

## 1. DEFINITIONS

In the specification, the following words and expression shall have the meanings assigned to them here under except where the context otherwise requires:

AEROTHAI	Aeronautical Radio of Thailand Ltd.
Essential requirement specification [E]	Essential requirement specification which is mandatory requirement by which the Tenderer shall fully comply with AEROTHAI's requirement stipulated in Scope of Specifications. The Proposal will be rejected if the proposed system, functions of features fail to comply with Essential requirement specification.
Tenderer	The juristic person, firm or company who offers to provide materials or perform a service or do a job with AEROTHAI at a specified cost or rate.
ICAO Annex 10 Vol. I	Aeronautical Telecommunications : Volume I Radio Navigation Aids. Sixth Edition, July 2006, Amendments 89
ICAO Annex 14 Vol. I	Aerodromes : Volume I Aerodrome Design and Operations. Sixth Edition, July 2013, Amendments 11–B
ICAO Doc 8071 Vol. I	Manual on Testing of Radio Navigation Aids: Volume I Testing of Ground–Based Radio Navigation Systems. Fourth Edition – 2000, Amendments 1
ICAO Doc 9157	Aerodrome Design Manual Part 6: Frangibility, First Edition – 2006
Proposal	The response to the requirement specified in Scope of Specifications.
Contractor	The juristic person, firm or company whose Tender(s)/Proposal(s) has/have been accepted by AEROTHAI and who agrees to accomplish the activities for AEROTHAI.

**2. GENERAL REQUIREMENTS [E]**

- 2.1 Four (4) DVOR/DME Systems shall be installed to replace the current system at Chumphon Airport, Mae Sot Airport, Buri Ram Airport and Krabi Airport.
- 2.2 The DVOR/DME System shall be designed based on dual transmitters and dual monitors configuration which consists of the following:
  - 2.2.1 Dual DVOR Equipment;
  - 2.2.2 Dual DME Equipment;
  - 2.2.3 Antenna Systems for the above equipment;
  - 2.2.4 Status Indicator for the above equipment specified in 2.2.1–2.2.3 which shall be equipped at Control Tower;
  - 2.2.5 Remote Control Equipment for the above equipment specified in 2.2.1–2.2.3 which shall be equipped at Technical Control Room;
  - 2.2.6 Remote Maintenance and Monitoring Equipment for the above equipment specified in 2.2.1–2.2.3 which shall be equipped at Technical Control Room.
- 2.3 The DVOR/DME System shall have SNMP management capability are specified in clause 6.
- 2.4 The system performance and signal quality shall at least complied with the ICAO Annex 10 Vol. I.
- 2.5 All RF Generators shall be synthesizers.
- 2.6 The equipment shall be the modular design, or an easy plug-in card or modules for the quick replacement with the purpose for easy maintenance and repair.
- 2.7 The dual independent transmitters shall be housed in the cabinet (s) and operated as main and standby facilities. Maintenance on any equipment shall be accomplished without disruption the operation of the others.
- 2.8 The equipment shall be designed in common of modules and printed circuit boards.
- 2.9 The equipment shall be designed for high-reliability operation. The Tenderers shall submitted reliability analysis (MTBF, MTBO) of DVOR/DME System in the proposal.
- 2.10 The DME equipment shall be installed in co-location with the DVOR equipment.
- 2.11 Each Line Replaceable Units (LRU) of DVOR/DME Equipment shall be easily exchangeable.
- 2.12 All outdoor materials 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 Vol. I.

- 2.13 Transmission lines, Cables and Accessories.
- 2.13.1 All transmission lines, AC power lines and accessories shall be provided.
- 2.13.2 All buried cables shall be provided with underground-type and fitted in HDPE or RSC pipes which the inner diameter shall at least wide enough for fitting all cables easily.
- 2.13.3 All transmission lines shall be laid in a different pipe separated from that of AC power lines.
- 2.13.4 The underground cable work shall be done by the Contractor. The trench for lying underground cable shall be dug with more than fifty (50) cms in depth from ground surface and not less than thirty (30) cms in width. The trench basement shall be covered with twenty (20) cms thick of sand which is the base of underground cable. Finally, the underground cable shall be covered with twenty (20) cms thick of sand topping with twenty (20) cms thick of soil.
- 2.13.5 Cable route markers shall be installed at every 10 meters for indicating underground cables. The cable route marker specifications are detailed in section 2: Counterpoise and Grounding System Requirements.
- 2.13.6 The Contractor shall take all responsible precautions to protect existing underground equipment and utilities. All known power and control cables leading to the facility shall be marked out by the Contractor with the aid of AEROTHAI personnel.
- 2.13.7 Test cables and accessories required for initial set up and maintenance shall be provided.
- 2.14 Power Supply
- 2.14.1 The DVOR/DME System and all peripheral equipments shall be operated with 220 ± 10 VAC, 50 Hz ± 5% single phase.
- 2.14.2 The UPS for the DVOR/DME System shall be provided and shall be installed at the site.
- 2.14.3 The UPS system shall consists of one or more UPS modules, an energy-storage battery, and accessories as required to provide a reliable and high quality power supply. The UPS system isolates the load from the primary and secondary sources and in the event of a power interruption provides regulated power to the critical load for a specified period. (The battery typically has a 15-minute capacity when operating at full load.)
- 2.14.4 Power supply module for DVOR and DME equipments shall be individually supplied.

- 2.14.5 Surge and Lightning Arrestor unit with indicator for the power supply of each station shall be provided and installed at the site. The units shall provide a maintenance free service and bypass the energy from direct lightning strike to the incoming power line without interrupt of power supply. The units shall include indicator lamps to indicate failure of the Lightning Arrestors. Type, model and diagram shall be submitted in the Proposal.
- 2.14.6 At the minimum, Surge and Lightning Arrestor shall be provided as follow:
  - 2.12.6.1 Maximum Continuous Operating Voltage (Uc) at least 320 VAC;
  - 2.12.6.2 Voltage Protection Level (Up) less than 1.5 KV;
  - 2.12.6.3 Maximum Discharge Current (Imax) (8/20  $\mu$ s) at least 100 KA.
- 2.15 Operating Environment
  - 2.15.1 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%.
  - 2.15.2 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.
- 2.16 The total resistance of the grounding system shall not exceed 5  $\Omega$ .
- 2.17 The DVOR/DME equipment shall have the battery back up with charger unit. Maintenance-free batteries shall have sufficient capacity to enable to operate for a minimum period of One (1) hour in the event of an AC mains failure.

### **3. DOPPLER VHF OMNI RANGE (DVOR) EQUIPMENT [E]**

- 3.1 System Accuracy
  - 3.1.1 Azimuth accuracy shall be better than  $\pm 1$  degree on ground measurement.
  - 3.1.2 Azimuth stability shall be better than  $\pm 0.5$  degree measured at a monitor.
- 3.2 The dual DVOR equipment shall comprise, but not limited to:
  - 3.2.1 Dual carrier transmitters;
  - 3.2.2 Dual sideband transmitters;
  - 3.2.3 Dual monitors;
  - 3.2.4 DVOR test generator;
  - 3.2.5 Antenna Switching Unit;
  - 3.2.6 Antenna System.

**3.3 Carrier Transmitter**

- 3.3.1 Frequency band – 108 MHz to 117.975 MHz
- 3.3.2 Operating frequency – 110.00 MHz for Chumphon Airport
  - 116.70 MHz for Mae Sot Airport
  - 117.20 MHz for Buri Ram Airport
  - 111.00 MHz for Krabi Airport
- 3.3.3 Frequency stability –  $\pm 0.002\%$  from the operating frequency
- 3.3.4 Output power – at least 50 watts (adjustable)
- 3.3.5 Spurious output – better than 60 dB below carrier
- 3.3.6 Carrier modulation:
  - 3.3.6.1 Reference frequency –  $30 \text{ Hz} \pm 0.2\%$
  - 3.3.6.2 Modulation depth – 30% (adjustable)
  - 3.3.6.3 Identification frequency –  $1020 \text{ Hz} \pm 50 \text{ Hz}$
  - 3.3.6.4 Identification modulation depth – 10% (adjustable)
  - 3.3.6.5 Speech channel filter – band pass at the range of 300 to 3000 Hz within 3 dB relative to the level at 1000 Hz
  - 3.3.6.6 Speech modulation depth – up to 30% (the transmission of speech shall not interfere in any way with basic navigation function) (adjustable)
- 3.3.7 The Identification unit shall be able to generate any three letters International Morse Code for both DVOR and DME equipment.
- 3.3.8 The setting up of DVOR Identification code shall be computerized.
- 3.3.9 The DME Identification shall be generated on every fourth DVOR Identification cycle.
- 3.3.10 Protection shall be provided for the RF amplifier from damage caused by open or short circuit of the output.
- 3.3.11 Thruline (line section) and plug-in elements with RF Wattmeter shall be equipped for all radiating power output of the transmitters. Type, model and diagram shall be submitted in the Proposal.

### 3.4 Sideband Transmitter

3.4.1 A double-sideband DVOR equipment shall be provided.

3.4.2 The Sub-carrier modulation mid-frequency shall be 9960 Hz  $\pm$  1%.

3.4.3 Phase control circuit shall maintain phase stability between the Sidebands and carrier signals.

3.4.4 Each Thrulines (line section) and plug-in elements with RF Wattmeter shall be equipped for all radiating power output of the transmitters. Type, model and diagram shall be submitted in the Proposal.

### 3.5 Monitor

3.5.1 The DVOR Monitor system shall be capable continuous monitoring fault (s) detection and producing alarm signal (s) for the following conditions occurs:

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

3.5.1.2 Reference signal 30 Hz modulation depth exceeds  $\pm$  2% from the nominal value;

3.5.1.3 Sub-carrier 9960 Hz modulation depth exceeds  $\pm$  2% from the nominal value;

3.5.1.4 Sub-carrier 9960 Hz deviation ratio exceeds  $16 \pm 1$ .

3.5.2 The bearing alarm limit shall be adjustable with the step of not more than 0.1 degree.

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

3.5.4 The identification alarm shall be provided for the following conditions:

3.5.4.1 Continuous keyed;

3.5.4.2 Loss of identification for more than 15 second (adjustable).

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

3.5.6 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.

- 3.5.7 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 and Remote Control and Status Unit (RCSU)
  - 3.5.8 Alarm delay shall be adjustable.
  - 3.5.9 Alarm history shall be provided to identify the parameter that has deviated beyond the alarm limit and caused the alarm.
  - 3.5.10 The parameters of DVOR Transmitter and Monitor shall be provided and show on display. Control and Selection for display of those parameters shall be done by computerization which is permanently located at site. The following parameters, including but not limited to, shall be available:
    - 3.5.10.1 The bearing information;
    - 3.5.10.2 Reference signal 30 Hz modulation depth;
    - 3.5.10.3 Sub-carrier 9960 Hz modulation depth;
    - 3.5.10.4 Sub-carrier 9960 Hz deviation ratio;
    - 3.5.10.5 Identification;
    - 3.5.10.6 Forward and reflected power or standing wave ratio.
  - 3.5.11 The field Monitor (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.
  - 3.5.12 Double LED obstruction lighting devices with photo-switch shall be installed with the monitor antenna which conforms with the ICAO Annex 14 Vol. I Chapter 6 – Visual Aids For Denoting Obstacles or Federal Aviation Administration (FAA) Specification for Obstruction Lighting Equipment (AC 150/5345-43F OR 43G). Type and model shall be submitted in the Proposal.
- 3.6 Test Generator
- 3.6.1 The Test Generator for DVOR equipment shall be able to check and calibrate the monitor to conform with ICAO Annex 10 Vol. I.
  - 3.6.2 Type and model of the Test Generator shall be submitted in the Proposal (in case of separated unit).

3.6.3 Built-in-Test (BIT) or Fault Diagnostics shall be provided for all Lowest Replaceable Units (LRU) and capable of being initiated locally and remotely.

3.7 Antenna Switching

3.7.1 The RF Power Distributor in the Antenna Switching unit shall be broadband for operation in the range of 108 MHz to 117.975 MHz.

3.7.2 Surge and Lightning Arrestors shall be provided for all output ports of the distributor.

3.8 Antenna System

3.8.1 The operating frequency of each Antenna element shall be adjusted from the factory.

3.8.2 The Proposal shall describe the method of sideband feed lines fabrication and any other adjustment procedures.

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

3.8.4 The Antenna System shall provide sufficient coverage as required in ICAO Annex 10 Vol. I Paragraph 3.3.4 except where topographical features are dictated.

**4. DISTANCE MEASURING EQUIPMENT (DME) [E]**

4.1 The DME equipment shall comprise:

- 4.1.1 Dual transponders;
- 4.1.2 Dual monitors;
- 4.1.3 Antenna system.

4.2 Transponder

- 4.2.1 Frequency band – 960 MHz to 1215 MHz
- 4.2.2 Operating channel
  - CH 37X for Chumphon Airport
  - CH 114X for Mae Sot Airport
  - CH 119X for Buri Ram Airport
  - CH 47X for Krabi Airport

4.2.3 Transmitter characteristics

4.2.3.1 The radio frequency of operation shall not vary more than  $\pm 0.002\%$  from the assigned frequency.

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



- 4.2.3.3 Pulse spacing shall meet the requirements specified in ICAO Annex 10 Vol. I Paragraph 3.5.4.1.4.
- 4.2.3.4 The peak power of each pulse of any pulse pair shall not differ by more than 1 dB.
- 4.2.3.5 Peak effective radiation power of the reply pulse shall not be less than 30 dBw.
- 4.2.3.6 The transponder power amplifier shall provide full peak output power of not less than 1000 watts to the antenna.
- 4.2.4 Receiver characteristics
  - 4.2.4.1 The centre frequency of the receiver shall not vary more than  $\pm 0.002\%$  from the assigned frequency.
  - 4.2.4.2 Transponder sensitivity shall meet the requirements specified in ICAO Annex 10 Vol. I Paragraph 3.5.4.2.3.
  - 4.2.4.3 Bandwidth and selectivity shall meet the requirements specified in ICAO Annex 10 Vol. I Paragraph 3.5.4.2.6.
  - 4.2.4.4 CW and echo suppression shall be provided and meet the requirements specified in ICAO Annex 10 Vol. I Paragraph 3.5.4.2.9.
- 4.2.5 Video
  - 4.2.5.1 Interrogating pulse spacing error more than  $\pm 2$  microseconds shall be rejected.
  - 4.2.5.2 Receiver dead time shall be adjustable for echo suppression as measured after main delay time.
  - 4.2.5.3 Long distance echo suppressor shall be provided by automatic receiver gain reduction according to each echo pulse level.
  - 4.2.5.4 The minimum transmission rate shall be as close as practicable to 700 PPS.
  - 4.2.5.5 The maximum transmission rate shall be at least 4800 PPS.
  - 4.2.5.6 Identification shall meet the requirements specified in ICAO Annex 10 Vol. I Paragraph 3.5.3.6 for association with the DVOR identification.
  - 4.2.5.7 The time delay shall meet the requirements specified for DME/N in ICAO Annex 10 Vol. I Paragraph 3.5.4.4.

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

#### 4.3 DME Monitor

4.3.1 The Monitor shall serve two purposes.

4.3.1.1 To ensure that the transponder signal is within the tolerance as specified for DME/N in ICAO Annex 10 Vol. I Paragraph 3.5.4.7.2

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

4.3.2 The Monitor shall initiate an alarm signal if any of the following conditions occurs:

4.3.2.1 Reply delay error exceed 1 microsecond;

4.3.2.2 Transmitting pulse spacing error exceed  $\pm 0.25$  microsecond;

4.3.2.3 Reply efficiency is less than 70%;

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

4.3.2.5 Transmitting pulse count falls below 700 PPS;

4.3.2.6 Continuous or loss of identification.

4.3.3 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 4.3.2.1) or transmitting pulse spacing error (in 4.3.2.2).

4.3.4 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 in 4.3.2.3–4.3.2.6.

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

4.3.6 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.

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

- 4.3.8 Test signal generator output shall be selected, The channel frequency deviation of  $\pm 200$  KHz and  $\pm 900$  KHz of the transponder receiver can be tested.
- 4.3.9 Test signal generator output level shall be adjustable from  $-94$  dBm to  $-25$  dBm or wider at input point of transponder.
- 4.3.10 Test signal generator PRF shall be adjustable from 700 to 4800 PPS.
- 4.3.11 At least the following Transponder and Monitor parameters shall be available for display at the designated control points:
  - 4.3.11.1 Reply delay;
  - 4.3.11.2 Reply pulse pair spacing;
  - 4.3.11.3 Reply efficiency;
  - 4.3.11.4 Transmit power;
  - 4.3.11.5 Transmitter pulse count;
  - 4.3.11.6 Identification.
- 4.3.12 Settings and selection for display of the Transponder and Monitor parameters in 4.3.11 shall be done by a Desktop Computer which shall be supplied and permanently located at the Site.
- 4.4 DME Antenna System
  - 4.4.1 The Antenna shall be an Omni-directional antenna type.
  - 4.4.2 The Antenna shall be capable of radiating DME signal throughout the DME frequency band (960 MHz to 1215 MHz) so that changing of the operating frequency needs no readjustment of the Antenna.
  - 4.4.3 The Antenna system shall provide sufficient coverage as required in ICAO Annex 10 Vol. I Paragraph 3.5.3.1.2.1 except for where topographical features dictate.
  - 4.4.4 The radiation patterns of the Antenna System shall be submitted with the Tender.
  - 4.4.5 Double LED obstruction lighting devices with photo-switch shall be installed with the antenna which conforms either the ICAO Annex 14 Vol. I Chapter 6 – Visual Aids For Denoting Obstacles or Federal Aviation Administration (FAA) Specification for Obstruction Lighting Equipment (AC150/5345-43F OR 43G). Type and model shall be submitted in the Proposal.

**5. CONTROL AND MONITORING [E]**

## 5.1 DVOR Local Control Unit

- 5.1.1 The front-panel control unit with indicators shall be at least capable of:
  - 5.1.1.1 Selecting the main equipment from the front-panel switch;
  - 5.1.1.2 Turning on the standby transmitter into dummy loads for testing purposes;
  - 5.1.1.3 Bypassing the monitor;
  - 5.1.1.4 Selecting Remote/Local Control;
  - 5.1.1.5 Resetting the alarm;
  - 5.1.1.6 Shutting down the station;
  - 5.1.1.7 Displaying operating status of the equipment.
- 5.1.2 The DVOR equipment shall be able to operate on local or remote control.
- 5.1.3 The Automatic Transfer System from the selected transmitter to a standby transmitter and/or shut down in the event of alarm shall be provided.
- 5.1.4 Each DVOR transmitter shall be selectable as main or standby equipment.
- 5.1.5 Operating status of the equipment shall be displayed on an indicator panel.
- 5.1.6 The standby transmitter shall be able to turn on into the built-in dummy load for test.
- 5.1.7 Reset facility shall be provided to clear fault condition (s) and restart normal operation.
- 5.1.8 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.
- 5.1.9 Four (4) 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. The Desktop Computer Specifications are specified in clause 11.
- 5.1.10 The software for monitoring and controlling the DVOR equipment shall be installed in the Desktop Computer. The recovery CD/DVD for the software shall be provided. The user's license for the software shall be provided for AEROTHAI.

## 5.2 DME Local Control Unit

- 5.2.1 The DME equipment shall be able to operate on local or remote control. It shall have at least the following control and monitoring functions:

- 5.2.1.1 Selecting the main equipment
- 5.2.1.2 Turning on the standby transponder into dummy loads for testing purposes;
- 5.2.1.3 Bypassing the monitor;
- 5.2.1.4 Selecting Remote/Local control;
- 5.2.1.5 Resetting the alarm;
- 5.2.1.6 Shutting down the station;
- 5.2.1.7 Displaying the operating status of the equipment.
- 5.2.2 The DME Local Control Unit shall automatically transfer from the selected transponder to a standby transponder and/or shut down in the event of an alarm.
- 5.2.3 The DME Local Control Unit shall be able to select either DME transponder to be main or standby equipment.
- 5.2.4 Operating status of the equipment shall be displayed on an indicator panel.
- 5.2.5 The DME Local Control Unit shall be able to turn on the standby transponder into the built-in dummy load for test.
- 5.2.6 Reset facility shall be provided to clear fault condition (s) and restart normal operation.
- 5.2.7 The Local Control Unit shall be able to adjust, display transmitter and monitor parameters via a Desktop Computer which is permanently located at site.
- 5.2.8 Four (4) 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. The Desktop Computer Specifications are specified in clause 11.
- 5.2.9 The software for monitoring and controlling the DME equipment shall be installed in the Desktop Computer. The recovery CD/DVD for the software shall be provided. The user's license for the software shall be provided for AEROTHAI.
- 5.3 Remote Control and Status Unit (RCSU)
  - 5.3.1 The DVOR/DME RCSU shall have at least the following control and monitoring functions:
    - 5.3.1.1 Turn on/off the selected transmitter/transponder with indicator;
    - 5.3.1.2 Transfer and shutdown with indicator;
    - 5.3.1.3 NORMAL/ALARM indicator and audible alarm;

- 5.3.1.4 Alarm silence control with indicator;
- 5.3.1.5 Alarm reset.
- 5.3.2 RCSU shall be housed in a cabinet suitable for installation on either desktop or rack in the technical control room at ATC tower.
- 5.3.3 RCSU shall be connected via land line (provided by AEROTHAI) and the outdoor wireless link (5.150–5.850 GHz) (provided by the Contractor).
- 5.3.4 The wireless link between the DVOR/DME site and the technical control room for the RCSU shall be installed. The wireless link specification is specified in clause 7.3
- 5.3.5 The selection capability for using the land line or the outdoor wireless link as the main communication link between DVOR/DME equipment and the technical control room shall be provided.
- 5.3.6 Surge and lightning protection shall be provided at both ends of land line and the outdoor wireless link. Type, model and diagram shall be submitted in the Proposal.
- 5.4 Remote Status Unit (RSU)
  - 5.4.1 The status indicator shall be provided with audible alarm, that installed in the control room at ATC tower.
  - 5.4.2 The RSU shall have at least the following features:
    - 5.4.2.1 Display the operating status of the DVOR/DME;
    - 5.4.2.2 Visual and audible alarm with an alarm silence control;
    - 5.4.2.3 Turn on/off switch for the RSU.
- 5.5 Remote Monitoring and Maintenance Equipment (RMM)
  - 5.5.1 The Remote Monitoring and Maintenance Equipment shall monitor and control DVOR/DME equipment by TCP/IP.
  - 5.5.2 The Remote Monitoring and Maintenance Equipment shall have at least the following functions for each equipment:
    - 5.5.2.1 Selecting the main/standby transmitter/transponder;
    - 5.5.2.2 Turning on the standby transmitter/transponder into dummy loads for testing purposes;
    - 5.5.2.3 Bypassing the monitor;
    - 5.5.2.4 Resetting the alarm;

- 5.5.2.5 Shutting down the station;
- 5.5.2.6 Adjusting and displaying transmitter / transponder and monitor parameters.
- 5.5.3 The Remote Monitoring and Maintenance Equipment shall be interfaced to DVOR/DME site via land line (provided by AEROTHAI) and TCP/IP network with the outdoor wireless link (provided by the Contractor) as specified in clause 7.3.
- 5.5.4 The communication for the RMM must be separated from that for the RCSU for redundancy.
- 5.5.5 The wireless link between the DVOR/DME sites and the Technical Control 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.
- 5.5.6 Surge and Lightning protection shall be provided at both ends of the Land line and the outdoor wireless link. Type, model and diagram of the Surge and Lighting protection shall be submitted in the Proposal.
- 5.5.7 The Remote Monitoring and Maintenance shall be performed by Notebook Computer or Desktop Computer.
- 5.5.8 Four (4) sets of Desktop Computer and Four (4) sets of Notebook Computer shall be provided as part of the Remote Monitoring and Maintenance. The Desktop and Notebook Computer Specifications are specified in clause 11 and 12 respectively.
- 5.5.9 The Remote Monitoring and Maintenance software for monitoring and controlling the DVOR/DME equipment from anywhere shall be installed in the Notebook Computer and the Desktop Computer. The recovery CD/DVD for the RMM software shall be provided. The user's license for the software shall be provided for AEROTHAI.
- 5.5.10 Four (4) sets of Color Laser Printers for hard copy report of the station status and meter reading shall be provided as part of the Remote Monitoring and Maintenance.

**6. INTERSYSTEM CONNECTION**

- 6.1 The DVOR/DME System and UPS system shall be connected with [RCSU](#) and RCMS (supplied by the contractor), CCMS and EMMC (provided by AEROTHAI) to send update information.
- 6.2 The Update information shall comprise at least the system operation status, as specified in clause 5.1.5, 5.2.4 and 10.3.7.1 by using the Simple Network Management Protocol (SNMP) and appropriate protocol (if any) over Ethernet port as specified in clause 13.
- 6.3 The Tenderer shall provide and detail the DVOR/DME/UPS – RCMS, CCMS, EMMC information exchange.
- 6.4 The Tenderer shall provide and detail the mechanism to provide data integrity and security against unauthorized access, intrusion and malicious computer attacks.
- 6.5 The Tenderer shall provide network equipment and communication link details for inter-system connection (DVOR/DME/UPS to RCMS, CCMS and EMMC) to AEROTHAI network at Technical Control Room as depicted in the clause 13.
- 6.6 The Contractor shall provide a list of all necessary standards documents and Interface Control Documents (ICDs) with regards to the DVOR/DME/UPS – RCMS, CCMS and EMMC information exchange
- 6.7 The network equipment shall have, at the minimum, the following feature:
  - 6.7.1 Stateful Firewall
  - 6.7.2 Access Control List
  - 6.7.3 VPN Service (Client to Site, Site to Site)
  - 6.7.4 VPN tunnel encryption (IPSec, SSL)
  - 6.7.5 IPSec + Zone-Based Firewall Performance.
  - 6.7.6 WAN Access Speeds (Bandwidth) 50 MBPS Throughput(IMIX) 55 MBPS

**7. SUPPLEMENTS**

- 7.1 Portable Navigational Signal Analyzer (PNSA) **[E]**
  - 7.1.1 Four (4) sets of Portable Navigational Signal Analyzer shall be provided. They shall be used for ground test of the ILS, VOR and Marker beacon. Each PNSA shall comprises:
    - 7.1.1.1 Receiver for Localizer, Glide Slope, VOR and Marker Beacon;
    - 7.1.1.2 Built-in rechargeable battery;



- 7.1.1.3 Antennas for Localizer, Glide Slope and VOR;
- 7.1.1.4 Battery Charger;
- 7.1.1.5 Antenna Pole;
- 7.1.1.6 Accessories.

- 7.1.2 The PNSA shall be designed for outdoor purpose with compact and weatherproof.
- 7.1.3 All ILS/VOR channels shall be selectable.
- 7.1.4 Performance analyzer of ILS Localizer, Glide Slope, Marker Beacon and VOR shall be performed in accordance with ICAO Doc 8071 Vol. I.
- 7.1.5 All parameters shall be printed out directly or export to the external portable storage media eg. HD/USB drive or other devices in text format.
- 7.1.6 PNSA shall be provided real time measurement data directly via RS 232 C or USB port.
- 7.1.7 Battery charger shall be operated on  $220 \pm 10$  VAC, 50 Hz

7.2 Portable Vector Network Analyzer (PVNA) [E]

- 7.2.1 Two (2) sets of Portable Vector Network Analyzer (PVNA) equipment shall be provided.
- 7.2.2 General Requirements
  - 7.2.2.1 The PVNA equipment shall be able to perform the following functions: Vector Network Analyzer (VNA), Vector Volt Meter, Spectrum Analyzer.  
  
The PVNA equipment shall be able to analyze the test results from Transmission / Reflection Measurement, Return loss, VSWR, Cable loss, Distance to fault, Spectrum Analysis, Smith Chart and shall be able to receive the Global Positioning Satellite (GPS) signal.
  - 7.2.2.2 The PVNA equipment shall be designed for outdoor purpose with compact and weatherproof.
  - 7.2.2.3 The equipment shall be equipped with full two (2) Vector Network Analyzer Measurement ports, internal memory and USB Ports.
- 7.2.3 Technical Requirements
  - 7.2.3.1 Vector Network Analyzer specifications
    - 7.2.3.1.1 Frequency
      - 7.2.3.1.1.1 Frequency range : 100 KHz to 5 GHz
      - 7.2.3.1.1.2 Frequency accuracy :  $\leq 2$  ppm

- 7.2.3.1.1.3 Frequency resolution : ≤ 10 Hz
- 7.2.3.1.1.4 Data points : capable of zoom in and zoom out signal shape
- 7.2.3.1.2 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
- 7.2.3.1.3 Reflection measurement
  - Directivity : > 30 dB at 100 KHz to 5 GHz
- 7.2.3.1.4 Maximum cable length for measurement : ≥ 500 m
- 7.2.3.1.5 Measurement parameter : S11, S12, S21, S22
- 7.2.3.2 Spectrum Analyzer specifications
  - 7.2.3.2.1 Frequency range : 200 KHz to 6 GHz
  - 7.2.3.2.2 Maximum continuous Input (≥10 dB Attn) : ≥ 27 dBm
  - 7.2.3.2.3 Frequency accuracy : ± 2 ppm
  - 7.2.3.2.4 Frequency resolution : ≤ 1 Hz
  - 7.2.3.2.5 Frequency reference aging : ± 1 ppm/years
  - 7.2.3.2.6 Frequency span : 10 Hz to 6 GHz plus 0 Hz (zero span)
  - 7.2.3.2.7 Resolution bandwidth (–3dB bandwidth) : 10 Hz to 3 MHz
  - 7.2.3.2.8 Video bandwidth (–3 dB bandwidth) : 1 Hz to 3 MHz
  - 7.2.3.2.9 Sweep time (span 0 Hz) : 200 μs to 100 s
  - 7.2.3.2.10 Amplitude measurement range : DANL to + 20 dBm
  - 7.2.3.2.11 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	< –149 dBm	< –130 dBm

  - 7.2.3.2.12 Amplitude units : log scale modes dBm, dBmV, dBμV, V, W
  - 7.2.3.2.13 Attenuator range : 0 to 30 dB

## 7.2.3.3 General specifications

- 7.2.3.3.1 The runtime of internal battery shall not less than 2 hours under full function usage condition.
- 7.2.3.3.2 Type N female RF connectors
- 7.2.3.3.3 Maximum damage input power:  $\geq 20$  dBm
- 7.2.3.3.4 Internal memory:  $\geq 256$  Traces
- 7.2.3.3.5 USB interface for transfer data
- 7.2.3.3.6 LAN Interface for remote control
- 7.2.3.3.7 AC power supply: 110 V–220 V  $\pm 10$  %
- 7.2.3.3.8 Colour LCD displayed
- 7.2.3.3.9 Built-in internal speaker
- 7.2.3.3.10 Built-in GPS receiver and removable GPS antenna
- 7.2.3.3.11 Having an authorized representative in Thailand

## 7.2.4 Accessories

- |          |  |        |
|----------|--|--------|
| 7.2.4.1  | Rechargeable battery (Li-ion)                        | 1 set  |
| 7.2.4.2  | AC adapter/charger                                   | 1 set  |
| 7.2.4.3  | Car charger  | 1 set  |
| 7.2.4.4  | Software analysis and software control               | 1 set  |
| 7.2.4.5  | Calibration kit                                      | 1 set  |
| 7.2.4.6  | Adapter kits 50 $\Omega$ , (N-Type, SMA, TNC, BNC ㉿) | 1 set  |
| 7.2.4.7  | Test port cable DC–6 GHz, 50 $\Omega$ , N(m)–N(f)    | 1 set  |
| 7.2.4.8  | Operation manual                                     | 2 sets |
| 7.2.4.9  | Service manual or maintenance manual                 | 1 set  |
| 7.2.4.10 | Soft carrying case                                   | 1 ea   |
| 7.2.4.11 | Hard case (Factory Product)                          | 1 ea   |

## 7.3 Wireless Link Radio Equipment [E]

- 7.3.1 The wireless link between the DVOR/DME sites and the technical room for the Remote Control and Status (RCSU) and Remote Maintenance and Monitoring (RMM) shall be provided.

- 7.3.2 Radio
  - 7.3.2.1 Frequency range : 5.150–5.850 GHz
  - 7.3.2.2 Channel bandwidth :  $\geq 20$  MHz
- 7.3.3 Data communication
  - 7.3.3.1 The air link shall be at least AES 128 bits encryption.
  - 7.3.3.2 VLAN support : 802.1 q
  - 7.3.3.3 Maximum throughput :  $\geq 20$  Mbps
- 7.3.4 Antenna & Transmission line
  - 7.3.4.1 Antenna gain :  $\geq 16$  dBi
  - 7.3.4.2 The sufficient transmission line shall be provided.
- 7.4 DVOR Spare Parts
  - 7.4.1 Eight (8) sets of DVOR spare parts shall be provided.
  - 7.4.2 Each set of DVOR spare parts in 7.4.1 shall consist of one complete unit of each line replaceable module (LRM), printed circuit boards (PCBs), backplanes and RF switches (Coaxial relays, RF distribution units) which is under single system configuration.
- 7.5 DME Spare Parts
  - 7.5.1 Eight (8) sets of DME spare parts shall be provided.
  - 7.5.2 Each set of DME spare parts in 7.5.1 shall consist of one complete unit of each line replaceable module (LRM), printed circuit boards (PCBs), backplanes and RF switches (Coaxial relays) which is under single system configuration.
- 7.6 RCSU and RSU Spare Parts
  - 7.6.1 Eight (8) sets of RCSU and RSU spare parts shall be provided.
  - 7.6.2 Each set of RCSU and RSU spare parts in 7.6.1 shall consist of one complete unit of each line replaceable module (LRM), printed circuit boards (PCBs) and backplanes.
- 7.7 Wireless Link Equipment Spare Parts
  - Eight (8) Wireless Link Equipments shall be provided as spare parts.
- 7.8 The network equipment Spare Parts (in clause 6.7)
  - Twelve (12) sets of network equipment shall be provided as spare parts.
- 7.9 Double LED obstruction lighting Spare Parts (in clause 3.5.12 and 4.4.5)
  - Eight (8) sets of Double LED obstruction lighting equipment shall be provided as spare parts.

**8. TOOLS KITS AND MAINTENANCE AIDS**

- 8.1 For system installation and hardware adjustment, tool kits and maintenance aids list as specified in **Appendix B** per DVOR/DME system shall be provided.
- 8.2 A suitable waveform analysis tool, RF power analysis, thru-line wattmeter and digital multimeter tool shall be provided, with functions including but not limited to, as specified in **Appendix B**.
- 8.3 Extension cables and cards as required for each module/ PCB of the DVOR/DME shall be provided for maintenance.
- 8.4 Test cables, dummy loads and attenuation kits for transmitter calibration and flight inspection shall be provided.
- 8.5 Installation materials such as external and internal cabling, cable trays, connectors, cable ties and conduits shall be provided.

**9. TECHNICAL DOCUMENTS AND TEST REPORTS [E]**

The Contractor shall provide the following documents:

- 9.1 Five (5) sets for hard copy and six (6) sets for CD/DVD, of mechanical and electrical DVOR/DME drawings essential for installation, maintenance and troubleshooting of the equipment, including such drawings as are needed to identify the components and cable within the equipment or its sub units;
- 9.2 Five (5) sets for hard copy and six (6) sets for CD/DVD, of DVOR/DME installation and equipment instruction manuals, setting out in detail the procedures for operation, routine maintenance, troubleshooting of the equipment, test and alignment procedures, including schematics and inter-cabling diagrams;
- 9.3 Five (5) sets of hard copy and CD/DVD for DVOR/DME component part lists which includes manufacturer part numbers or descriptions of any generic component level devices (ICs, transistors, capacitors, etc.) in each Line Replaceable Modules (LRMs) shall be provided for the purpose of comparing for the generic devices with electronic component in the market in order to repair the LRMs after the warranty period.
- 9.4 One (1) original and Four (4) hard copies of Factory Acceptance Test (FAT) report shall be provided at the factory after the completion of FAT.
- 9.5 Four (4) original and Four (4) hard copies of Site Acceptance Test (SAT) report shall be provided at the site after the completion of the commissioning flight check.

**10. UNINTERRUPTED POWER SUPPLY (UPS)**

## 10.1 General Requirements

- 10.1.1 At minimum, the full UPS configuration shall consist of the components as depicted in clause 14.
- 10.1.2 At minimum, two (2) sets of UPS for each site shall be provided.
- 10.1.3 At minimum, two (2) sets of STS (Static Transfer Switch) equipment for each site shall be provided.
- 10.1.4 Each set of UPS shall provide enough electric power for all equipment in the facility for a minimum of 15 minutes.
- 10.1.5 The Tenderer shall be responsible for electric current load calculation for each facility and each set of UPS.
- 10.1.6 The Tenderer shall propose and detail the connection between UPS to equipment.
- 10.1.7 The Tenderer shall propose the UPS supplies list and related components.
- 10.1.8 The Contractor shall also be responsible to demonstrate a complete full load field test and successful field testing of the UPS compatibility with AEROTHAI emergency backup generator.
- 10.1.9 The Contractor shall provide, install, and test a complete and operable UPS in specified locations.
- 10.1.10 The STS shall connect to both sets of UPS equipment to receive electric power supply as depicted in clause 14.
- 10.1.11 The STS shall automatically select electric power from available UPS to equipment in the condition that one of UPS is dysfunctional.
- 10.1.12 The Tenderer shall provide product description/Technical Characteristics of UPS systems, Static Transfer Switch, and other related components.
- 10.1.13 All UPS equipment shall be new and factory tested.

## 10.2 Characteristics of UPS

- 10.2.1 The UPS shall be True On-Line Type with Double Conversion.
- 10.2.2 The UPS shall be provided with protection against overcharging, over current and short-circuit, spill proof, maintenance free and with capability of latching shutdown on overload.

- 10.2.3 In the event of a main electric power failure, the battery shall automatically take over without any interruption of the system operation.
- 10.2.4 When UPS failure or overload is occurred, it shall be able to automatically transfer the load supplied by the inverter to the reserve line without any interruption of the system operation.
- 10.2.5 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 of the system operation.
- 10.2.6 The Tenderer shall provide the detailed connection diagram between UPS at DVOR/DME station to RCMS at the Technical Control Room and EMMC.
- 10.2.7 The Contractor shall provide ICDs of the connection between UPS at DVOR/DME station to RCMS and EMMC at the Technical Control Room.
- 10.2.8 The RCMS shall be provided with the facility to authorized user in order to monitor and control the functionality and system devices of the UPSs.
- 10.2.9 Both audible and visual alarm indications shall be provided upon detection of RCMS equipment fault and/or any out of tolerance parameters in the monitoring equipment.
- 10.2.10 The visual alarm shall remain on RCMS until the fault is resolved.
- 10.2.11 The SNMP usage shall be encouraged for RCMS function.
- 10.2.12 The UPS shall send update information of system status warning, alarm messages and monitor parameters using SNMP protocol via AEROTHAI network to CCMS and EMMC.
- 10.2.13 The Tenderer shall provide the detailed connection diagram between UPS at DVOR/DME station to CCMS and EMMC.
- 10.2.14 The Contractor shall provide ICDs of the connection between UPS at DVOR/DME station to CCMS and EMMC.
- 10.2.15 The Tenderer shall provide network equipment and communication link and details for inter-system connection (UPS to CCMS and EMMC) to AEROTHAI network at Technical Control Room as depicted in the clause 13.
- 10.2.16 The UPS System at DVOR/DME site shall be connected via land line (provided by AEROTHAI) and the outdoor wireless link (5.150–5.850 GHz) (provided by the Contractor) as specified in clause 13.

- 10.2.17 The network equipment shall have, at the minimum, the following feature:
- 10.2.17.1 Stateful Firewall
  - 10.2.17.2 Access Control List
  - 10.2.17.3 VPN Service (Client to Site, Site to Site)
  - 10.2.17.4 VPN tunnel encryption (IPSec, SSL)
  - 10.2.17.5 IPSec + Zone-Based Firewall Performance.
  - 10.2.17.6 WAN Access Speeds (Bandwidth) 50 MBPS Throughput(IMIX) 55 MBPS
- 10.2.18 Protection shall be provided against damage of semiconductors due to the battery polarity being inadvertently reversed.
- 10.2.19 The battery charger shall be capable of charging batteries which are completely discharged.
- 10.2.20 The battery shall be continuously float charged.
- 10.3 Technical Requirements
- 10.3.1 Input
    - 10.3.1.1 Voltage : 220 VAC or 230 VAC  $\pm$  15% or better
    - 10.3.1.2 Frequency : 50 Hz  $\pm$  5% or better
    - 10.3.1.3 Phase : Single (2 Wire + Ground)
  - 10.3.2 Output
    - 10.3.2.1 Voltage : 220 VAC or 230 VAC  $\pm$  15%
    - 10.3.2.2 Frequency : 50 Hz  $\pm$  0.5%
    - 10.3.2.3 Phase : Single (2 Wire + Ground)
    - 10.3.2.4 Wave Form : Sine wave
    - 10.3.2.5 Total harmonics distortion :  $\leq$  3 % for 100% Linear Load
    - 10.3.2.6 Overall efficiency :  $\geq$  84% at load
    - 10.3.2.7 AC to AC – Crest factor : 3:1 or better
  - 10.3.3 Overload capacity – 120% Load : 1 Min or better
  - 10.3.4 Environment
    - 10.2.4.1 Ambient temperature : 0–40 °C (Continuous) or better
    - 10.2.4.2 Humidity : 90% continuously with non–condensing
  - 10.3.5 Audible noise :  $\leq$  55 dB(A) at 1 m.



10.3.6 Battery

10.3.6.1 Type : Maintenance free sealed lead acid

10.3.6.2 Discharge : High rate discharge

10.3.6.3 Life time : ≥ 4 years at 25° C

10.3.6.4 Back up time : ≥ 15 minutes at full load of UPS

10.3.7 Status and Control Indicator the capability, including but not limited to, shall be as follows.

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

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

10.3.7.3 Enable and disable alarm.

10.4 Technical of STS Requirements

10.4.1 Nominal input voltage : 220 VAC or 230 VAC ± 15%

10.4.2 Frequency : 50 Hz ± 0.5%

10.4.3 Phase : Single (2 Wire + Ground)

10.4.4 Transfer time ≤ 4 msec (S1-S2 synchronized)  
≤ 10msec (S1-S2 non-synchronized)

10.4.5 Transfer methods : Automatic-Manual

10.4.6 Communication port : RS232 standard and TCP/IP

**11. DESKTOP COMPUTER**

The Tenderers shall provide the Desktop Computer including all attached devices that are installed for system operation and monitoring. The Tenderers shall propose the technical specifications of Desktop Computer which comply with or is better than the following specifications.

11.1 Desktop, Display and Keyboard shall be produced from the same manufacturer with permanent logo/ brand on product.

11.2 Processor/ Chip set

11.2.1 3<sup>rd</sup> Generation Intel Core i5

11.2.2 Clock speed – 2.4 GHz

11.3 RAM

11.3.1 Technology – DDR 3 SDRAM

- 11.3.2 Memory speed – 1066 MHz
- 11.3.3 Size – 4.0 GB/ 8.0 GB (max)
- 11.4 One (1) Hard disk Drive
  - 11.4.1 Capacity – 1 x 1.0 TB
  - 11.4.2 Interface type – Serial ATA
- 11.5 One (1) Optical Storage
  - Internal DVD +/- RW Drive
- 11.6 Graphic Controller
  - Built-in with resolution 1280 x 1024 pixels
- 11.7 One (1) Display
  - 18.5 inches LED
- 11.8 Networking
  - 11.8.1 Built-in on board
  - 11.8.2 10/100/1000 Mbps Ethernet
  - 11.8.3 RJ-45 Interface type
- 11.9 Audio Output
  - Sound output including speakers
- 11.10 I/O Interfaces
  - 11.10.1 Minimum 4 ports USB 2.0
  - 11.10.2 1 Serial ports or 1 converted device for converting USB to Serial
- 11.11 One (1) Keyboard
  - 11.11.1 Standard QWERTY keyboard with USB interface
  - 11.11.2 104 keys at minimum
  - 11.11.3 Each key shall be permanently printed with both Thai and English characters
- 11.12 One (1) Mouse
  - 11.12.1 Optical Mouse with scroll wheel
  - 11.12.2 USB interface
  - 11.12.3 A suitable mouse pad
- 11.13 Operation System/ Software
  - 11.13.1 Shall be installed with the Desktop Computer
  - 11.13.2 Capable of operating with the software of the proposed DVOR/DME System

- 11.13.3 Recovery CD/DVD with a copy right shall be provided.
- 11.14 Compliant Standards
  - FCC or UL or CSA or ETL
- 11.15 The Operating System and License which is capable of operating the DVOR/DME System shall be provided.
- 11.16 One (1) set of Office table and chair which is suitable for computer operation shall be provided.
- 11.17 The Seller shall provide the two (2) years Manufacturer warranty for the Desktop Computer which starts from the completion of the fifth payment date according to the term of payment stipulated in non-technical term of reference.
- 11.18 The Desktop Computer shall have a manufacturer branch office authorized representative in Thailand.
- 11.19 The manufacture of the Desktop Computer shall receive ISO 9000 Series Certification.
- 11.20 The CD/DVD for software driver shall be provided with the product.

## **12. NOTEBOOK COMPUTER**

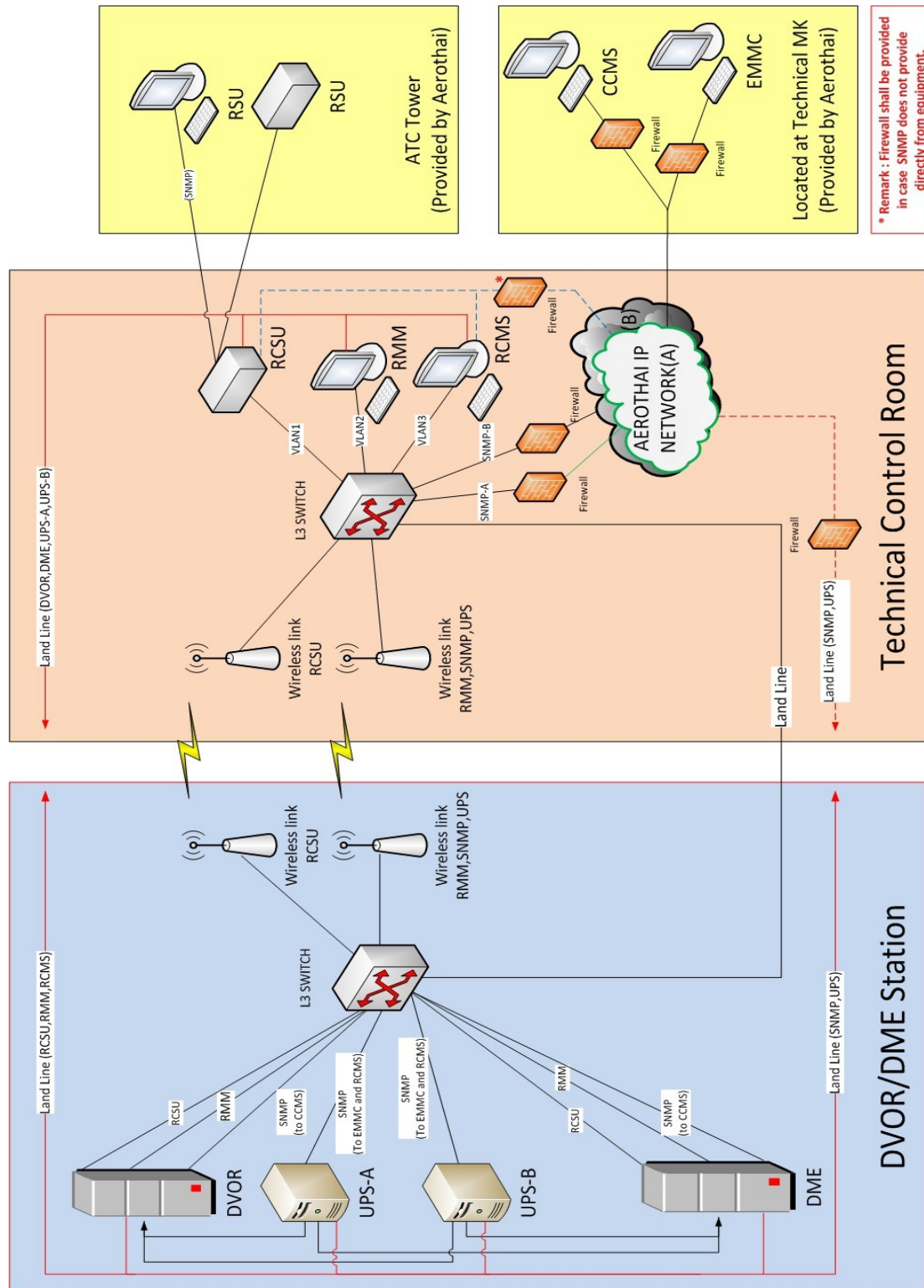
The Tenderers shall provide the Notebook Computer including all attached devices that are installed for system operation and monitoring. The Tenderers shall propose the technical specifications of Notebook Computer which comply with or is better than the following specifications.

- 12.1 Processor/ Chip set
  - 12.1.1 3<sup>rd</sup> Generation Intel Core i5
  - 12.1.2 Clock speed – 2.4 GHz
- 12.2 RAM
  - 12.2.1 Technology – DDR 3 SDRAM
  - 12.2.2 Memory speed – 1066 MHz
  - 12.2.3 Size – 4.0 GB/ 8.0 GB (max)
- 12.3 One (1) Hard disk Drive
  - 12.3.1 Capacity – 1 x 500 GB
  - 12.3.2 Interface type – Serial ATA
- 12.4 One (1) Optical Storage
  - Internal DVD +/- RW Drive

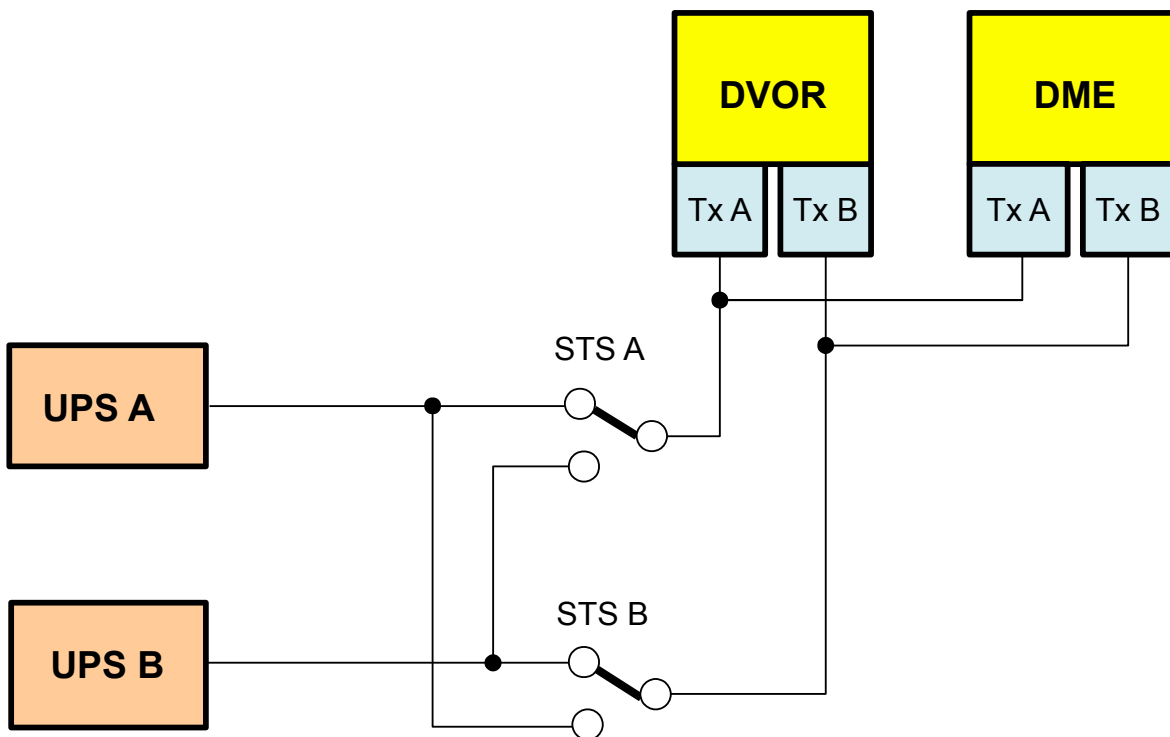
- 12.5 Graphic Controller
  - Minimum graphic card memory 512 MB GDDR 3
  - Support display resolution WXGA
- 12.6 Display
  - 14 inches LED
- 12.7 Internal Wireless LAN
  - Standards 802.11 b/g/n
- 12.8 Modem
  - Minimum speed 56 Kbps
- 12.9 Network Interface
  - 12.9.1 Built-in on board
  - 12.9.2 10/100/1000 Mbps
- 12.10 Audio Output
  - Sound output including built-in speakers
- 12.11 I/O Interfaces
  - 12.11.1 Three (3) ports USB 2.0
  - 12.11.2 One (1) VGA port, One (1) Serial port or One (1) converted device for converting USB to Serial
- 12.12 Keyboard
  - Each key shall be permanently printed with both Thai and English characters
- 12.13 Mouse
  - 12.13.1 Optical Mouse with scroll wheel
  - 12.13.2 USB interface
  - 12.13.3 A Suitable mouse pad
- 12.14 Pointing Device
  - Touch pad
- 12.15 Battery
  - Lithium Ion rechargeable
- 12.16 Operation System/ Software
  - 12.16.1 Shall be installed with the Notebook Computer
  - 12.16.2 Capable of operating with the software of the proposed DVOR/DME System

- 12.16.3 Recovery CD/DVD with a copy right shall be provided.
- 12.17 Compliant Standards  
FCC or UL or CSA or ETL
- 12.18 The Operating System and License which is capable of operating the DVOR/DME System shall be provided.
- 12.19 The Notebook Computer shall have a manufacturer branch office authorized representative in Thailand.
- 12.20 The manufacture of the Notebook Computer shall receive ISO 9000 Series Certification.  
Operating Manual and software driver CD or DVD shall be provided with the product.
- 12.21 One (1) 14 inches Notebook carrying case shall be provided with the Notebook Computer.
- 12.22 Maximum weight 2.5 Kilogram including battery.
- 12.23 The Seller shall provide the two (2) years Manufacturer warranty for the Notebook Computer which starts from the completion of the fifth payment date according to the term of payment stipulated in non-technical term of reference.

13. INTERSYSTEM CONNECTION AND COMMUNICATION DIAGRAM



14. CONCEPTUAL DIAGRAM OF FULL UPS CONFIGURATION



**APPENDIX A: LIST OF ABBREVIATIONS**

Abbreviations	Full Name
°C	Degree Celsius
AC	Alternating Current
AEROTHAI	Aeronautical Radio of Thailand Ltd.
CCMS	Central Control and Monitoring System
cms	Centimeters
CW	Continuous Wave
dB	Decibel
DDM	Difference in Depth of Modulation
DME	Distance Measuring Equipment
DVOR	Doppler Very High Frequency Omnidirectional Range
EMMC	Electrical Monitoring and Management Center
FAA	Federal Aviation Administration
GHz	Giga Hertz
GS	Glide Slope
Hz	Hertz
HDPE	High Density Polyethylene
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
ILS	Instrument Landing System
Imax	Maximum Discharge Current
Intl	International
KVA	Kilo Volt Amp



<b>Abbreviations</b>	<b>Full Name</b>
Kms	Kilometers
KHz	Kilo Hertz
MHz	Mega Hertz
MTBF	Mean Time Between Failure
MTBO	Mean Time Between Outage
mph	Mile per hour
$\mu$ s	Microsecond
PABX	Private Automatic Branch Exchange
PCB	Printed Circuit Board
PMDT	Portable Maintenance Data Terminal
PNSA	Portable Navigational Signal Analyzer
PVNA	Portable Vector Network Analyzer
RCMS	Remote Control and Monitoring System
RCSU	Remote Control and Status Unit
RF	Radio Frequency
RSC	Ring Stiffness Constant
RSU	Remote Status Unit
RMM	Remote Monitoring and Maintenance
SNMP	Simple Network Management Protocol.
SDM	Sum in Depth of Modulation
STS	Static Transfer Switch or one (1) Source Transfer Switch
Uc	Maximum Continuous Operating Voltage

**Project Name**

DVOR/DME for Chumphon Airport, Mae Sot Airport,  
Buri Ram Airport and Krabi Airport

**Date**

Feb 29, 2016

**Version 1.1**

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Abbreviations	Full Name
Up	Voltage Protection Level
UHF	Ultra High Frequency
UPS	Uninterrupted Power Supply
USB	Universal Serial Bus
VAC	Voltage of Alternating Current
VOR	Very high frequency Omnidirectional Range

**APPENDIX B: TOOLS AND MAINTENANCE AIDS**

Tool	Functions at minimum
<ul style="list-style-type: none"> <li>- Digital Multimeter</li> </ul>	<ul style="list-style-type: none"> <li>- True RMS voltage and current measurements</li> <li>- 6000 count resolution</li> <li>- Digital Display with analog bar graph</li> <li>- Manual and automatic ranging</li> <li>- DC basic Accuracy <math>\pm 0.15\%</math>.</li> </ul>
<ul style="list-style-type: none"> <li>- Waveform analysis</li> </ul>	<ul style="list-style-type: none"> <li>- Band Width <math>\geq 300</math> MHz</li> <li>- Input Channel 4 channel</li> <li>- LCD Color display</li> <li>- Sample rate on each channel <math>\geq 2</math> Giga Sampling/sec.</li> <li>- Vertical resolution 8 bits or better.</li> <li>- Time base accuracy <math>\pm 20</math> part/million (ppm) or better.</li> </ul>
<ul style="list-style-type: none"> <li>- RF Power analysis</li> </ul>	<ul style="list-style-type: none"> <li>- Frequency: 9KHz to 110 GHz or better</li> <li>- Power : <math>\geq 63</math> dBW</li> <li>- Reads forward and reflected CW or FM power in watts or dBm</li> <li>- Calculates SWR, return loss in dB and modulation</li> </ul>
<ul style="list-style-type: none"> <li>- Thruline Wattmeter with element</li> </ul>	<ul style="list-style-type: none"> <li>- Frequency band VHF 50-125 MHz or better</li> <li>- 100 milliwatts, 250 milliwatts, 1 watt, 25 watts, 50 watts, 100 watts.</li> <li>- Frequency band UHF 328-336 MHz or better</li> <li>- 100 milliwatts, 250 milliwatts, 1 watt, 5 watts.</li> </ul>
<ul style="list-style-type: none"> <li>- Tool kits</li> </ul>	<ul style="list-style-type: none"> <li>- Alignment tools (2)</li> <li>- Bumisher (pkg./3)</li> <li>- DIP/IC extractor</li> <li>- Feeler gauge</li> <li>- File kit, (3 pc.)</li> </ul>

Tool	Functions at minimum
<ul style="list-style-type: none"> <li>- Tool kits (continuous)</li> </ul>	<ul style="list-style-type: none"> <li>- Hammer, ball peen, 4 oz.</li> <li>- Handle, driver blades (2):4-1/8", "T"</li> <li>- Handle, File</li> <li>- Hemostat, straight, 5"</li> <li>- Hexdriver blades (9): .050, 1/16, 5/64, 3/32, 7/64, 1/8, 9/64, 5/32, 3/16"</li> <li>- Hex key set, (10 pc.)</li> <li>- Hex key fold up (7): 2-8 mm</li> <li>- Knife precision</li> <li>- Knife blades</li> <li>- Mirror, inspection</li> <li>- Nutdriver blades (9): 3/16, 7/32, 1/4, 9/32, 5/16, 11/32, 3/8, 7/16, 1/2"</li> <li>- Outlet tester</li> <li>- Parts box</li> <li>- Penlight</li> <li>- Pliers (7): diag. cutter 4-1/4"; diag. cutter 5-1/4"; groove joint 7"; groove joint 10"; long nose 4-3/4"; long nose with cutter 6-3/4"; retaining ring, external</li> <li>- Pliers, locking, 5"</li> <li>- Punch, center, 3/32"</li> <li>- Punch, pin,(2): 1/16, 1/8"</li> <li>- Rule, stainless, 6"</li> <li>- Scissors, electrician 's</li> <li>- Screwdrivers (12) : Phillips offset ratchet, #0 x 3" pocket clip, #1 x 3", #2 stubby, #2 x 4"; slotted offset ratchet, 1/8 x 3" pocket clip, 1/8 x 8", 3/16 x 3", 1/4" stubby, 1/4 x 4", 5/16 x 6"</li> <li>- Screwdrivers set, jeweler's, (7 pc.)</li> </ul>

- Tool kits (continuous)	- Screwstarter (2): Phillips magnetic; slotted magnetic - Scriber - Solder aid, fork and reamer - Solder aid, knife and brush - Solder removal tool - Soldering iron - Spring tool combination - Tape measure, 12' - Trimpot tool - Tweezer, reverse action - Wire crimper/stripper - Wire stripper/cutter - Wrench, adjustable, 6" - Tool case with pallets
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