SCOPE OF SPECIFICATIONS

1. TECHNICAL SPECIFICATIONS

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TOR OF DVOR/DME SYSTEMS FOR RADIO NAVIGATION AIDS

SECTION 1

TECHNICAL SPECIFICATIONS

In the event that the proposed technical specifications are inconsistent with the published technical specifications on the manufacturer's website, AEROTHAI reserves the right to adhere to the information on the website.

1. Definitions

[CO] In the specifications, 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.
Tenderer	The juristic person, firm, or company that offers to provide materials, or perform a service, or do a job for 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.
Proposal	The response to the requirement specified in Scope of Specifications.
ICAO Annex 10, Vol. I	Aeronautical Telecommunications : Volume I, Radio Navigation Aids. Eighth Edition, July 2023, Amendment 93.
ICAO Doc 8071, Vol. I	Manual on Testing of Radio Navigation Aids : Volume I, Testing of Ground-based Radio Navigation Systems, Fifth Edition – 2018.
ICAO Annex 14, Vol. I	Aerodromes : Volume I, Aerodrome Design and Operations, Eighth Edition, July 2018, Amendment 15.
FAA Order 6820.10	VOR, VOR/DME and VORTAC Siting Criteria, April 17, 1986.
[CO] Comply Only	This symbol indicates that the tenderer shall comply and implement accordingly, with no supporting evidence required at the time of Tender.
[ET] Evidence with Tender	This symbol indicates that the Tenderer must provide relevant supporting evidence with the tender.
[EC] Evidence at Contract Stage	This symbol indicates requirements for which the Contractor must submit supporting evidence for approval during contract execution. The Tenderer is only required to acknowledge these items; no submission is required at the tendering stage.

2. General Requirements

2.1 [CO]	Six (6) complete systems of DVOR/DME (Doppler VHF Omnidirectional Radio Range /Distance Measuring Equipment) are required at the following stations (see also APPENDIX A) :				
	Item	Station Name			
	2.1.1	LAMPANG Airport			
	2.1.2	NARATHIWAT Airport			
	2.1.3	PETCHABUN Airport			
	2.1.4	ROI ET Airport			
	2.1.5	NAKHON SI THAMMARAT Airport			
	2.1.6	SURAT THANI Airport			
2.2 [CO]	For each DVOR/DME system, the Tenderer shall propose the equipment, as follows :				
	2.2.1 [CO]	DVOR and DME equipment, including their respective antenna systems			
		2.2.1.1 [ET]	Doppler VHF Omnidirectional Radio Range (DVOR) equipment shall consist of dual transmitters and dual monitors, which shall be capable of transmitting at least 100 watts of power		
		2.2.1.2 [ET]	Distance Measuring Equipment (DME) shall consist of dual transponders and dual monitors.		
			2.2.1.2.1 [ET]	DME equipment shall be DME/N (Narrow Spectrum Characteristics).	
			2.2.1.2.2 [ET]	DME equipment shall be capable of transmitting at least 1000 watts of power – the so called *"high-powered"* DME.	
			2.2.1.2.3 [ET]	DME equipment shall be collocated with DVOR equipment. and, the identification of DME shall be synchronized with the identification of DVOR.	
	2.2.2 [CO]	Control and monitoring system, computers and network equipment are as specified in [5] [6] and [7], respectively.			
[CO]	The equipment shall be finalized and <u>not</u> in prototype form at the time the Tenderer submits the proposal.				
2.3 [CO]	The Contractor shall provide or renovate the DVOR/DME buildings and/or counterpoises, including complete works described in Section 2 : Construction Works.				
	Item	Station Name	DVOR/DME building	Counterpoise	
	2.3.1	LAMPANG Airport	Renovation	Renovation	
	2.3.2	NARATHIWAT Airport	Renovation	Renovation	
	2.3.3	PETCHABUN Airport	Renovation	Renovation	

	2.3.4	ROI ET Airport	Renovation	Renovation
	2.3.5	NAKHON SI THAMMARAT Airport	Renovation	Renovation
	2.3.6	SURAT THANI Airport	-	-
	Remark : The term "Renovation" indicates the stations where the Contractor shall renovate DVOR/DME buildings and/or counterpoise.			
2.4 [CO]	General requirements for DVOR and DME equipment.			
	2.4.1 [CO]	Power Supply System		
		2.4.1.1 [ET]	Each unit of DVOR and DME equipment shall be designed to operate on a single-phase AC power system with a nominal voltage and frequency used in Thailand (220 VAC / 50 Hz).	
		2.4.1.2 [ET]	Each unit of DVOR and DME equipment shall be equipped with dual "BUILT-IN" AC/DC power supply modules, so that no transmitter is shut down when a failure occurs in one of the AC/DC power supply modules.	
		2.4.1.3 [ET]	Each unit of DVOR and DME equipment shall be equipped with "BATTERY" backup which is capable of supporting equipment operation at least one (1) hour in the event of a main AC failure.	
	2.4.2 [ET]	*"Signal-in-space quality"* of DVOR/DME shall at least comply with [Doc 8071 / Vol. I / Chapter 2 / Table I-2-3] and [Doc 8071 / Vol. I / Chapter 3 / Table I-3-3]. DVOR transmitter shall not contribute to the bearing information error more than ± 2 degrees, for all elevation angles between 0 and 40 degrees from the center of the DVOR antenna system [ANNEX 10 / Vol. I / Paragraph 3.3.3.2]. *"High-powered"* DME transponder, shall not contribute to the overall system error more than ± 1.0 μs (≈ 150 m for "ONE-WAY" range error). Additionally, the combination of the transponder errors, transponder location coordinate errors, propagation effects and random pulse interference effects shall not contribute more than ± 185 m (0.1 NM) to the overall system error [ANNEX 10 / Vol. I / Paragraph 3.5.4.5.1 and 3.5.4.5.1.2].		
	2.4.3 [ET]	For each DVOR/DME system, the brand of the DVOR equipment and the DME equipment shall be the same. Additionally, AEROTHAI forces the Tenderer to propose all such DVOR/DME systems in the same specifications.		

	2.4.4 [ET]	The equipment shall be designed for high-reliability operation. Tenderer shall submit a reliable report of performance, such as "INTEGRITY" and/or "MTBF", as part of the proposal. MTBF of each unit of the DVOR and DME equipment shall be at least 1,000 hours. [ANNEX 10 / Vol. I / Attachment F / Paragraph 1.2.4, 1.2.5 and Figure F-1].	
	2.4.5 [ET]	The information of each unit of DVOR and DME equipment shall be provided in "ENGLISH" language, not to be mixed with other languages, at least, as follows:	
		2.4.5.1	Names and labels of hardware assemblies
		2.4.5.2	Software menus and data [5.4.2.2]
		2.4.5.3	Technical documents and test reports [11]
	2.4.6 [ET]	All RF generators of DVOR and DME equipment shall be synthesizers.	
	2.4.7 [EC]	Each unit of DVOR and DME equipment shall be capable of independently data (events) logging (e.g. alarm history), not depending on a connection to any external control & monitoring unit -- the LMM and/or RMM computer.	
		2.4.7.1	All data (event) logs shall be marked with *"Date & Time"*.
		2.4.7.2	*"Date & Time"* of the equipment shall be adjustable to be at the present time.
		Additionally, all proposed navigation equipment and associated software shall be Year 2038 - Compliant, the Contractor shall provide verification document demonstrating that the system still operates correctly for date/time values beyond 19 January 2038, 03:14:07 UTC, especially regarding data (events) logging with accurate time stamps and functionality scheduling.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during during the Factory Acceptance Test (FAT).	
	2.4.8 [ET]	If the status data of any DVOR or DME or RCMU equipment does not natively support the "ETHERNET" format for remote control & monitoring purpose, "ADAPTERS" for converting other data formats to the Ethernet shall be provided. Additionally, each unit of DVOR and DME equipment shall provide relevant spare communication ports (which may be of different types) to accommodate potential failures of the main RCMU and/or RMM communication ports.	

	2.4.9 [EC]	For each DVOR/DME system, the Contractor shall provide one (1) set of Interface Control Documents (ICDs) detailing data format exchanges.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Site Acceptance Test (SAT).	
	2.4.10 [CO]	Environmental Conditions	
		2.4.10.1 [ET]	Indoor equipment shall be designed for continuous operation under the ambient temperature range of <u>at least</u> 0 °C to +50 °C with a relative humidity of up to 60%.
		2.4.10.2 [ET]	Outdoor equipment shall be designed to be weatherproof. (The maximum relative humidity in Thailand is approximately 85%.)
2.5 [CO]	AC/DC power lines, transmission lines, communication lines (including construction works)		
	2.5.1 [EC]	The Contractor shall provide all AC/DC power lines, transmission lines (and monitoring cables), communication lines and all related installation materials (e.g. connectors, cable trays/ladders, conduits/ducts and cable ties).	
	2.5.2 [EC]	All transmission lines shall be provided with RF connectors, that comply with IEC 61169 international standard or other international standard. The Contractor shall also conclude the specifications of the indoor transmission lines, outdoor transmission lines, and the RF connectors to AEROTHAI.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the the Site Acceptance Test (SAT).	
	2.5.3 [EC]	In case that the field monitoring system is installed outside the DVOR counterpoise, the installation work involves buried cables, which shall be of the *"underground"* type. AC power lines and monitoring cable shall be separated into distinct groups, each of which shall be routed through its own *"underground"* conduit (such as HDPE or RSC), having sufficient inner diameter for easy installation of all associated cables.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the site installation.	

	2.5.4 [CO]	The Contractor shall carry out the underground cable work, at least, as follows :	
		2.5.4.1 [CO]	Trenching and underground cable work shall be carried out in accordance with Section 2 : Construction Works.
		2.5.4.2 [CO]	The Contractor shall take responsibilities for any damages to existing and/or nearby underground cable and utilities.
	2.5.5 [EC]	The Contractor shall mark out all AC power lines, transmission lines (and monitoring cable) and communication lines leading to the facilities, using appropriate indicators /labels. Additionally, route markers shall also be installed to ensure that the path of the buried cable is clearly visible.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the site installation.	
2.6 [CO]	Lightning and Surge Protection (LSP) System A complete *"Lightning and Surge Protection (LSP)"* system shall consist of a) Air-Termination System b) Down Conductor System c) Earth-Termination (Grounding) System including equipotential earth bonding d) Surge Protective Device (SPD)		
	2.6.1 [EC]	For each type of navigation station (DVOR/DME station), the Contractor shall summarize all LPS subsystems stated in [2.6.1.1] and [2.6.1.2] into "ONE" interconnection diagram before the site installation, the diagram shall include : a) AC power protection, as designed by the Contractor b) Telecommunication protection, as designed by the Contractor	
		2.6.1.1 [CO]	For AC power protection from LPZ 0 (Lightning Protection Zone 0) to LPZ 2, the Contractor shall design and provide a LSP subsystem that reflects the actual installation condition.
		2.6.1.2 [CO]	For telecommunication protection from antenna systems to RF transmission lines, the Contractor shall design and provide a LSP subsystem, as follows :
			2.6.1.2.1 [EC] The Contractor shall design Air-Termination System, so that it protects the DVOR/DME antenna system.
			2.6.1.2.2 [EC] The Contractor shall design *"RF Transmission Line"* surge protective devices capable of passing DC power along the transmission line, if DC power is carried through the line.

			2.6.1.2.3 [EC]	The Contractor shall detail the Earth-Termination System for all antenna systems, including the field monitor antenna, according to the manufacturer's standards. The Earth-Termination System for the antenna systems shall be bonded to the Earth-Termination System [2.6.1.1] with an earth-resistance not exceeding 5 ohms.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the site installation.
		[EC]	The Contractor shall also submit a list of, at least, major subsystems and/or devices of [2.6.1.1] and [2.6.1.2] to AEROTHAI. The proposed details regarding brands and models may be omitted.	
2.7 [CO]	Technical Supports For each DVOR/DME system, the Contractor shall provide technical supports as follows :			
	2.7.1 [CO]	The Contractor shall be responsible for all installation works.		
	2.7.2 [CO]	The Contractor shall assist AEROTHAI engineers to set up/configure all units of the DVOR/DME system until the results of "COMMISSIONING" flight inspection and/or validation meet the requirements of the Civil Aviation Authority of Thailand (CAAT). AEROTHAI engineers hold primary responsibility to set up/configure all units of the DVOR/DME equipment, for preparations of the ground inspection and flight inspection.		
2.8 [CO]	The Contractor shall provide to the following products – manufacturer warranties, which start from the date next to the completion of the final payment date of each DVOR/DME system.			

Item	Description	Warranty
(a)	"COMPLETE" Lightning and Surge Protection (LSP) System	5 years
(b)	DVOR, DME, RCMU and RSU Equipment	5 years
(c)	Spare Parts	5 years
(d)	Computers	2 years
(e)	Measuring Instruments	2 years

3. Specifications of DVOR

[CO] The specifications described below represent AEROTHAI's requirements. ANNEX10 / Vol. I and/or other international standard references stated at the end of each item are only for citations. The interpretations may not exactly match AEROTHAI's specific requirement.

3.1 [CO]	DVOR Transmitter characteristics		
	3.1.1 [ET]	The system shall operate with horizontal polarization in the frequency band of 108 MHz to 117.975 MHz, with 50 KHz spacing between channels [ANNEX10 / Vol. I – Paragraph 3.3.2.1 and 3.3.3.1].	
	3.1.2 [ET]	The frequency channels among DVOR and DME system shall be paired [ANNEX10 / Vol. I – Table A / p. 3-103].	
	3.1.3 [ET]	The frequency tolerance of radio frequency carrier shall not exceed ± 0.002% [ANNEX 10 / Vol. I / Paragraph 3.3.2.2].	
	3.1.4 [CO]	The 30 and 9960 Hz modulating signals (for bearing information) shall meet the specifications as follows :	
		3.1.4.1 [ET]	The frequency tolerance of 30 Hz reference shall be within 30 Hz ± 1%. The frequency tolerance of 9960 Hz subcarrier shall be within 9960 Hz ± 1%. [ANNEX 10 / Vol. I / Paragraph 3.3.5.4 and 3.3.5.5].
		3.1.4.2 [ET]	The modulation depth of 30 Hz reference shall be adjustable, at least, between the limits of 28% and 32% The modulation depth of 9960 Hz subcarrier shall be adjustable, at least, between the limits of 28% and 32% [ANNEX 10 / Vol. I / Paragraph 3.3.5.2].
	3.1.5 [CO]	The 1020 Hz modulating signal (for identification) shall meet the specifications as follows :	
		3.1.5.1 [ET]	The frequency tolerance of 1020 Hz tone shall be within 1020 ± 50 Hz [ANNEX 10 / Vol. I / Paragraph 3.3.6.5].
		3.1.5.2 [ET]	The modulation depth of 1020 Hz tone shall be adjustable close to, but not more than 20% [ANNEX 10 / Vol. I / Paragraph 3.3.6.6].
	3.1.6 [CO]	DVOR identification signal.	
		3.1.6.1 [ET]	The DVOR identification signal shall employ the International Morse Code and be configurable to consist of two or three letters. It shall also meet the requirements specified in [ANNEX 10 / Vol. I / Paragraph 3.3.6.4, 3.3.6.5 and 3.3.6.6].
		3.1.6.2 [EC]	The identifications of DVOR and DME shall be synchronized.

		3.1.6.3 [EC]	The DVOR identification signal shall be automatically suppressed, when the system is set to bypass (testing) mode.
		3.1.6.4 [EC]	The DVOR identification code shall be configurable by means of software only, with no necessity for hardware settings. Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Factory Acceptance Test (FAT).
	3.1.7 [EC]	An automatic protection shall be applied to RF power amplifiers to prevent damage in the event that there is a high VSWR fault at the output of RF power amplifier. Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Factory Acceptance Test (FAT).	
	3.1.8 [EC]	Line sections with *"Plug-in Elements"*. To facilitate the measurement of the in-line parameters during system maintenance, line sections with *"Plug-in Elements"* shall be embedded in/inserted to each RF transmission line as follows :	
		Item — Name of the Transmission Line (a) — Transmission Line for Carrier (b) — Transmission Line (s) for LSB (Lower Sideband Signal) (c) — Transmission Line (s) for USB (Upper Sideband Signal)	
		Remark : If the transmission lines originally come with internal sensors/measurement from the factory, *"Plug-in Elements"* may be exempted only if the product design also provides an alternative mean that allows maintenance engineers to crosscheck the correctness of those *"in-line"* parameter values by "EXTERNAL" measuring instruments. Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the site installation.	
	3.1.9 [EC]	DVOR parameters which affect the bearing information shall be mainly adjustable by software. However, some parameters may be additionally adjusted by hardware, if necessary. AEROTHAI also requires an adjustment of *"Azimuth Offset"* with a resolution of, at least, 0.1 degrees or finer.	

3.2	DVOR Monitor Characteristics			
[CO]	3.2.1	The monitoring system of DVOR shall serve, at least, the following purposes.		
	[CO]	3.2.1.1 [EC]	To monitor basic maintenance parameters; at least, power supply voltage, mode of operation, aerial/standby transmitter status, transmission frequency, RF transmission power and environmental sensing data.	
		3.2.1.2 [EC]	To be used as an *"Integrity Certification"*. The monitor, in conjunction with a built-in test unit for calibration and testing, shall guarantee itself that the detection capability remains accurate and correct. The process may be done with turning off the equipment, AEROTHAI will <u>not</u> strictly require. If the process is being done, an indication showing the status of *"Integrity Certification"* shall also be informed. Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Factory Acceptance Test (FAT).	
			3.2.1.2.1 [EC]	Be able to generate, at least, <u>both</u> *"in tolerance"* <u>and</u> *"out of tolerance"* azimuth.
			3.2.1.2.2 [EC]	Be able to generate, at least, <u>both</u> *"in tolerance"* <u>and</u> *"out of tolerance"* 30 Hz Reference Modulation Depth.
			3.2.1.2.3 [EC]	Be able to generate, at least, <u>both</u> *"in tolerance"* <u>and</u> *"out of tolerance"* 9960 Hz Subcarrier Modulation Depth.
			3.2.1.2.4 [EC]	Be able to generate, at least, <u>both</u> *"in tolerance"* <u>and</u> *"out of tolerance"* FM Index (9960 Hz Deviation Ratio).
		3.2.1.3 [ET]	To ensure that the DVOR signal is still radiated within the conditions or tolerances specified in [ANNEX 10 / Vol. I / Paragraph 3.3.7.1], the monitoring system of DVOR shall provide a "<u>FIELD</u>" monitoring system which may be installed either on "<u>OR</u>" outside the DVOR counterpoise, depending on manufacturer's design. In case that the field monitoring system is installed outside the DVOR counterpoise, the Contractor shall also provide a DVOR field monitor tower of the "<u>FIELD</u>" monitoring system (including construction works of the foundation). However, the Contractor shall <u>not</u> provide the DVOR field monitor tower to SURAT THANI Airport, as AEROTHAI has recently replaced one.	
		3.2.1.4 [EC]	To be used as *"Fault Detection"*. DVOR equipment shall be able to detect and initiate an appropriate *"notification"* and/or *"action"*, if any related abnormal condition occurs.	

	3.2.2	The "FIELD" monitoring system of DVOR.	
	[CO]	3.2.2.1 [ET]	The field monitoring system shall provide, at least, the critical parameters as follows :
			Item — Parameter (a) DVOR (Composite or Carrier) RF Level (b) Clockwise Bearing (Azimuth) (c) 30 Hz Reference Modulation Depth (d) 9960 Hz Subcarrier Modulation Depth (f) FM Index (9960 Hz Deviation Ratio) (g) 1020 Hz Ident (at least status)
	3.2.3	Warning and Alarm Conditions	
	[CO]	In this context, an "ALARM" is a notification triggered when the system operates with out-of-tolerance conditions. While, a "WARNING/ALERT" is a notification triggered when the system operates with abnormal status but remains within tolerance. In case that the tolerance is defined by a numeric range, the "WARNING/ALERT" may be referred to as a "PRE-ALARM".	
		3.2.3.1 [EC]	*"Alarm Limits"* of the monitored parameters stated in [3.2.2.1], if exist, shall be adjustable to be equal to their respective alarm limit values [ANNEX 10 / Vol. I / Paragraph 3.3.7.1]. AEROTHAI also requires an adjustment of *"Azimuth Alarm Limit"* values with a resolution of, at least, 0.1 degrees or finer.
		3.2.3.2 [EC]	The monitoring system shall issue a "WARNING/ALERT" or an "ALARM", both in "AUDIBLE" and "VISUAL" mode.
	3.2.4 [ET]	The monitoring system shall be configurable to either single or dual monitor system. When dual monitor system is configured, the decision logic of "AND" and "OR" mode shall also be available.	
	3.2.5 [ET]	For DVOR, the maximum period allowing the system to radiate out-of-tolerance signal including period(s) of zero radiation (detected by the "AERIAL" monitoring system), shall be as short as practicable, not exceed 10 seconds under any circumstances. The maximum period shall also be adjustable, at least, from 0 to 10 seconds.	

		Additionally, design and operation of the monitor system shall be consistent with the requirement that radiation shall cease "OR" identification and navigation components are removed from the carrier and a warning or alarm will be provided at the designated "REMOTE" control points in the event of failure of the monitor system itself [ANNEX 10 / Vol. I / Paragraph 3.3.7.2]. Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Factory Acceptance Test (FAT).
3.3	DVOR antenna system	
[CO]	3.3.1 [ET]	The Tenderer shall design and who has become the Contractor shall provide both the transmitting (TX) antenna system and field monitoring (MON) antenna system, The TX antenna system shall be *"Alford Loop"* type.
	[EC]	After site installation, the Contractor shall also conclude the specifications of, at least, the following attributes : (a) "Number" of DVOR sideband antennas (b) "Gain" of DVOR antenna, for both carrier and sideband type. (c) "Type" of field monitor antenna [3.2.1.3]. Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Site Acceptance Test (SAT). Remark : 1. The TX antenna system shall be capable of radiating the DVOR signal throughout the DVOR frequency band (108 – 117.975 MHz) 2. All antenna supporters – mast and counterpoise, shall also be included in the antenna system (see also [2.3]).
	3.3.2 [EC]	The Contractor shall install the field monitoring antenna system at a specific distance, which complies with the manufacturer installation manual, from the center of the DVOR antenna system.
	3.3.3 [ET]	The Contractor shall provide Double LED obstruction lights with photo switches as follows :
		Item Installation Position (a) At the top of field monitoring antenna (1 set), only if the field monitoring antenna system [3.2.1.3] is installed outside the DVOR counterpoise.

		The LED obstruction light shall be weatherproof and comply with [Annex 14 /Vol. I /Paragraph 6.2.3.19, Table 6-1, Table 6-2] or other international standard for obstruction lights. Additionally, the Contractor shall also submit brand and model/type in the proposal.
	3.3.4 [ET] 	The Contractor shall provide marking and/or lighting, which comply to [ANNEX 14 / Vol. I / Chapter 6/ 6.2], for denoting building/shelter, antenna system and obstruction light as obstacles. Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the site installation.

4. Specifications of DME/N

[CO] The specifications described below represent AEROTHAI's requirements. ANNEX10 / Vol. I and/or other international standard references stated at the end of each item are only for citations. The interpretations may not exactly match AEROTHAI's specific requirement.

4.1	DME Transponder characteristics		
[CO]	4.1.1 [ET]	The system shall operate with vertical polarization in the frequency band of 960 MHz to 1215 MHz, with 1 MHz spacing between channels [ANNEX10 / Vol. I – Paragraph 3.5.3.2].	
	4.1.2 [ET]	The frequency channels between DVOR and DME system shall be paired. Additionally, the interrogation and reply frequencies of DME shall also be paired [ANNEX10 / Vol. I – Paragraph 3.5.3.3.4, Table A / p. 3-103].	
	4.1.3 [ET]	Both the operating frequency of the reply signal and the center frequency of the receiver shall not vary more than ± 0.002 % from their assigned frequencies [ANNEX 10 / Vol. I / Paragraph 3.5.4.1.2 and 3.5.4.2.2].	
	4.1.4 [ET]	For *"high-powered"* DME, in case that interrogation pulse pairs with correct spacing and nominal frequency trigger the transponder to reply with an efficiency of at least 70%, the minimum peak power density at the "TRANSPONDER ANTENNA" required for such triggering shall be not more than -103 ± 1 dBW/m^2 [ANNEX 10 / Vol. I / Paragraph 3.5.4.2.3.1, 3.5.4.2.3.2, 3.5.4.2.3.5 and 3.5.4.2.3.6]. For an example of unit conversion, the value of -103 ± 1 dBW/m^2 is approximately -88.45 ± 1 dBm, where DME antenna gain and cable loss are assumed to be 8 dBi and -2 dB respectively. However, if there is any additional attenuation embedded in the equipment, the attenuation value shall also be reported to AEROTHAI.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Factory Acceptance Test (FAT).	
	4.1.5 [CO]	For each incoming interrogation frequency drift, the bandwidth of the receiver shall meet the requirements as specified in the following :	
		4.1.5.1 [ET]	Inside the frequency range of $f \pm 100$ KHz from the center frequency of interrogation signal, the transponder sensitivity shall not deteriorate by more than 3 dB [ANNEX 10 / Vol. I / Paragraph 3.5.4.2.6.1].
		4.1.5.2 [ET]	Outside the frequency range of $f \pm 900$ KHz from the center frequency of interrogation signal, the interrogation signal shall not trigger the transponder [ANNEX 10 / Vol. I / Paragraph 3.5.4.2.6.5].

		Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Factory Acceptance Test (FAT).	
	4.1.6 [ET]	For DME/N-Decoder Rejection, an interrogation pulse pair with a spacing of $\pm 2\ \mu s$, or more from the nominal value, shall be rejected. [ANNEX 10 / Vol. I / Paragraph 3.5.4.3.3].	
	4.1.7 [ET]	Pulse shape shall meet the requirements of [ANNEX 10 / Vol. I / Paragraph 3.5.4.1.3].	
		4.1.7.1	Pulse rise time (between 10% to 90% of the leading edge) $\leq 3\ \mu s$
		4.1.7.2	Pulse decay time (between 90% to 10% of trailing edge) $\approx 2.5\ \mu s$, but $\leq 3.5\ \mu s$
		4.1.7.3	Pulse duration (between 50% of the leading, and trailing edges) $3.5 \pm 0.5\ \mu s$
		4.1.7.4	The instantaneous amplitude of the pulse shall not, at any instant between the point of the leading edge which is 95% of the maximum amplitude and the point of the trailing edge which is 95% of the maximum amplitude, fall below a value which is 95% of the maximum amplitude of the pulse.
	4.1.8 [ET]	Pulse pair shall meet the requirements of [ANNEX 10 / Vol. I / Paragraph 3.5.4.1.4.3 and 3.5.4.1.5.4].	
		4.1.8.1	Pulse pair spacing shall be not exceed $(12.00 \pm 0.10)\ \mu s$.
		4.1.8.2	The peak power of the constituent pulses of any transponder pulse pair shall not differ by more than one (1) dB.
	4.1.9 [ET]	Reply delay, the interval between 50% amplitude of the leading edge of the interrogation pulse and that of the corresponding reply pulse, shall be typically $50\ \mu s$ for X-channel, and shall also be decreasingly adjustable, at least, from the nominal value in order to permit aircraft interrogators to indicate "ZERO" distance at a specific point remote from the transponder site [ANNEX 10 / Vol. I / Paragraph 3.5.4.4.1 and 3.5.4.4.3]	
		Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the flight inspection/validation.	
	4.1.10 [ET]	Dead time and echo suppression shall be adjustable and also properly configured at each DME station, in order to prevent any undesired signal degrading the system performance [ANNEX 10 / Vol. I / Paragraph 3.5.4.2.9, 3.5.4.3 and 3.5.4.6.2].	
		Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the flight inspection/validation.	

	4.1.11 [CO]	The transponder shall be capable of continuous operation at a transmission rate (the so-called *"Pulse Repetition Rate"*) as follows :	
		4.1.11.1 [ET]	The minimum transmission rate, including randomly distributed pulse pairs and distance reply pulse pair, shall not be less than and be close as practicable to 700 ppps, except during identity [ANNEX 10 / Vol. I / Paragraph 3.5.4.1.5.6].
		4.1.11.2 [ET]	The maximum transmission rate shall not be less than 4800 ppps, which is higher than the requirement recommended by ICAO at 2,700 ± 90 ppps [ANNEX 10 / Vol. I / Paragraph 3.5.4.1.5.5].
	4.1.12 [CO]	DME identification signal	
		4.1.12.1 [ET]	The DME identification signal shall employ the International Morse Code and be configurable to consist of two or three letters. It shall also meet the requirements specified in [ANNEX 10 / Vol. I / Paragraph 3.5.3.6].
		4.1.12.2 [EC]	The DME identification code shall be configured by means of software only, with no necessity for hardware settings.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Factory Acceptance Test (FAT).
	4.1.13 [EC]	An automatic protection shall be applied to RF power amplifiers to prevent damage in the event that there is a high VSWR fault at the output of RF power amplifier.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Factory Acceptance Test (FAT).	
	4.1.14 [ET]	DME equipment shall be equipped with a coupling port ("BUILT-IN" or external) so that *"the peak output power"* can be measured by an external measuring instrument, without turning off the equipment and without interrupting the operation of the "AERIAL" transmitter.	
	4.1.15 [EC]	DME parameters which affect the DME ranging signal shall be mainly adjustable by software. However, some parameters may be additionally adjusted by hardware, if necessary.	

4.2 [CO]	DME Monitor characteristics			
	4.2.1 [CO]	The monitoring system of DME shall serve, at least, the following purposes.		
		4.2.1.1 [EC]	To monitor basic maintenance parameters; at least, power supply voltage, mode of operation, aerial/standby transmitter status, interrogation/reply frequency, Effective Radiated Power (or at least RF transmission power) and environmental sensing data.	
		4.2.1.2 [EC]	To be used as an *"Integrity Certification"*. The monitor, in conjunction with a built-in test unit for calibration and testing, shall guarantee itself that the detection capability remains accurate and correct. The process may be done with turning off the equipment, AEROTHAI will <u>not</u> strictly require. If the process is being done, an indication showing the status of *"Integrity Certification"* shall also be informed. Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Factory Acceptance Test (FAT).	
			4.2.1.2.1 [EC]	Be able to generate, at least, <u>both</u> *"in tolerance"* <u>and</u> *"out of tolerance"* pulse pair spacing [4.2.1.3.1].
			4.2.1.2.2 [EC]	Be able to generate, at least, <u>both</u> *"in tolerance"* <u>and</u> *"out of tolerance"* reply delay [4.2.1.3.2].
			4.2.1.2.3 [EC]	Be able to select /adjust the deviated frequency of simulated interrogation signals, at least ± 100 KHz and ± 900 KHz [4.1.5].
			4.2.1.2.4 [EC]	Be able to provide *"Dynamic Range"* test When the power density of the actual interrogation signals at the "<u>TRANSPONDER ANTENNA</u>" has any value between the value specified in [4.1.4] up to a maximum of -22 dBW/m^2 the performance of the transponder shall be maintained [ANNEX 10 / Vol. I / Paragraph 3.5.4.2.3.3]. For an example of unit conversion, the value of -22 dBW/m^2 is approximately -7.45 dBm, where DME antenna gain and cable loss are assumed to be 8 dBi and -2 dB respectively. However, if there is any additional attenuation embedded in the equipment, the attenuation value shall also be reported to AEROTHAI.
			4.2.1.2.5 [EC]	Be able to provide *"Transmission Rate"* test The DME transponder shall be capable of continuous operation at a transmission rate, complying with [4.1.11].

		4.2.1.3 [EC]	To ensure that the DME signal is still radiated within the condition or tolerance specified in [ANNEX 10 / Vol. I / Paragraph 3.5.4.7.2]. In other words, the monitor system shall initiate an appropriate *"notification"* and/or *"action"* if any related abnormal condition occurs, as follows :	
			4.2.1.3.1 [EC]	Spacing error of transmitted pulse pair exceeds ± 1.0 μs [ANNEX 10 / Vol. I / Paragraph 3.5.4.7.2.4 c)].
			4.2.1.3.2 [EC]	Reply delay error exceeds ± 1.0 μs for *"high-powered"* DME [ANNEX 10 / Vol. I / Paragraph 3.5.4.7.2.2 a)].
			4.2.1.3.3 [EC]	A fall of 3 dB or more in transmitted power output [ANNEX 10 / Vol. I / Paragraph 3.5.4.7.2.4 a)].
			4.2.1.3.4 [EC]	A fall of 6 dB or more in the minimum transponder receiver sensitivity provided that this is <u>not</u> due to the action of the receiver automatic gain reduction circuits [ANNEX 10 / Vol. I / Paragraph 3.5.4.7.2.4 b)].
		4.2.1.4 [EC]	To be used as *"Fault Detection"*. DME equipment shall be able to detect and initiate an appropriate *"notification"* and/or *"action"*, if any related abnormal condition occurs.	
	4.2.2 [CO]	Warning and Alarm Conditions In this context, an "<u>ALARM</u>" is a notification triggered when the system operates with out-of-tolerance conditions. While, a "<u>WARNING/ALERT</u>" is a notification triggered when the system operates with abnormal status but remains within tolerance. In case that the tolerance is defined by a numeric range, the "<u>WARNING/ALERT</u>" may be referred to as a "<u>PRE-ALARM</u>".		
		4.2.2.1 [EC]	*"Alarm Limits"* of the monitored parameters stated in [4.2.1.3.1] to [4.2.1.3.4], if exist, shall be adjustable to be equal to their respective alarm limit values [ANNEX 10 / Vol. I / Paragraph 3.1.5.7.1].	
		4.2.2.2 [EC]	The monitoring system shall issue an "<u>ALARM</u>", both in "<u>AUDIBLE</u>" and "<u>VISUAL</u>" mode.	
	4.2.3 [ET]	The monitoring system shall be configurable to either single or dual monitor system. When dual monitor system is configured, the decision logic of "<u>AND</u>" and "<u>OR</u>" mode shall also be available.		

	4.2.4 [ET]	For DME, the maximum period allowing the system to radiate out-of-tolerance signal including period(s) of zero radiation (detected by the "AERIAL" monitoring system), shall be as short as practicable, not exceed 10 seconds under any circumstances [ANNEX 10 / Vol. I / Paragraph 3.5.4.7.2.5]. The maximum period shall also be adjustable, at least, from 0 to 10 seconds. Additionally, design and operation of the monitor system shall be consistent with the requirement that radiation shall cease "OR" identification and navigation components are removed from the carrier and a warning or alarm will be provided at the designated "REMOTE" control points in the event of failure of the monitor system itself.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Factory Acceptance Test (FAT).
4.3	DME antenna system	
[CO]	4.3.1 [ET]	The Tenderer shall design and who has become the Contractor shall provide the transponder (XPDR) antenna system (no near-field monitoring antenna system for DME), The XPDR antenna system shall be *"Omni-Directional"* type.
	[EC]	After site installation, the Contractor shall also conclude the specifications of, at least, the following attributes : (a) "Main Lobe Elevation Angle" of DME antenna (3 or 6 degree) (b) "Gain" of DME antenna
		 Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Site Acceptance Test (SAT). Remark : 1. The XPDR antenna system shall be capable of radiating the DME signal throughout the DME frequency band (960 – 1215 MHz) 2. All antenna supporters – mast and counterpoise, shall also be included in the antenna system (see also [2.3]). 3. The Contractor shall mount the XPDR antenna at the top of *"DVOR Carrier Antenna"* 4. The Contractor shall also provide *"Lightning Rod Assembly"* for the XPDR antenna.

	4.3.2 [ET]	The Contractor shall provide Double LED obstruction lights <u>with</u> photo switches as follows : Item Installation Position (a) At the top of DME antenna (1 set), or anywhere on the DVOR counterpoise at the same elevation as the top of the DME antenna, but shall be easy to climb and safe for maintenance The LED obstruction light shall be weatherproof and comply with [Annex 14 /Vol. I /Paragraph 6.2.3.19, Table 6-1, Table 6-2] or other international standard for obstruction lights. Additionally, the Contractor shall also submit brand and model/type in the proposal.
	4.3.3 [ET]	The Contractor shall provide marking and/or lighting, which comply to [ANNEX 14 / Vol. I / Chapter 6/ 6.2], for denoting building/shelter, antenna system and obstruction light as obstacles.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the site installation.

5. Specification of Control and monitoring System

[CO]	A complete *"control & monitoring"* system of each DVOR/DME system shall consist of LCMU, RCMU, RSU, LMM computer and RMM computer. Each unit provides the equipment status/information, or may also provides control function of the equipment, to relevant users at the designated location.		
	5.1 [CO]	Local Control and Monitoring Unit (LCMU) LCMU is a "BUILT-IN" unit, used to locally monitor and control the equipment. It's typically embedded into each unit of DVOR and DME equipment.	
		5.1.1 [ET]	*"LCMU of DVOR"* and *"LCMU of DME"* shall provide, at least, the functions, as described in Table 5.1.
		5.1.2 [ET]	The Tenderer shall provide and detail both the physical connections and the connection configuration among the LCMU and the associated navigation equipment and/or other control and monitoring units. See also [2.4.8] and [2.7].
	5.2 [CO]	Remote Control and Monitoring Unit (RCMU) RCMU is a unit, used to remotely monitor and control the equipment. It's typically located at the technical control room of the ATC tower.	
		5.2.1 [ET]	*"RCMU of DVOR"* and *"RCMU of DME"* shall provide, at least, the functions, as described in Table 5.1.
		5.2.2 [ET]	RCMU of [5.2.1] shall be combined into the same unit – *"RCMU of DVOR/DME"*.
		5.2.3 [ET]	The Tenderer shall provide and detail both the physical connections and the connection configuration among the RCMU and the associated navigation equipment and/or other control and monitoring units. See also [2.4.8] and [2.7].
		5.2.4 [ET]	The Contractor shall also provide a suitable-sized rack for mounting the *"RCMU of DVOR/DME"*.
	5.3 [CO]	Remote Status Unit (RSU) RSU is a unit, used only to remotely monitor the equipment. It's typically located at the ATC room of the ATC tower.	
		5.3.1 [ET]	*"RSU of DVOR"* and *"RSU of DME"* shall provide, at least, the functions, as described in Table 5.1.
		5.3.2 [ET]	RSU of [5.3.1] shall be combined into the same unit – *"RSU of DVOR/DME"*.

	5.3.3 [ET]	The Tenderer shall provide and detail both the physical connections and the connection configuration among the RSU and the associated navigation equipment and/or other control and monitoring units. See also [2.4.8] and [2.7].	
5.4 [CO]	Local Maintenance Monitoring (LMM) and Remote Maintenance Monitoring (RMM) Computer LMM computer is a unit, used to locally monitor and control the equipment. It's typically located at the DVOR/DME station. RMM computer is a unit, used to remotely monitor and control the equipment. It's typically located at the technical control room of the ATC tower.		
	5.4.1 [ET]	LMM and RMM computer shall provide, at least, the functions, as described in Table 5.1.	
	5.4.2 [CO]	LMM and RMM computer shall be a desktop computer, complying with [6.1].	
		5.4.2.1 [EC]	One (1) LMM computer shall be provided for one (1) DVOR/DME station. One (1) RMM computer shall be provided for one (1) airport. Additionally, one (1) desktop computer shall also be provided as a spare unit for one (1) airport.
		5.4.2.2 [EC]	All equipment software for LMM and RMM shall be compatible with "WINDOWS OS". The equipment software shall be readily installed in the desktop computer (including the spare computer). Additionally, the recovery CD/DVD (or any portable data storages) shall also be provided to AEROTHAI.
	5.4.3 [ET]	The Tenderer shall provide and detail both the physical connections and the connection configuration among the LMM computers, the RMM computer and the associated navigation equipment and/or other control and monitoring units. See also [2.4.8] and [2.7].	

[CO] Table 5.1 : Functions of control & monitoring unit

The symbol " ✓ " indicates the minimum requirements of functions provided by the control and monitoring unit.

Item	Function	LCMU	RCMU	RSU	LMM/ RMM
1	Display the operating status and/or system parameters, and generate "VISUAL" and "AUDIBLE" warning/alarm (with volume control or mute) when failure occurs. If the unit is just only *"Basic Status Indicator"*, not *"User Interface (UI) Display"*, It shall also provide push button for lamp test.	✓	✓	✓	
2	Display the "MAIN/STANDBY" of the transmitter /transponder. The capability to select "MAIN/STANDBY" will not be strictly required.	✓	-	-	-
3	Select the "LOCAL/REMOTE" control, with higher priority on the "LOCAL" control.	✓	-	-	-
4	Manually turn on/off and changeover the transmitter /transponder with an "ON-ANT"/"ON-LOAD" indication.	✓	✓	-	✓
5	Bypass the monitor.	✓	-	-	✓
6	Reset some designated hardware and software, in order that the equipment could attempt to turn on.	✓	-	-	✓
7	Adjust/configure (by software) the system parameters of both transmitters/transponders and monitors, for a specific purpose.	-	-	-	✓

6. Specifications of Computer.

6.1 [CO]	Desktop Computer The Contractor shall provide desktop computers, including all attached devices complying with, at least, as follows :		
	6.1.1 [ET]	The desktop computer shall be *"ALL in One"* type.	
	6.1.2 [ET]	Processor/Chipset	
		6.1.2.1	The number of processing unit : Core ≥ 6 cores, Thread ≥ 6 threads
		6.1.2.2	Base clock frequency ≥ 1.2 GHz
		6.1.2.3	Maximum single-core clock frequency ≥ 4.5 GHz
	6.1.3 [ET]	RAM	
		6.1.3.1	Technology – DDR5 or better
		6.1.3.2	Capacity ≥ 8 GB
	6.1.4 [ET]	One (1) Storage Drive	
		6.1.4.1	Solid State Drive ≥ 480 GB
	6.1.5 [ET]	One (1) Optical Disc Drive	
		6.1.5.1	Internal or portable DVD-RW Drive, or better
	6.1.6 [ET]	Graphic Controller	
		6.1.6.1	Built-in graphic or dedicated graphic controller
		6.1.6.2	Graphic memory (including the memory allocated from RAM) ≥ 1.0 GB
	6.1.7 [ET]	One (1) Display	
		6.1.7.1	≥ 21.5 inches LED with resolution 1920 x 1080 pixels
	6.1.8 [ET]	Networking	
		6.1.8.1	Gigabit Ethernet, or better
		6.1.8.2	Wi-Fi, at least compliant with Wi-Fi 5 (IEEE 802.11ac) 2.4 GHz / 5 GHz
		6.1.8.3	Bluetooth
	6.1.9 [ET]	I/O Interface	
		6.1.9.1	Serial Port, or an adapter converting USB to Serial Port
	6.1.10 [ET]	One (1) Keyboard and One (1) Mouse	
		6.1.10.1	Each key shall be permanently printed with both Thai and English characters.

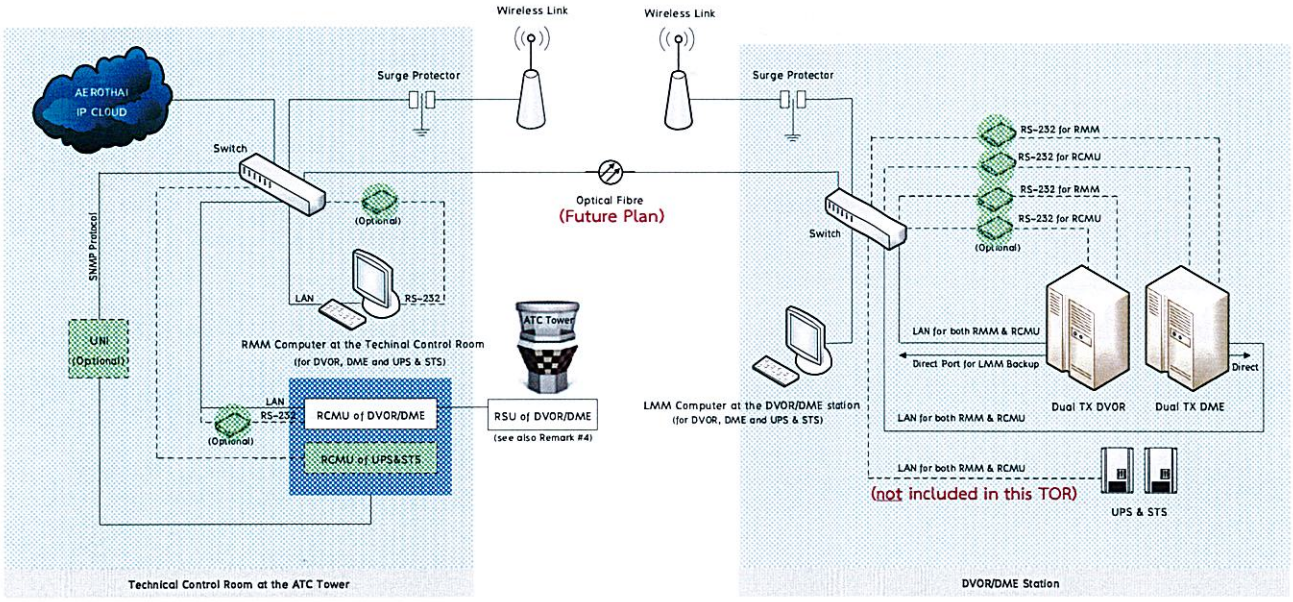
	6.1.11 [EC]	Operation System, Drivers and Software	
		6.1.11.1	The operating system shall be "WINDOWS-BASED".
		6.1.11.2	Operation system, drivers and software shall be readily installed in the desktop computers (including the spare computers).  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Site Acceptance Test (SAT).
		6.1.11.3	The recovery CD/DVD (or any portable data storage devices) and the user's license for the software shall be provided for AEROTHAI.
	6.1.12 [EC]	The Desktop Computer shall have a manufacturer branch office authorized representative in Thailand.	
	6.1.13 [EC]	One (1) set of office table and chair shall be provided for one (1) desktop computer (not including the spare computers).	

7. Specifications of Network Equipment

[CO] For this procurement, the Contractor shall not provide a set of network equipment (microwave and peripheral devices) for each DVOR/DME system (station), as AEROTHAI will be using the "EXISTING" ones.

8. Intersystem Connection and Network Diagram

[CO]	This section will depict intersystem connection and network diagram among equipment, which is stated in [3] to [7]. The Tenderer and who has become the Contractor shall comply with the requirements, at least, as follows :		
	8.1 [EC]	For each DVOR/DME system, the *"Intersystem Connection and Network Diagram"* ([Fig. 8-1]) shall be used as a guideline. After site installation, the Contractor shall submit the diagram that reflects the actual installation condition to AEROTHAI. Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Site Acceptance Test (SAT).	
	8.2 [CO]	Be reminded that, for each DVOR/DME system, the Contractor shall provide the equipment in order to fulfill a complete *"control & monitoring"* system as follow:	
		8.2.1 [CO]	A set of control & monitoring equipment [5][6]
		8.2.2 [CO]	A set of network equipment (microwave and peripheral devices) [7] For this procurement, the Contractor shall <u>not</u> provide a set of network equipment (microwave and peripheral devices) for each DVOR/DME system (each station), as AEROTHAI will be using the "<u>EXISTING</u>" ones.
		8.2.3 [CO]	A set of optical fibers For this procurement, the Contractor shall <u>not</u> provide a set of optical fibres for each DVOR/DME system (station), as AEROTHAI plans to install optical fibres separately.
	[CO]	For this procurement, The Contractor shall assist AEROTHAI engineers to set up /configure the network connections [2.7].	



Remark :

1. Equipment in the shade of GREEN (including the dash line) is not compulsory (optional) and may be omitted if Ethernet connection (primary connection) exists.
2. If exists, RS-232 for RMM and RS-232 for RCMU may be designed into the same connection.
3. UNI (Universal Navaids Integrator) is developed by AEROTHAI for supporting the case that RCMUs do not provide SNMP information.
4. RSU of ILS/DME may support Ethernet Connection.
5. This diagram does not show the interconnection details between AEROTHAI IP cloud and CENTRAL monitoring office at MAHAMEK.

Figure 8-1 : Intersystem connection for each DVOR/DME system
(AEROTHAI Conceptual Diagram)

9. Requirements of Spare Parts

[CO]	The Tenderer and who has become the Contractor shall comply with the requirements of spare parts, at least, as follows :	
9.1 [EC]	For each unit of the DVOR equipment, DVOR spare parts shall be provided for a "SINGLE" configuration system (a single transmitter and a single monitor), at least, power supply modules, line replaceable modules (LRMs), circuit card assemblies (CCAs), and any other common subsystem, such as backplanes, RF transfer switches, RF distribution unit (DU) and DVOR antenna system. When the spare parts of the DVOR antenna system are as follows :	
	Item Spare Parts (a) One (1) set of Carrier Antenna (b) One (1) set of Sideband Antenna (c) One (1) set of Field Monitoring Antenna	
	For each unit of the DVOR equipment, one (1) set of double LED obstruction light with photo switch shall also be provided as the spare parts, only if the "FIELD" monitoring system [3.2.1.3] is installed outside the DVOR counterpoise.	
9.2 [EC]	For each unit of the DME equipment, DME spare parts shall be provided for a "SINGLE" system configuration (a single transponder and a single monitor), at least, power supply modules, line replaceable modules (LRMs), circuit card assemblies (CCA), and any other common subsystem, such as backplanes, RF transfer switches, and DME antenna system. When the spare parts of the DME antenna system are as follows :	
	Item Spare Parts (a) One (1) set of DME Antenna not including *"Lightning Rod Assembly"* for the XPDR antenna [4.3.1].	
	For each unit of the DME equipment, one (1) set of double LED obstruction light with photo switch shall also be provided as the spare parts.	
9.3 [EC]	For each DVOR/DME system, one (1) unit of *"RCMU of DVOR/DME"* shall be provided as a spare unit (see also [5.2.2]).	
9.4 [EC]	For each DVOR/DME system, one (1) unit of *"RSU of DVOR/DME"*, shall be provided as a spare unit (see also [5.3.2])	

10. Requirements of Supplements.

10.1 [CO]	The Contractor shall submit the basic requirements of supplements – *"Measuring Instruments"* and *"Tools & Accessories"*, at least, as follows :	
	10.1.1 [EC]	The Contractor shall submit a list of *"Measuring Instruments"* [10.2] to [10.4], suitable for system calibration and maintenance, identifying brand and model of each item. Additionally, the Contractor shall also submit certificates, test reports, operation manual and service manual, that cover all of the "DELIVERED" measuring instruments.
	10.1.2 [EC]	The Contractor shall submit a list of *"Tools & Accessories"* [10.5], suitable for system calibration and maintenance, with no necessity to identify brand and model of each item.
	Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Site Acceptance Test (SAT).	
10.2 [CO]	For each station, the Contractor shall provide only one (1) Portable Navigational Signal Analyzer (PNSA) :	
	10.2.1 [EC]	The PNSA shall be designed for measuring critical performance parameters of at least LOC, GP and DVOR equipment.
	10.2.2 [EC]	The PNSA shall be designed for outdoor/field measurements with built-in battery powering, portable and compact size, weatherproof and corrosion-resistance. The Contractor shall also provide necessary accessories, at least, an antenna pole, a bag for the antenna pole and a bag for the PNSA.
	10.2.3 [EC]	All parameters shall be transferred to an external portable storage, via USB, in text format.
	Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the site installation.	
10.3 [CO]	For this procurement, the Contractor shall provide only one (1) of *"Handheld"* Vector Network Analyzer (VNA), only for the LAMPANG airport :	
	10.3.1 [EC]	The VNA shall be designed for outdoor/field measurements with built-in battery powering, portable and compact size, weatherproof and corrosion-resistance. The Contractor shall also provide necessary accessories, at least, a bag for the VNA.
	10.3.2 [EC]	Frequency range, at least from 30 KHz to 3 GHz
	103.3 [EC]	Support full two-port S-parameter (S11, S12, S21, S22) measurements in various display formats.

	Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the site installation.
10.4 [EC]	For each station, the Contractor shall provide only one (1) set of *"Measuring Instruments"*, suitable for system calibration and maintenance, at least, as follows :
	Item — List of Measuring Instruments (a) Digital Multimeter (b) Frequency Counter (c) RF Wattmeter for DVOR (d) RF Power Sensor or RF Power Analyzer for DME, depending on maintenance procedures (e) Oscilloscope, with a feature which still mark and lock the cursor positions of the measured signal even though the scaling is altered. Therefore, when the position of 50% amplitude of the leading edge of each DME pulse in [4.1.9] are zoomed and exactly known/marked, each cursor position will still be locked even though the scaling is altered, in order that the value of *"Reply Delay"* between those of DME pulses could be measured accurately. AEROTHAI also requires the measurement of *"time delay"* parameter with a resolution of, at least, 0.01 μs .
	Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the site installation.
10.5 [EC]	For each station, the Contractor shall provide only one (1) set of *"Tools & Accessories"*, suitable for system calibration and maintenance, at least, as follows :
	Item — List of Tools & Accessories (a) A set of watt elements, only if RF wattmeter or RF power analyzer is used (b) A directional coupler for DME, only if "BUILT-IN" coupling port is not provided [4.1.14] (c) A set of RF sampler elements for DVOR (d) A set of RF adapter kit (e) A set of dummy loads, only if the maintenance procedure required (f) A set of extension cards and/or cables, only if the maintenance procedure required (g) A set of test cables with specific electrical length, only if the maintenance procedure required (h) A set of tuning tools, only if the maintenance procedure required (i) A set of attenuation kit, only if the maintenance procedure required
	Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the site installation.

11. Requirements of Technical Documents and Test Reports

[CO]	The Contractor shall provide documents as follows :		
	11.1 [EC]	After completion of factory acceptance test (FAT), the *"FAT Report"* shall be provided for each DVOR/DME system :	
		11.1.1	One (1) original.
		11.1.2	Two (2) sets of hard copy.
		11.1.3	One (1) set of soft copy.
		Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI after completion of factory acceptance test (FAT).	
	11.2 [EC]	Before site installation, the related *"Equipment Manual"* containing all information about installation, operation and maintenance procedure, shall be provided for each unit of DVOR, DME, RCMU and RSU equipment.	
		11.2.1	Two (2) sets of hard copy.
		11.2.2	One (1) set of soft copy.
		Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI before site installation.	
	11.3 [EC]	Before site installation, the related *"Assembly Drawings"* and *"Schematic Diagrams"* shall be provided for each unit of DVOR, DME, RCMU and RSU equipment.	
		11.3.1	Two (2) sets of hard copy.
		11.3.2	One (1) set of soft copy.
		Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI before site installation.	
	11.4 [EC]	After completion of site acceptance test (SAT) and commissioning flight inspection, the *"SAT Report"* shall be provided for each DVOR/DME system, The document shall include information about DVOR, DME, RCMU and RSU equipment.	
		11.4.1	One (1) original.
		11.4.2	Two (2) sets of hard copy.
		11.4.3	One (1) set of soft copy.
		Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI after completion of site acceptance test (SAT).	

APPENDIX A

List of DVOR/DME Systems

Item	Station Name	Airport Operator	Regional Control Center	Frequency /Channel	
				DVOR (MHz)	DME (CH.)
1.	LAMPANG Airport	DOA	CHIANG MAI	114.7	094X
2.	NARATHIWAT Airport	DOA	HAT YAI	116.3	110X
3.	PETCHABUN Airport	DOA	PHITSANULOK	115.4	101X
4.	ROI ET Airport	DOA	UBON RATCHATHANI	111.2	049X
5.	NAKHON SI THAMMARAT Airport	DOA	SURAT THANI	117.4	121X
6.	SURAT THANI Airport	DOA	SURAT THANI	110.6	043X

APPENDIX B

Supporting Documents and Bill of Quantities

The Contractor shall provide the quantities as stated in Table B.1 :

Table B.1 : Bill of Quantities for DVOR/DME systems

Item	Descriptions	Quantity (หมายเหตุ)	Remark
1	DVOR/DME Building	-	See [2.3]. The quantities are already stated in BOQ of section 2: Construction Works
2	DVOR Counterpoise DVOR Antenna Supporter DVOR Field Monitor Tower DME XPDR Antenna Supporter	5 6 N 6	See [2.3]. See [3.2.1.3]. Where N = 0, for *"Counterpoise-Edge"* N = 5, for *"Nearfield"*. In case that the "FIELD" monitoring system is installed outside the DVOR counterpoise, the Contractor shall provide a DVOR field monitor tower of the "FIELD" monitoring system, including construction works of the foundation. The Contractor shall not provide the one to SURAT THANI Airport.
3	Set of AC power lines Set of Transmission lines Set of Communication Lines Set of Installation Materials	6 6 6 6	See [2.5.1] for each DVOR/DME system
4	A complete LSP system for DVOR/DME - An interconnection diagram - A list of, at least, major subsystems and/or devices	6 6 6	See [2.6.1] for each DVOR/DME station.
5	A summary of the DVOR specifications with the key attributes A summary of the DME specifications with the key attributes	1 1	See [3.3.1] See [4.3.1]

Item	Descriptions	Quantity	Remark
6	DVOR Equipment	6	See [3.1] and [3.2].
	DME Equipment	6	See [4.1] and [4.2].
	TX Antenna System for DVOR	6	See [3.3] and [9.1].
	- CA as spare units	6 CA	CA is *"Carrier Antenna"*,
	- SA as spare units	6 SA	SA is *"Sideband Antenna"*,
	XPDR Antenna System for DME	6	See [4.3] and [9.2].
	- A whole spare unit	6	
	Field MON Antenna System for DVOR	6	See [3.3] and [9.1].
	- A whole spare unit	6	
7	Adapter to Ethernet Data Format	as designed	See [2.4.8] only if the status data do not natively support Ethernet format.
8	Double LED OBS Light for DVOR (Field MON)	N	See [3.3.3] and [9.1],
	- A whole spare unit	N	including photo switch.
			Where N = 0, for *"Counterpoise-Edge"*
			N = 6, for *"Nearfield"*.
	Double LED OBS Light for DME	6	See [4.3.2] and [9.2],
	- A whole spare unit	6	including photo switch.
9	RCMU of DVOR/DME	6	See [5.2] and [9.3].
	- A whole spare unit	6	The Contractor shall also provide a suitable-sized rack for mounting the *"RCMU of DVOR/DME"*.
10	RSU of DVOR/DME	6	See [5.3] and [9.4].
	- A whole spare unit	6	
11	Desktop Computer for LMM	6	See [5.4.2.1].
	- A whole spare unit	6	One (1) LMM computer shall be provided for one (1) DVOR/DME station
	(with components in the remark)		
	Desktop Computer for RMM	6	One (1) RMM computer shall be provided for one (1) airport.
	(with components in the remark)		One (1) computer shall also be provided as a spare unit for one (1) airport.

Item	Descriptions	Quantity	Remark
			Related components shall be provided. a) Operating System with User's License b) Equipment Software c) Recovery CD/DVD/data storages for a) and b) d) A Set of Table and Chair [6.1.13]
12	After site installation a version of *"Intersystem Connection and Network Diagram"*, including frequency allocation of each microwave routing, shall be submitted.	6	See [8.1].
13	Spare Parts for DVOR Spare Parts for DME Spare Parts for LSP	6 6 N/A	See [9.1] and [9.2]. Spare parts shall be provided for a "SINGLE" configuration system, including any other common subsystem. The spare parts of all antenna system are already included in [Item 6]. The spare parts of the Double LED OBS Light are already included in [Item 8].
14	Measuring Instrument (with documents in the remark)		See [10.1.1][10.2][10.3] and [10.4] for each station. Related documents shall be provided. a) List of Measuring Instrument (Brands and models are required) b) Certificates c) Test Reports d) Operation Manual e) Service Manual
	PNSA Digital Multimeter Frequency Counter RF Wattmeter for DVOR RF Power Sensor for DME (or RF Power Analyzer for DME) Oscilloscope	6	
	"Handheld" VNA	1	For this procurement, the Contractor shall provide only one (1) of *"Handheld"* Vector Network Analyzer (VNA), only for the LAMPANG airport

Item	Descriptions	Quantity	Remark
15	Tools & Accessories (with documents in the remark)	6	See [10.1.2] and [10.5] for each station. Related documents shall be provided. a) List of Tools and Accessories, only if the maintenance procedure required. (Brands and models are <u>not</u> required)
	A Set of Watt Elements A Directional Coupler for DME A Set of Sampler Elements for DVOR A Set of RF Adapter Kit A Set of Dummy Loads A Set of Extension Cards and/or Cables A Set of Test Cable A Set of Tuning Tools A Set of Attenuation Kit		
16	FAT Report (Original) FAT Report (Hard Copy) FAT Report (Soft Copy) Verification Document of Year 2038	6 12 6 6	See [11.1]. See [2.4.7].
17	SAT Report (Original) SAT Report (Hard Copy) SAT Report (Soft Copy)	6 12 6	See [11.4]. for <u>each</u> DVOR/DME system (including RCMU and RSU equipment).
18	Equipment Manual for DVOR (HC) Equipment Manual for DME (HC) Equipment Manual for RCMU/RSU (HC) ICDs for DVOR/DME (HC) Equipment Manual for LSP (HC) Equipment Manual for DVOR (SC) Equipment Manual for DME (SC) Equipment Manual for RCMU/RSU (SC) ICDs for DVOR/DME (SC) Equipment Manual for LSP (SC)	12 12 12 12 Optional 6 6 6 6 Optional	See [11.2] and [2.4.9]. Where HC is Hard Copy and SC is Soft Copy.

Item	Descriptions	Quantity	Remark
19	Assembly Drawings for DVOR (HC)	12	See [11.3]
	Assembly Drawings for DME (HC)	12	Where HC is Hard Copy and SC is Soft Copy.
	Assembly Drawings for RCMU/RSU (HC)	12	
	Assembly Drawings for DVOR (SC)	6	
	Assembly Drawings for DME (SC)	6	
	Assembly Drawings for RCMU/RSU (SC)	6	
20	Schematic Diagrams for DVOR (HC)	12	
	Schematic Diagrams for DME (HC)	12	
	Schematic Diagrams for RCMU/RSU (HC)	12	
	Schematic Diagrams for DVOR (SC)	6	
	Schematic Diagrams for DME (SC)	6	
	Schematic Diagrams for RCMU/RSU (SC)	6	
21	A set of tables and chairs	12	See [6.1.13]