

Project Name

Date

Procurement for 6 systems of DVOR/DME

February 20, 2018

And 3 DME Systems for PBN Infrastructure.

Version 1.0

SCOPE OF SPECIFICATION

1. TECHNICAL SPECIFICATIONS
2. COUNTERPOISE AND GROUNDING SYSTEM REQUIRMENTS
3. ANTENNA MAST FOR DME AND CIVIL WORK REQUIRMENTS

Project Name

Date

Procurement for 6 systems of DVOR/DME

February 20, 2018

And 3 DME Systems for PBN Infrastructure.

Version 1.0

SECTION 1

TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

	Page
1. DEFINITIONS	1
2. GENERAL REQUIREMENTS	2
3. DOPPLER VHF OMNI RANGE (DVOR) EQUIPMENT	5
4. DISTANCE MEASURING EQUIPMENT (DME)	9
5. CONTROL AND MONITORING	12
6. INTERSYSTEM CONNECTION	15
7. SUPPLEMENTS	16
8. TOOLS FOR SETTING UP AND SITE ACCEPTANCE TEST	17
9. TECHNICAL DOCUMENTS AND TEST REPORTS	17
10. UNINTERRUPTED POWER AND STATIC TRANSFER SWITCH (UPS & STS)	18
11. DESKTOP COMPUTER	23
12. CONCEPTUAL DIAGRAM OF INTERSYSTEM CONNECTION AND COMMUNICATION	25
13. CONCEPTUAL DIAGRAM OF POWER SUPPLY CONFIGURATION	27
APPENDIX A: LIST OF ABBREVIATIONS	28
APPENDIX B: Figure C-20 of ANNEX 10/Vol. I/Attachment C/Paragraph 7.2.1	30
APPENDIX C: Location	31

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.
Proposal	The response to the requirement specified in Scope of Specifications.
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.
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.
ICAO Annex 10 Vol. I	Aeronautical Telecommunications: Volume I Radio Navigation Aids. Sixth Edition, July 2006, Amendments 90.
ICAO Annex 14 Vol. I	Aerodromes: Volume I Aerodrome Design and Operations. Seventh Edition, July 2016, Amendments 1-13-A.
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.

2.	GENERAL REQUIREMENTS [E]	
2.1	The Project consists of DVOR/DME systems and DME Systems for PBN Infrastructure as the following:	
2.1.1	Six (6) DVOR/DME Systems shall be installed to replace the current system at Lampang Airport, Narathiwat Airport, Phetchabun Airport, Roi Et Airport, Nakhon Si Thammarat Airport and Surat Thani Airport;	
2.1.2	Three (3) DME systems for PBN Infrastructure are required for a new installation at Sukhothai Airport, Tak Airport and Prachinburi Station.	
2.2	The DVOR/DME Systems 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/N Equipment;	
2.2.3	Antenna Systems for the above equipment;	
2.2.4	Local Control and Status Equipment of DVOR and DME include its local computer at DVOR/DME station, as specified in [5.1].	
2.2.5	Remote Status Unit (RSU) for the above equipment specified in 2.2.1-2.2.3 which shall be equipped at Control Tower; as specified in [5.4].	
2.2.6	Remote Control and Status Unit (RCSU) for the above equipment specified in 2.2.1-2.2.3 which shall be equipped at Technical Control Room; as specified in [5.3].	
2.2.7	Remote Maintenance and Monitoring (RMM) Equipment (Computer) for the above equipment specified in 2.2.1-2.2.3 which shall be equipped at Technical Control Room, as specified in [5.5].	
2.3	The DME systems for PBN Infrastructure shall consist of :	
2.3.1	Dual DME/N Equipment;	
2.3.2	Antenna system for above equipment;	
2.3.3	Local Control and Status Equipment of DME (typically embedded in the DME equipment) and its local computer at DME station, as specified in [5.1];	
2.3.4	Remote Status Unit (RSU) of DME shall be equipped at Control Tower, as specified in [5.4];	
2.3.5	Remote Control and Status Unit (RCSU) of DME at the Technical Control Room , as specified in [5.3];	
2.3.6	Remote Maintenance and Monitoring (RMM) Equipment (Computer) of DME at the technical control room of ATC tower, as specified in [5.5].	

2.4	The DVOR/DME systems and DME systems for PBN Infrastructure shall have SNMP management capability are specified in clause 6.
2.5	The system performance and its signal-in-space quality shall at least comply with the ICAO Annex 10 Vol. I.
2.6	All RF Generators shall be synthesizers.
2.7	The equipment shall be the modular design, or an easy plug-in card or modules for quick replacement with the purpose for easy maintenance and repair.
2.8	The dual independent transmitters shall be housed in the cabinet(s) and operated as main and standby facilities. Maintenance on one equipment shall be accomplished without disruption the operation of the others.
2.9	The equipment shall be designed in common of modules and printed circuit boards.
2.10	The MTBO of each system shall be greater than 10,000 hours. The Tenderers shall submit reliability analysis (MTBF, MTBO) in the Proposal.
2.11	The DME equipment shall be installed in co-location with the DVOR equipment and shall be conformed to DME-DME operation.
2.12	Each Line Replaceable Units (LRU) of DVOR/DME Equipment shall be easily exchangeable.
2.13	Indoor equipment shall be designed for continuous operation <u>at least</u> under the ambient temperature range of 0 °C to +50 °C with a relative humidity of up to 95%. Outdoor equipment shall be designed for continuous operation <u>at least</u> under the temperature range of -40 °C to +60 °C with a relative humidity of up to 100%, up to 100 mph (160 Km/h) wind velocity. 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.
2.14	AC/DC power lines, transmission lines, control lines, test cables and all relevant accessories shall be as follows:
2.14.1	All AC/DC power lines, transmission lines, control lines and relevant accessories (e.g. connectors, cable trays, conduits and cable ties) shall be provided by the contractor. The transmission line shall be the rodent protection type. If the installation work involves buried cables, they shall be “underground-type” and fitted in HDPE or RSC pipes which the inner diameter shall be wide enough for fitting all cables easily;
2.14.2	All transmission lines shall be laid in a different pipe separated from that of AC power lines;

Project NameProcurement for 6 systems of DVOR/DME
and 3 DME Systems for PBN Infrastructure.**Date**

February 20, 2018

Version 1.0

	2.14.3	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;
	2.14.4	All known power and control lines (or else cable routes) leading to the facility shall be marked out by the contractor;
	2.14.5	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;
	2.14.6	All relevant accessories necessary for initial set up, maintenance, or else system calibration (Both transmitter and monitor calibration) shall be provided;
	2.14.7	The Contractor shall take all responsible precautions to protect existing underground equipment and utilities;
	2.14.8	The Contractor shall supply all external RF connectors complied with IEC61169-16 or equivalent.
	2.15	Power supply
	2.15.1	The DVOR/DME System and DME systems for PBN Infrastructure including all peripheral equipment shall be operated with 220 VAC $\pm 15\%$, 50 Hz $\pm 5\%$ single phase or better.
	2.15.2	The UPS & STS for the DVOR/DME System and DME systems for PBN Infrastructure shall be provided and shall be installed at each site. (Refer to diagrams in clause 13.)
	2.15.3	Power supply module for DVOR and DME equipment shall be individually supplied.
	2.16	Lightning protection, surge protection and grounding system shall be as follows.
	2.16.1	All above system must be complied with IEC-62305 international standard or equivalent.
	2.16.2	The tenderer shall provide or detail the interconnection diagram of complete protection system in the proposal.
	2.16.3	The lightning protection system shall adequately protect all of the DVOR/DME and peripheral equipment in the event of a lightning strike.
	2.16.4	The surge protection for all Telecom line shall be provided.
	2.16.5	The surge protection system shall be provided to all Power line. Each unit of Arrestor shall also be embedded with an indicator to alarm when damage/ failure occur.

	2.16.6	The power surge protection shall meet the following specifications:	
		2.16.6.1	Maximum Continuous Operating Voltage (Uc) at least 320 VAC;
		2.16.6.2	Voltage Protection Level (Up) less than 1.5 kV;
		2.16.6.3	Maximum Discharge Current (Imax) (8/20 μ s) at least 100 kA.
	2.16.7	The Contractor shall supply RF Coaxial cable surge protection for VOR band and DME band complied with IEC-62305 or equivalent.	
	2.17	The total resistance of the grounding system shall not exceed 5 Ω .	
	2.18	The backup battery with charger unit for DVOR/DME equipment shall also be included in the power supply system. Note that, this equipment is not the same part as backup battery used for supporting the UPS system.	
	2.19	The backup battery shall have sufficient capacity to enable to operate at least Three (3) 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 ± 1 degree on ground measurement.
		3.1.2	Azimuth stability shall be better than ± 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 - 114.7 MHz for Lampang Airport - 116.3 MHz for Narathiwat Airport - 115.4 MHz for Phetchabun Airport - 111.2 MHz for Roi Et Airport - 117.4 MHz for Nakhon Si Thammarat Airport - 110.6 MHz for Surat Thani 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 Hz \pm 0.2%
	3.3.6.2	Modulation depth	- 30% (adjustable)
	3.3.6.3	Identification frequency	- 1020 Hz \pm 50 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	Thru-lines (line sections) with plug-in elements shall be equipped at each RF power output of the transmitters. One (1) RF Wattmeter shall be provided for RF power reading. 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	Thru-lines (line sections) with plug-in elements shall be equipped at each RF power output of the transmitters. One (1) set of RF Wattmeter shall be provided for RF power reading. 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 ± 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		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:
		3.5.8.1	The bearing information;
		3.5.8.2	Reference signal 30 Hz modulation depth;
		3.5.8.3	Sub-carrier 9960 Hz modulation depth;
		3.5.8.4	Sub-carrier 9960 Hz deviation ratio;
		3.5.8.5	Identification;
		3.5.8.6	Forward and reflected power or standing wave ratio.
	3.5.9		Alarm delay shall be adjustable.

	3.5.10	Alarm history shall be provided to identify the parameter that has deviated beyond the alarm limit and caused the alarm.
	3.5.11	The field Monitor (including the Monitor antenna, the Antenna mast, transmission lines with RF surge protection, obstruction lighting) 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 equipment with photo-switch shall be installed at Near-field monitor's antenna. The LED obstruction lighting equipment shall conform with 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.
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	DVOR/DME systems - CH 94X for Lampang Airport - CH 110X for Narathiwat Airport - CH 101X for Phetchabun Airport - CH 49X for Roi Et Airport - CH 121X for Nakhon Si Thammarat Airport - CH 43X for Surat Thani Airport DME System for PBN Infrastructure - CH100X for Sukhothai Airport - CH47x for Tak Airport - CH110x for Prachinburi Station
	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. and 3.5.5.1.3
		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 constituent pulses of any pair of pulses 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 power amplifier of the transponder shall provide full peak output power of <u>not less than 1000 watts</u> to the antenna.

		4.2.3.7	DME equipment shall provide/embed the coupling port for measuring peak output power <u>without</u> shutdown/turn OFF the equipment.
		4.2.3.8	Long distance echo suppressor shall be provided by automatic receiver gain reduction according to each echo pulse level.
		4.2.3.9	The minimum transmission rate shall be as close as practicable to 700 PPS.
		4.2.3.10	The maximum transmission rate shall be at least 4800 PPS.
		4.2.3.11	Identification shall meet the requirements specified in ICAO Annex 10 Vol. I Paragraph 3.5.3.6 for association with the DVOR identification.
		4.2.4	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	Interrogation pulse pairs with correct spacing and nominal frequency shall trigger the transponder if the peak power density at the transponder antenna is at least -103 dBW/m ² and this value cause the transponder to reply with an efficiency of at least 70% complies with in ICAO Annex 10 Vol. I Paragraph 3.5.4.2.3.1, 3.5.4.2.3.2, 3.5.4.2.3.5 and 3.5.5.3.2.1.
		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.
		4.2.4.5	DME/N-Decoder rejection. An interrogation pulse pair with a spacing of ± 2 μ s or more, from the nominal value, shall be rejected and meet the requirements specified in ICAO Annex 10 Vol. I Paragraph 3.5.4.3.3
		4.2.4.6	Receiver dead time shall be adjustable for echo suppression as measured after main delay time.
		4.2.5	Time Delay
		4.2.5.1	The time delay shall meet the requirements specified for DME/N in ICAO Annex 10 Vol. I Paragraph 3.5.4.4.
		4.2.5.2	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 ± 0.5 microsecond;
	4.3.2.2	Transmitting pulse spacing error exceed ± 1 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 ± 200 kHz and ± 900 kHz of the transponder receiver can be tested.
	4.3.9	Test signal generator (interrogation) output level shall be adjustable at least from -91 dBm to -20 dBm at the transponder antenna connector.
	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 (refer to 5.2.4. and 5.2.5)
	4.4	DME Antenna System	
		4.4.1	The radiation patterns of the Antenna System shall be submitted with the Tender. For the horizontal radiation pattern, the antenna shall be Omni-directional type. For the vertical radiation pattern, The antenna main lobe shall be maximum at three (3) degrees (see Figure C-20 of [ANNEX 10 / Vol. I / Attachment C / Paragraph 7.2.1]) in Appendix B.
		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 gain shall <u>not</u> be less than +9 dBi.
		4.4.4	Double LED obstruction lighting equipment with photo-switch shall be installed with the antenna. The LED obstruction lighting equipment shall conform to 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 (LCU)	
		5.1.1	The DVOR equipment shall be able to operate on local or remote control. It shall have at least the following control and monitoring functions:
		5.1.1.1	Selecting the main;
		5.1.1.2	Turning on/off transmitter;
		5.1.1.3	Turning on/off the standby transmitter into dummy loads for testing purposes;
		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;
		5.1.1.8	Bypassing the monitor.
	5.1.2	The DVOR Local Control Unit shall automatically transfer from the selected antenna to a standby antenna and/or shut down in the event of an alarm.	
	5.1.3	Reset function shall be provided to clear fault condition (s) and restart normal operation.	
	5.1.4	Six (6) 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.	
	5.1.5	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 (LCU)	
	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/off transponder;
		5.2.1.3	Turning on/off the standby transponder into dummy loads for testing purposes;
		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;
		5.2.1.8	Bypassing the monitor.
	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	Reset function shall be provided to clear fault condition (s) and restart normal operation.	
	5.2.4	Six (6) sets of Desktop Computer for DVOR/DME systems 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.	

	5.2.5	Three (3) sets of Desktop Computer for DME systems shall be provided as part of the Local Control Unit for DME. The Desktop Computer Specifications are specified in clause 11.
	5.2.6	The software for monitoring and controlling the DME equipment shall be installed in the Desktop Computer. The recovery 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	The DVOR/DME 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	The DVOR/DME RCSU shall be connected via land line or the Microwave link (provided by the AEROTHAI).
	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 in case of DVOR/DME system;
	5.4.2.2	Display the operating status of the DME in case of DME system for PBN Infrastructure;
	5.4.2.3	Visual and audible alarm with an alarm silence control;
	5.4.2.4	Turn on/off switch for the status indicator.
	5.5	Remote Monitoring and Maintenance Equipment (RMM)
	5.5.1	The RMM Equipment shall monitor and control equipment by TCP/IP or better.
	5.5.2	The RMM Equipment shall have at least the following functions for each equipment:
	5.5.2.1	Selecting the main transmitter/transponder;
	5.5.2.2	Turning on/off transmitters/transponders;
	5.5.2.3	Turning on the standby transmitter/transponder into dummy loads for testing purposes;

		5.5.2.4	Bypassing the monitor;
		5.5.2.5	Resetting the alarm;
		5.5.2.6	Shutting down the station;
		5.5.2.7	Adjusting and displaying transmitter/transponder and monitor parameters.
	5.5.3	The RMM Equipment shall be interfaced to DVOR/DME station via land line or TCP/IP network with the Microwave link (provided by AEROTHAI).	
	5.5.4	The communication for the RMM must be separated from that for the RCSU for redundancy propose.	
	5.5.5	The RMM Equipment shall be performed by Desktop Computer.	
	5.5.6	Six (6) sets of Desktop Computer shall be provided as part of the DVOR/DME RMM. The Desktop Computer Specifications are specified in clause 11.	
	5.5.7	Three (3) sets of Desktop Computer shall be provided as part of the DME systems for PBN Infrastructure RMM. The Desktop Computer Specifications are specified in clause 11.	
	5.5.7	The RMM Equipment software for remote monitoring and controlling the DVOR/DME equipment from anywhere shall be installed in the Desktop Computer. The recovery CD/DVD or any portable data storage devices for the RMM software shall be provided. The user's license for the software shall be provided for AEROTHAI.	

6.	INTERSYSTEM CONNECTION		
6.1	The DVOR/DME System, DME for PBN Infrastructure and UPS systems shall be connected with RCSU and RCMS (Provided by the contractor), CCMS and EMMC (provided by AEROTHAI) to send update information.		
6.2	The DVOR/DME, DME for PBN Infrastructure and UPS & STS system operation status shall be updated by Simple Network Management Protocol (SNMP) over Ethernet port.		
6.3	The Tenderer shall provide and detail the DVOR/DME/UPS&STS – 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.		
6.6	The Contractor shall provide a list of all necessary standards documents and Interface Control Documents (ICDs) with regards to the DVOR/DME/UPS&STS – RCMS, CCMS and EMMC information exchange.		

7.	SUPPLEMENTS		
7.1	Portable Navigational Signal Analyzer (PNSA) [E]		

	7.1.1	Six (6) 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 e.g. 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	PNSA shall be provided with the Interface Control Document (ICD) for extracting or decoding the real time measurement data.
	7.1.8	Battery charger shall be operated on 220 VAC $\pm 15\%$, 50 Hz $\pm 5\%$ single phase or better.
	7.2	DVOR Spare Parts
	7.2.1	Six (6) sets of DVOR spare parts shall be provided.
	7.2.2	The DVOR spare parts in 7.2.1 shall consist of one complete unit which is under single system configuration. The one complete unit shall consist of line replaceable module (LRM), printed circuit boards (PCBs), backplanes and RF switches (Coaxial relays), RF distribution units.
	7.3	DME Spare Parts
	7.3.1	Nine (9) sets of DME spare parts shall be provided.
	7.3.2	The DME spare parts in 7.3.1 shall consist of one complete unit which is under single system configuration. The one complete unit shall consist of line replaceable module (LRM), printed circuit boards (PCBs), backplanes and RF switches (Coaxial relays).
	7.4	RCSU and RSU Spare Parts
	7.4.1	Six (6) sets of RCSU and RSU spare parts for DVOR/DME systems shall be provided.

	7.4.2	Three (3) sets of RCSU and RSU spare parts for DME systems for PBN Infrastructure shall be provided.
	7.5	Double LED obstruction lighting Spare Parts (in clause 3.5.12 and 4.4.4)
	7.5.1	Twelve (12) sets of Double LED obstruction lighting equipment for DVOR/DME systems shall be provided as spare parts.
	7.5.2	Three (3) sets of Double LED obstruction lighting equipment for DME systems for PBN Infrastructure shall be provided as spare parts.
	7.6	The contractor shall provide manufacturer's certification for availability of spare parts for ten year from the expiration of the warranty period.

8. TOOLS FOR SETTING UP AND SITE ACCEPTANCE TEST		
	8.1	The contractor shall provide at least waveform analysis tools, thru-line wattmeter, digital multi-meter, portable RF power analysis, frequency counter and additional tools that complies with manufacturer recommendation for DVOR/DME system and DME systems for PBN Infrastructure installation and hardware adjustment. The contractor shall provide list of recommend installation tools from manufacturer.
	8.2	Extension cards and cables as required for each module/ PCB of the DVOR and DME shall be provided for maintenance.
	8.3	Test cables, dummy loads, RF adapter kits and attenuation kits for transmitter calibration and flight inspection shall be provided.
	8.4	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:		
DVOR/DME systems:		
	9.1	Six (6) sets for hard copy and seven (7) DVD sets for mechanical and electrical DVOR/DME drawings and whole network diagrams 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	Seven (7) sets for hard copy and eight (8) sets for 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	Seven (7) sets of hard copy and 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 propose 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 Six (6) hard copies of Factory Acceptance Test (FAT) report shall be provided at the factory after the completion of FAT.
9.5	Six (6) original and Seven (7) sets hard copies of Site Acceptance Test (SAT) report shall be provided at the site after the completion of the commissioning flight check.
DME Systems for PBN Infrastructure	
9.6	Three (3) sets for hard copy and Four (4) DVD sets for mechanical and electrical DME system drawings and whole network diagrams 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;
9.7	Four (4) sets for hard copy and Five (5) sets for DVD, of DME system 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;
9.8	Four (4) sets of hard copy and DVD for DME system 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 propose of comparing for the generic devices with electronic component in the market in order to repair the LRMs after the warranty period.
9.9	One (1) original and Three (3) hard copies of Factory Acceptance Test (FAT) report shall be provided at the factory after the completion of FAT.
9.10	Three (3) original and Four (4) sets 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 AND STATIC TRANSFER SWITCH (UPS & STS)	
10.1	General Requirements
10.1.1	At minimum, the full UPS configuration shall consists of the components as depicted in the clause 13.
10.1.2	Two (2) sets of UPS Equipment for each site shall be provided.
10.1.3	Two (2) sets of STS Equipment for each site shall be provided.

	10.1.4	Each set of UPS equipment, alone, shall provide enough electric power capacity for all equipments 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 equipment.
	10.1.6	The Tenderer shall propose and detail the connection between UPS to equipment in the clause 13.
	10.1.7	The Tenderer shall propose the list of UPS equipment and related components.
	10.1.8	The Contractor shall be responsible to demonstrate a complete full load field test.
	10.1.9	The Contractor shall be responsible to demonstrate that the UPS system compatible with AEROTHAI emergency backup generator.
	10.1.10	The Contractor shall provide, install, and test a complete and operable UPS system in specified locations.
	10.1.11	The STS shall connect to both sets of UPS equipment to receive electric power supply as depicted in the clause 13.
	10.1.12	The STS shall automatically select electric power from available UPS to equipments in the condition that one of UPS is dysfunctional.
	10.1.13	The Tenderer shall provide product description/Technical Characteristics of UPS systems and other related components.
	10.1.14	All UPS & STS equipment shall be new and factory tested.
	10.1.15	The contractor shall provide Five (5) years warranty to each UPS & STS equipment which starts from the completion of the <u>each sites final payment date</u> according to the term of payment stipulated in Non-technical term of reference.
	10.1.16	The contractor shall provide scheduled check and maintenance every 3 months during warranty period.
	10.1.17	The contractor shall provide <u>complete batteries replacement</u> including removal of old batteries and new battery installation at the end of 4 th warranty year.
	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 system 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 system at DVOR/DME station to the 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. The RCMS shall be performed by Desktop Computer (specified in clause 11).
	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 Tenderers 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 RCMS, CCMS and EMMC) to AEROTHAI network at Technical Control Room as depicted in the clause 12.
	10.2.16	The UPS & STS System at DVOR/DME site shall be connected via land line and outdoor microwave link (provided by the AEROTHAI) as specified in clause 12.
	10.2.17	Protection shall be provided against damage of semiconductors due to the battery polarity being inadvertently reversed.
	10.2.18	The battery charger shall be capable of charging batteries which are completely discharged.

	10.2.19	The battery shall be continuously float charged.	
	10.3	Technical Specification of UPS	
	10.3.1	Input	
		10.3.1.1	Voltage (Vrms) : 230 VAC \pm 10% or better
		10.3.1.2	Frequency : 50 Hz \pm 2% or better
		10.3.1.3	Phase : Single (2 Wire + GND)
		10.3.1.4	THD : \leq 10 % or better at full Load (Total harmonics distortion)
	10.3.2	Output	
		10.3.2.1	Voltage (Vrms) : 230 VAC \pm 1% or better for both Normal and Battery Mode
		10.3.2.2	Frequency : 50 Hz \pm 0.5% or better
		10.3.2.3	Number of Phase : Single (2 Wire + GND)
		10.3.2.4	Wave Form : Sine wave
		10.3.2.5	THD : \leq 3 % for 100% linear load (Total harmonics distortion)
		10.3.2.6	Power Factor : 0.8 lag or better
		10.3.2.7	AC to AC- Overall efficiency : \geq 85% at full load
		10.3.2.8	Crest factor : 3:1 or better
	10.3.3	Overload capacity 110% Load	: 2 Minutes or better
	10.3.4	Environment	
		10.3.4.1	Ambient temperature : 0°C to +40 °C (Continuous) or better
		10.3.4.2	Humidity : \geq 90% continuously with non-condensing
	10.3.5	Audible noise	: \leq 55 dB(A) at 1 meter
	10.3.6	Battery	
		10.3.6.1	Type : Maintenance-free sealed lead-acid
		10.3.6.2	Frame : Durable Polypropylene, ABS Resins or better
		10.3.6.3	Life time : 3 to 5 years at 25°C or better
		10.3.6.4	Back up time : \geq 15 minutes at full load of UPS
		10.3.6.5	Battery Standard : UL 94-V0 or compatible.
	10.3.7	Status and Control Indicator the capability, including but not limited to, shall be as follows:	

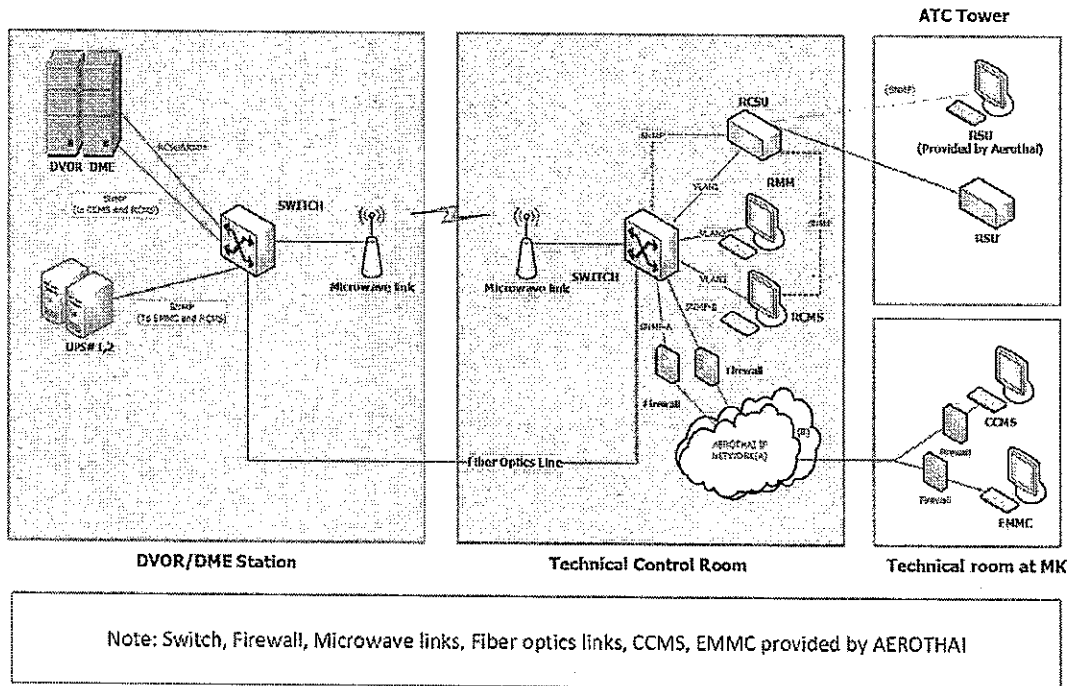
		10.3.7.1	Display status and parameters, line input, inverter, output, load on bypass, battery and fault;
		10.3.7.2	Provide visual and audible alarm when main fail, low battery and overload;
		10.3.7.3	Enable and disable alarm.
	10.3.8	UPS Standard	: มอก. 1291 เล่ม 1, 2-2553 มอก. 1291 เล่ม 3-2555
	10.4	Technical specification of STS	
	10.4.1	Input	
		10.4.1.1 Voltage (Vrms)	: 230 VAC \pm 10% (adjustable) or better
		10.4.1.2 Frequency	: 50 Hz \pm 2% or better
		10.4.1.3 Number of Phase	: Single (2 Wire + GND)
	10.4.2	Output	
		10.4.2.1 Voltage (Vrms)	: 230 VAC \pm 10% (adjustable) or better
		10.4.2.2 Rating	: \geq 5 kVA 32 A, \geq 10 kVA 45 A
		10.4.2.3 Overload Capacity (110%)	: 1 minute or better
		10.4.2.4 Transfer time	: \leq 5 ms for automatic transfer \leq 10 ms for manual transfer
		10.4.2.5 Efficiency	: \geq 95 %
	10.4.3	Environment	
		10.4.3.1 Operating Temperature	: 10 to 40 °C
		10.4.3.2 Relative Humidity	: non-condensed at least 90 %
		10.4.3.3 Noise Level	: \leq 60 dBA
	10.4.4	Communication port	: RS232 standard and TCP/IP
	10.4.5	Standard	: IEC 62310 series, EN 62310 series, or compatible.
	10.5	Load Center	
	10.5.1	Standard	: มอก. 1436-2540 or compatible
	10.6	Circuit Breakers	
	10.6.1	Standard	: IEC 60947 or compatible

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 are better than the following specifications.	
11.1	All components shall be produced from the same manufacturer with permanent logo/brand on products.
11.2	All in one computer
11.3	Processor/ Chip set
11.2.1	≥ 4 Core or ≥ 8 Thread
11.2.2	Base clock frequency ≥ 3.2 GHz
11.4	RAM
11.3.1	Technology – DDR3 or better
11.3.2	Capacity – ≥ 8 GB
11.5	One (1) Hard disk Drive
	SATA or better Capacity – ≥ 2.0 TB or Solid State Device ≥ 240 GB
11.6	One (1) Optical Disc Drive
	Internal DVD/RW Drive
11.7	Graphic Controller
	Built-in graphic or Dedicated graphic controller with ≥ 1 GB memory
11.8	One (1) Display
	≥ 19 inches LED with resolution 1920 x 1080 pixels
11.9	Networking
	10/100/1000 Mbps Ethernet
11.10	One (1) Keyboard and One (1) Mouse
	Each key shall be permanently printed with both Thai and English characters
11.11	Operation System/ Software
11.11.1	Shall be installed with the Desktop Computer
11.11.2	Capable of operating with the software of the proposed DVOR/DME System and DME Systems for PBN Infrastructure.
11.11.3	Recovery DVD with a copyright shall be provided
11.12	The operating system and license which is suitable for compute operating shall be provided.

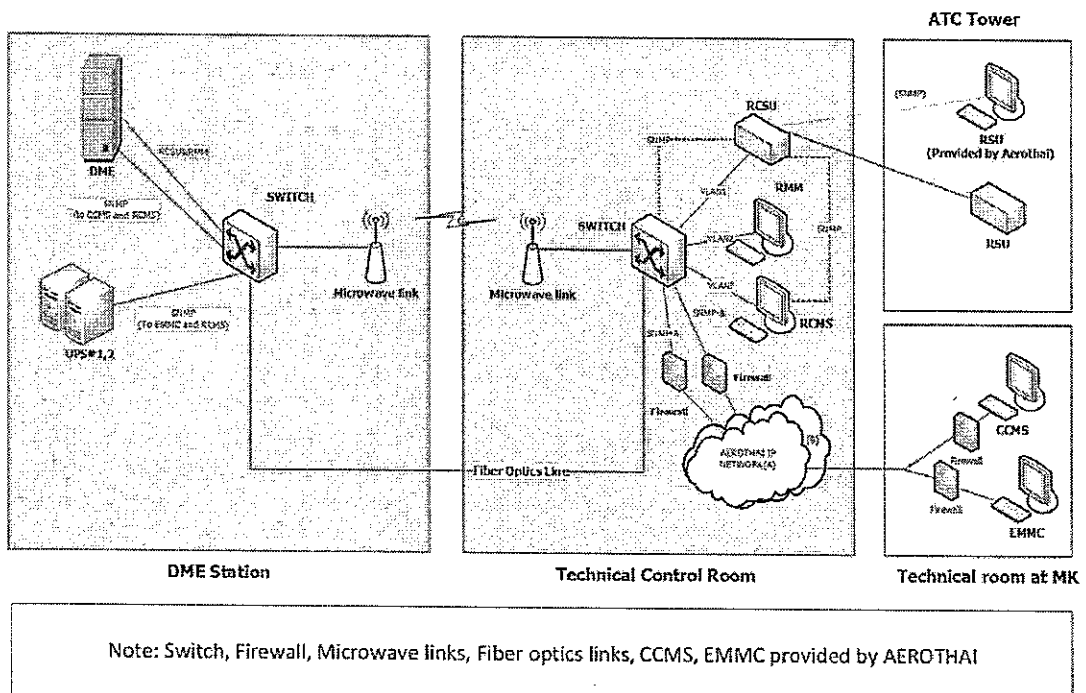
11.13	One (1) set of Office table and chair which is suitable for computer operation shall be provided.
11.14	The contractor shall provide to the Desktop Computer a two (2) years Manufacturer warranty which starts from the completion of the final payment date according to the term of payment stipulated in non-technical term of reference.
11.14	The Desktop Computer shall have a manufacturer branch office authorized representative in Thailand.
11.15	The DVD for software driver shall be provided with the product.

12. CONCEPTUAL DIAGRAM OF INTERSYSTEM CONNECTION AND COMMUNICATION

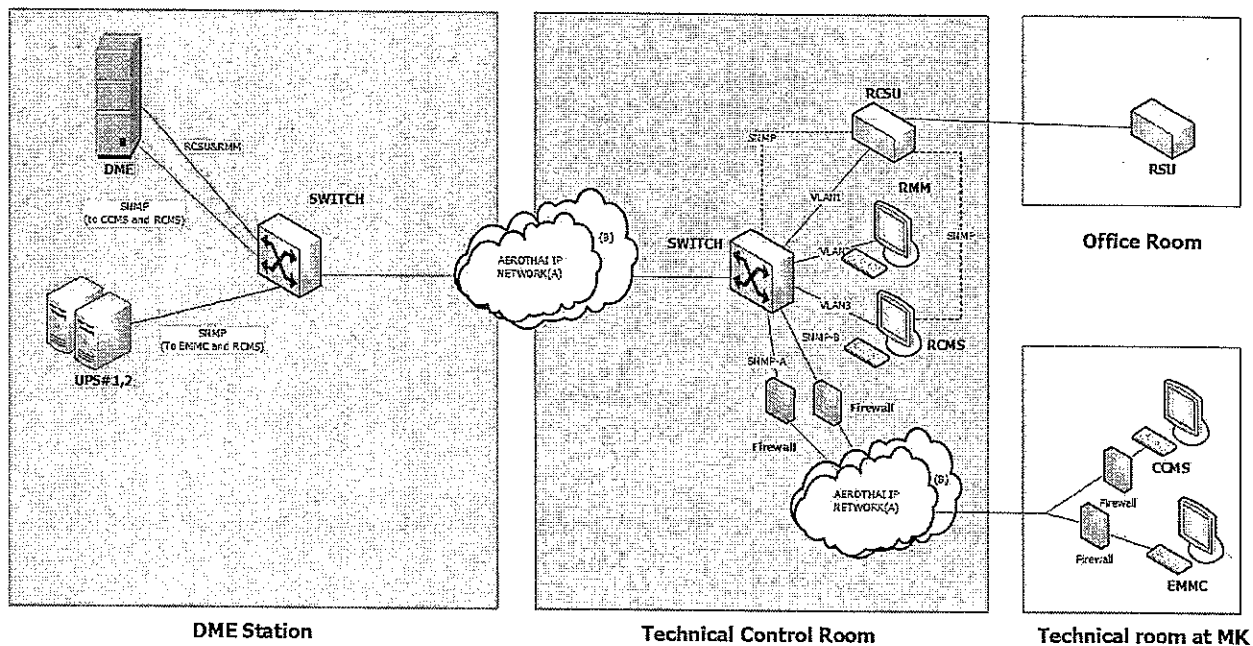
12.1 DVOR/DME Diagram



12.2 SUKHOTHAI and TAK DME Diagram



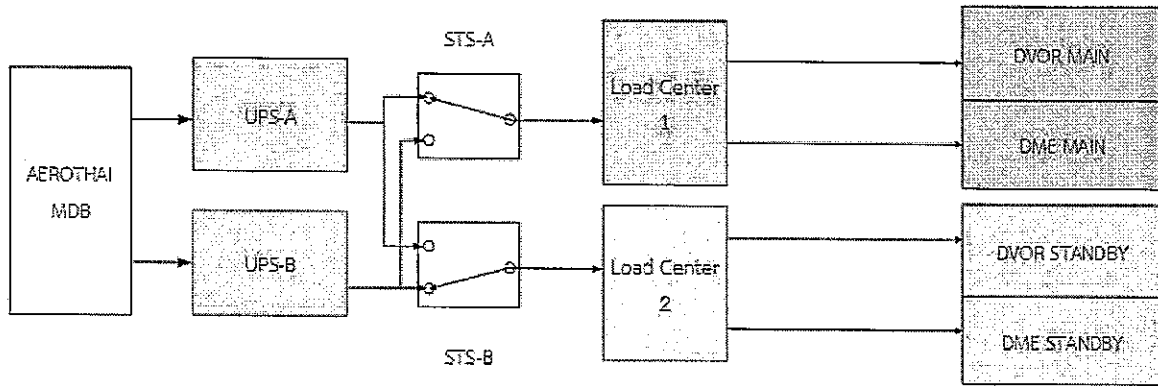
12.3 PRACHINBURI DME Diagram



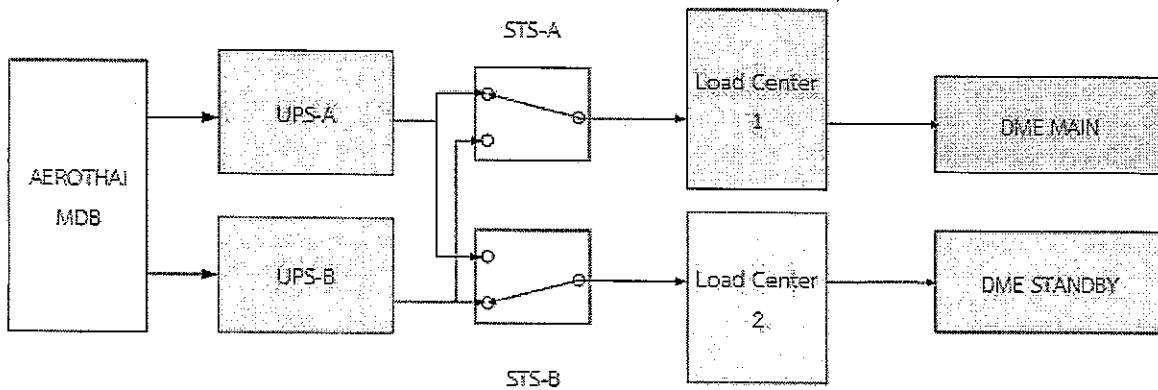
Note: Switch, Firewall, Microwave links, Fiber optics links, CCMS, EMMC provided by AEROTHAI

13. CONCEPTUAL DIAGRAM OF POWER SUPPLY CONFIGURATION

13.1 DVOR/DME UPS & STS Diagram



13.2 DME UPS & STS Diagram



Remark:

1. All UPSs are supplied with the electrical power from AEROTHAI MDB.
2. The specification of circuit breakers and all associated wires, provided by the contractor, must also be complied with the rate of the UPSs.
3. Figure above, is just a conceptual diagram, the real installation work may be adapted, depend on the personnel in charge; However, being still complied with the standard of ELECTRICAL AUTHORITY.

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
I _{max}	Maximum Discharge Current
Intl	International
kVA	Kilo Volt Amp
kms	Kilometers
kHz	Kilo Hertz
MHz	Mega Hertz
MTBF	Mean Time Between Failure
MTBO	Mean Time Between Outage
mph	Mile per hour
μs	Microsecond
PABX	Private Automatic Branch Exchange

Abbreviations	Full Name
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	Rigid Steel Conduit
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
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: Figure C-20 of [ANNEX 10 / Vol. I / Attachment C / Paragraph 7.2.1].

The protected coverage of DME/N shall be determined by using Figure C-20 of [ANNEX 10/ Vol. I / Attachment C/ Paragraph 7.2.1]. The propagation loss for paths without obstructions uses the IF-77 propagation model.

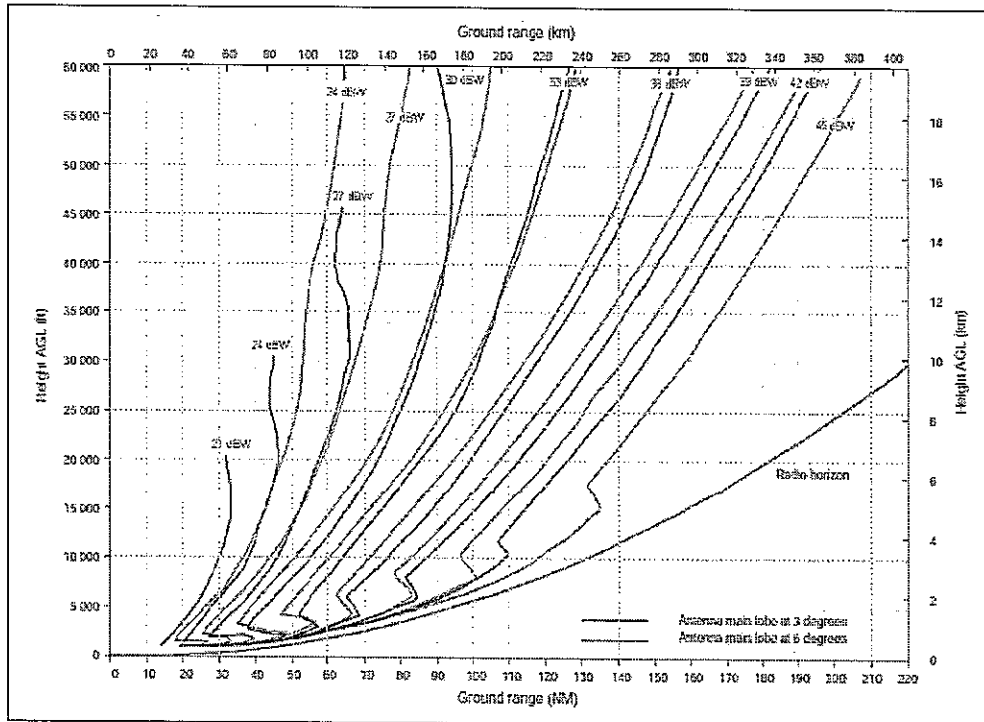


Figure C-20 of [ANNEX 10 / Vol. I / Attachment C / Paragraph 7.2.1]. Necessary EIRP of DME transponder to achieve a power density of -89 dBW/m^2 (at airborne receiver) as a function of height above and distance from the DME. The above figure is based on the following example,

1. Airborne receiver sensitivity : -120 dBW
2. Transmission line loss, mismatch loss, antenna polar pattern variation with respect to an isotropic antenna : $+9 \text{ dB}$
3. Antenna height : $+5 \text{ m (17 ft) AGL}$ over flat terrain
4. Power density required at antenna : -111 dBW

Remark: Minus 111 dBW at the antenna corresponds to minus 89 dBW/m^2 at the mid-band frequency.

APPENDIX C: Location

DVOR/DME	Location
- Lampang Airport	181635.87N 0993008.40E
- Narathiwat Airport	063138.24N 1014442.48E
- Phetchabun Airport	164033.66N 1011148.12E
- Roi Et Airport	160700.59N 1034619.45E
- Nakhon Si Thammarat Airport	083229.95N 0995648.67E
- Surat Thani Airport	093249.47N 1000342.27E
DME System for PBN Infrastructure	
- Sukhothai Airport	171408.28N 0994919.90E
- Tak Airport	165359.36N 0991506.27E
- Prachinburi Station	140707.29N 1012215.08E