

10.2 หน่วยความจำหลักแบบ DDR3 SDRAM (Memory Bus 1066 MHz) หรือมีคุณสมบัติดีกว่า ขนาดไม่น้อยกว่า 4GB และสามารถรองรับการขยายหน่วยความจำสูงสุดได้ไม่น้อยกว่า 8 GB

10.3 Harddisk Drive SATA หรือมีคุณสมบัติดีกว่า ขนาดความจุไม่น้อยกว่า 500 GB

10.4 ต้องมี DVD+/–RW Drive หรือมีคุณสมบัติดีกว่า ชนิด Internal Drive จำนวน 1 Drive

10.5 ต้องมีหน่วยควบคุมการแสดงผลที่มีหน่วยความจำขนาดไม่น้อยกว่า 512 MB ซึ่งใช้งานร่วมกับหน่วยความจำหลัก และรองรับ Microsoft Direct X 10 เป็นอย่างน้อย

10.6 ต้องมีช่องสำหรับต่ออุปกรณ์ภายนอก (I/O Interface) แบบ USB 2.0 หรือ ดีกว่า จำนวนไม่น้อยกว่า 3 ช่อง,External VGA Port จำนวน 1 ช่อง, มี Serial Port อย่างน้อย 1 ช่อง (หรือมีอุปกรณ์แปลง USB เป็น Serial อย่างน้อย 1 ชุด)

10.7 จอภาพมีขนาดไม่น้อยกว่า 14 นิ้ว

10.8 ต้องมี Internal Wireless LAN ตามมาตรฐาน 802.11b/g/n หรือมีคุณสมบัติดีกว่า

10.9 ต้องมีระบบเสียง พร้อมลำโพงภายในตัวเครื่อง

10.10 ต้องมี Modem ความเร็วไม่ต่ำกว่า 56 Kbps ภายในตัวเครื่อง หรือมีอุปกรณ์แปลง Modem ภายนอก

10.11 ต้องมี Network Interface เป็นแบบ Built-in ชนิด 10/100/1000 Mbps อย่างน้อย 1 ช่อง

10.12 แป้นพิมพ์ (Keyboard) มีอักษรภาษาไทย, ภาษาอังกฤษ, ตัวเลข และเครื่องหมายสัญลักษณ์ต่างๆ พิมพ์อยู่บนแป้นพิมพ์อย่างถาวร

10.13 ต้องมี Pointing Device แบบ TouchPad และมี Mouse เป็นชนิด Optical Mouse ที่มีปุ่ม Scroll Wheel โดยใช้หัวเชื่อมต่อแบบ USB โดยตรง ทั้งนี้จะต้องมี Mouse Pad ที่สามารถใช้งานร่วมกับ Optical Mouse ที่เสนอให้ด้วย

10.14 Battery ที่ใช้กับเครื่องคอมพิวเตอร์เป็นแบบ Lithium Ion ชนิด Rechargeable ขนาด 6 Cell หรือมีคุณสมบัติดีกว่า

10.15 มีโปรแกรมระบบปฏิบัติการ (Operating System) ติดตั้งให้มากับตัวเครื่องเป็นโปรแกรม ซึ่งสามารถใช้งานกับโปรแกรมควบคุมการทำงานของระบบเครื่องช่วยฯที่เสนอพร้อมแผ่นโปรแกรมหรือแผ่น Recovery CD ซึ่งมีลิขสิทธิ์ถูกต้องตามกฎหมาย

10.16 บริษัทเจ้าของผลิตภัณฑ์ต้องได้รับการรับรองมาตรฐาน ISO 9000 Series

10.17 เครื่องคอมพิวเตอร์รุ่นที่เสนอต้องผ่านการรับรองมาตรฐาน FCC หรือ UL หรือ CSA หรือ ETL เป็นอย่างน้อย

10.18 ต้องมีคู่มือการใช้งานของเครื่องคอมพิวเตอร์รุ่นที่เสนอ พร้อมโปรแกรมสนับสนุนการทำงาน (Software Driver) ของอุปกรณ์ต่างๆ ที่ติดตั้งมากับเครื่องซึ่งจำเป็นต่อการใช้งาน บรรจุอยู่ในแผ่น CD หรือ DVD

10.19 ต้องมีกระเป๋าสำหรับใส่เครื่องคอมพิวเตอร์แบบพกพาที่เสนอโดยเฉพาะ

10.20 เครื่องคอมพิวเตอร์ที่เสนอจะต้องมีบริษัทที่เป็นเจ้าของผลิตภัณฑ์ สาขาของบริษัท ที่เป็นเจ้าของผลิตภัณฑ์ หรือมีศูนย์บริการอยู่ในประเทศไทย

10.21 น้ำหนักของเครื่องรวมแบตเตอรี่ไม่เกิน 2.5 kg

10.22 ต้องรับประกันผลิตภัณฑ์ (อุปกรณ์ทั้งชุด) เป็นไปตามข้อ 14 ของเอกสารประกวดราคาฯ

11. PORTABLE VECTOR NETWORK ANALYZER

11.1 ความต้องการทั่วไป (General Requirements)

11.1.1 เป็นเครื่องมือ Vector Network Analyzer (VNA), Vector Volt Meter, Spectrum Analyzer และ Power Meter ที่สามารถวิเคราะห์ผลการทดสอบของ

Transmission/Reflection Measurement, Return loss, VSWR, Cable loss, Distance to fault, Terminating power Measurements, Spectrum Analysis, Smith Chart ฯ และสามารถรับสัญญาณ GPS ได้ในตัวเดียวกัน

11.1.2 เป็นเครื่องมือที่มีขนาดกะทัดรัด น้ำหนักเบา สามารถนำไปใช้งานภาคสนามได้โดยสะดวก มีน้ำหนักรวม Internal Battery แล้วไม่เกิน 5 กิโลกรัม

11.1.3 เป็นเครื่องมือที่ทันสมัย แข็งแรง ทนทาน สามารถใช้งานได้ดีในภูมิอากาศแบบประเทศไทย ที่อุณหภูมิระหว่าง 0 – 50 องศาเซลเซียส

11.1.4 เป็นเครื่องมือที่มี Full 2–port VNA Measurements

11.1.5 เป็นเครื่องมือที่มีหน่วยความจำภายใน ที่สามารถเก็บบันทึกผลข้อมูลได้

11.1.6 เป็นเครื่องมือที่มี USB Port สำหรับโอนถ่ายข้อมูลได้อย่างสะดวก

11.2 ความต้องการด้านเทคนิค (Technical Specification)

11.2.1 Vector Network Analyzer Specifications

11.2.1.1 Frequency

11.2.1.1.1 Frequency Range : 100 KHz to 5 GHz

11.2.1.1.2 Frequency Accuracy : $\leq$ 2 ppm

11.2.1.1.3 Frequency Resolution : $\leq$ 10 Hz

11.2.1.1.3 Data Points : สามารถปรับย่อ/ขยายรูปสัญญาณ เพื่อวิเคราะห์ผลการตรวจวัดได้

11.2.1.2 Transmission Measurement

- Dynamic Range : > 50 dB at 100 KHz to 300 KHz
  > 80 dB at 300 KHz to 2.5 GHz
  > 70 dB at 2.5 GHz to 5 GHz

11.2.1.3 Reflection Measurement

- Directivity : > 30 dB at 100 KHz to 5 GHz

11.2.1.4 Maximum Cable Length for Measurement : $\geq$ 500 m

11.2.1.5 Measurement Parameter : S11, S12, S21, S22

11.2.2 Spectrum Analyzer Specifications

11.2.2.1 Frequency Range : 200 kHz to 6 GHz

11.2.2.2 Maximum Continuous Input ($\geq$10 dB Attn) : 30 dBm

11.2.2.3 Frequency Accuracy : ± 2 ppm

11.2.2.4 Frequency Resolution : $\leq$ 1 Hz

11.2.2.5 Frequency Reference Aging : ±1 ppm/years

11.2.2.6 Frequency Span : 10 Hz to 6 GHz plus 0 Hz (zero span)

11.2.2.7 Resolution Bandwidth (–3 dB bandwidth) : 1 Hz to 3 MHz

11.2.2.8 Video Bandwidth (–3 dB bandwidth) : 1 Hz to 3 MHz

11.2.2.9 Sweep Time (Span 0 Hz) : 200 µs to 100 s

11.2.2.10 Amplitude Measurement Range : DANL to +30 dBm

11.2.2.11 Displayed Average Noise Level (DANL)

(DANL in 1 Hz RBW, 0 dB attenuation)

Frequency	**Max (Preamp On)**	**Max (Preamp Off)**
10 MHz to 6 GHz	□ –150 dBm	□ –130 dBm

11.2.2.12 Amplitude Units : Log Scale Modes dBm, dBmV, dBµV, V, W

11.2.2.13 Attenuator Range : 0 to 40 dB

11.2.3 Power Meter

11.2.3.1 Frequency Range : 100 MHz to 1.3 GHz

11.2.3.2 Power Displayed Unit : dBm and Watts

11.2.3.3 Input Connector : Type N, 50 ohm

11.2.3.4 RMS Power Measurement : 1 mW – 200 mW

11.2.4 General Specifications

11.2.4.1 สามารถใช้ Internal Battery กับทุก Function ตามที่กำหนดได้ไม่น้อยกว่า ๒ ชั่วโมง

11.2.4.2 Type N female RF connectors

11.2.4.3 Maximum Damage Input power : ≥ 20 dBm

11.2.4.4 Internal Memory : ≥ 256 Traces

11.2.4.5 USB interface for Transfer data

11.2.4.6 LAN Interface for Remote control

11.2.4.7 AC Power Supply : 110 V – 220 V ± 10 %

11.2.4.8 Colour LCD Displayed

11.2.4.9 มี Internal Speaker

11.2.4.10 มี GPS Receiver with GPS Antenna

11.2.4.11 ต้องเป็นผลิตภัณฑ์ที่มีตัวแทนจำหน่ายที่ถูกต้องในประเทศไทยโดยมีหนังสือรับรองจากบริษัทผู้ผลิต

11.2.4.12 จัดฝึกอบรมการใช้งานให้กับวิศวกร วช.บว. ที่ บริษัท วิทยุการบินแห่งประเทศไทย จำกัด

11.3 อุปกรณ์ประกอบ (Accessories)

11.3.1	Rechargeable Battery (Li-ion)	1 set
11.3.2	AC adapter/charger	1 set
11.3.3	Car Charger	1 set
11.3.4	Software Analysis and Software Control	1 set
11.3.5	Calibration Kit	1 set
11.3.6	Adapter Kit 50 Ω, (N-Type, SMA, TNC, BNC ฯ)	1 set
11.3.7	Test port Cable DC-6 GHz, 50 Ω, N(m)-N(f)	1 set
11.3.8	Operation Manual	2 set
11.3.9	Service Manual or Maintenance Manual	1 set
11.3.10	Soft Carrying Case	1 ea
11.3.11	Hard Case (Factory Product)	1 ea
11.3.12	Attenuation 50 w, 20 dB (DC-2 GHz)	1 ea
11.3.13	Attenuation 100 w, 30 dB (DC-2 GHz)	1 ea

12. DIAGRAM

ANNEX A: GLOSSARY

°C	Degree Celsius
AEROTHAI	Aeronautical Radio of Thailand Ltd.
AC	Alternating Current

dB	Decibel
DME	Distance Measuring Equipment
DVOR	Doppler Very high frequency Omni Radio range
FAA	Federal Aviation Administration
GHz	Giga Hertz
Hz	Hertz
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
ILS	Instrument Landing System
KVA	Kilo Volt Amp
Kms	Kilometers
MHz	Mega Hertz
MTBF	Mean Time Between Failure
MTBO	Mean Time Between Outage
mph	mile per hour
PABX	Private Automatic Branch Exchange
PCB	Printed Circuit Board
PMDT	Portable Maintenance Data Terminal
PNSA	Portable Navigational Signal Analyzer
PVNA	Portable Vector Network Analyzer
RF	Radio Frequency
RCSU	Remote Control and Status Unit
RSU	Remote Status Unit
RMM	Remote Monitoring and Maintenance
UHF	Ultra High Frequency
UPS	Uninterrupted Power Supply
USB	Universal Serial Bus
VAC	Voltage of Alternating Current
VOR	Very high frequency Omni Radio range

ANNEX B: REFERENCE DOCUMENTS

ICAO Annex 10 vol. I Radio Navigation Aids, Sixth Edition, Amendments 85

ICAO Annex 14 vol. I Fourth Edition

ICAO Doc 8071 Fourth Edition