

**Project Name**

Procurement for Betong DVOR/DME

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## SCOPE OF TECHNICAL SPECIFICATIONS

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## 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. Seventh Edition, July 2018, Amendments 91.
ICAO Annex 14 Vol. I	Aerodromes: Volume I Aerodrome Design and Operations. Eighth Edition, July 2018, Amendments 1-14.
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.

<b>2.</b>	<b>GENERAL REQUIREMENTS [E]</b>	
2.1	The Project consists of DVOR/DME systems as the following:	
	2.1.1	One (1) DVOR/DME Systems shall be installed at Betong Airport.
	2.1.2	DVOR/DME antenna and Counterpoise edge monitor antenna shall be installed by contractor that follow the manufacturer installation manual.
	2.1.3	Cable ladders shall be provided and installed by contractor
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 Unit (LCU) of DVOR and DME include its local computer at DVOR/DME station, as specified in [5.1-5.2].
	2.2.5	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 in ATC Tower; as specified in [5.3].
	2.2.6	Remote Status Unit (RSU) for the above equipment specified in 2.2.1-2.2.3 which shall be equipped at ATC Tower; as specified in [5.4].
	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 in ATC Tower, as specified in [5.5].
2.3	The DVOR/DME systems shall have SNMP management capability are specified in clause 6.	
2.4	The system performance and its signal-in-space quality shall at least comply with the ICAO Annex 10 Vol. I.	
2.5	All RF Generators shall be synthesizers.	
2.6	The equipment shall be the modular design, or an easy plug-in card or modules for quick replacement with the purpose for easy maintenance and repair.	
2.7	The dual independent transmitters shall be housed in the cabinet (s) and operated as main and standby facilities. Maintenance on one equipment shall be accomplished without disruption the operation of the others.	
2.8	The equipment shall be designed in common of modules and printed circuit boards.	
2.9	The MTBO of each system shall be greater than 10,000 hours. The Tenderers shall submit reliability analysis (MTBF, MTBO) in the Proposal.	

2.10	The DME equipment shall be installed in co-location with the DVOR equipment.
2.11	Each Line Replaceable Units (LRU) of DVOR/DME Equipment shall be easily exchangeable.
2.12	<p><b>Indoor</b> 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%.</p> <p><b>Outdoor</b> 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.</p> <p><b>All outdoor</b> 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.</p>
2.13	AC/DC power lines, transmission lines, control lines, test cables and all relevant accessories shall be as follows:
2.13.1	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. <b>The transmission line shall be the rodent protection type.</b> If the installation work involves buried cables, <b>they shall be “underground-type”</b> and fitted in HDPE or RSC pipes which the inner diameter shall be wide enough for fitting all cables easily;
2.13.2	All transmission lines shall be laid in a different pipe separated from that of AC power lines;
2.13.3	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;
2.13.4	All known power and control lines (or else cable routes) leading to the facility shall be marked out by the contractor;
2.13.5	Cable route markers shall be installed at every 10 meters for indicating underground cables. The cable route marker specifications are detailed in section 2: Counterpoise and Grounding System Requirements;
2.13.6	The Contractor shall take all responsible precautions to protect existing underground equipment and utilities;
2.13.7	The Contractor shall provide all external RF connectors type and model that complied with IEC61169 or other international standards.

	2.14	Power supply	
		2.14.1	The DVOR/DME System shall be operated with 230 VAC $\pm$ ( $\geq$ 10%), 50 Hz $\pm$ ( $\geq$ 2%).
		2.14.2	Power supply module for DVOR and DME equipment shall be individually supplied.
	2.15	Lightning protection, surge protection system shall be as follows.	
		2.15.1	All above system must be complied with IEC-62305 international standard or other international standards.
		2.15.2	The tenderer shall submit brand, model and the related document of lightning protection system in the proposal Including <ul style="list-style-type: none"> <li>- Air-Termination System.</li> <li>- Down Conductor System.</li> <li>- Lightning Arrester, the so-called "Surge Protective Device (SPD)".</li> </ul> The lightning protection system shall be installed and connected to existing station grounding system which is installed by AEROTHAI (see detail in Attachment Page 28 - 38)
		2.15.3	The lightning protection system shall adequately protect all of the DVOR/DME and peripheral equipment in the event of a lightning strike.
		2.15.4	The surge protection for all Telecom line shall be provided.
		2.15.5	The Contractor shall supply RF Coaxial cable surge protection for VOR band and DME band complied with IEC-62305 or other international standards.
	2.16	The total resistance of the grounding system shall not exceed 5 $\Omega$	
	2.17	The backup battery with charger unit for DVOR/DME equipment shall also be included in the power supply system.	
	2.18	The backup battery shall have sufficient capacity to enable to operate at least Three (3) hour in the event of an AC mains failure.	
	2.19	Equipment Warranty	
		2.19.1	Minimum 5 years warranty as follows:
		2.19.1.1	DVOR/DME Equipment and spare parts.
		2.19.1.2	Lightning Protection and Surge Protection System.
		2.19.1.3	PNSA and Tools for installation and maintenance.
		2.19.2	Minimum 2 years warranty as follows:
		2.19.2.1	Computer and its Accessories.

		As conform to detail in non technic TOR item No.14 (เอกสารประกวดราคาจัดซื้อข้อที่ 14 เรื่องการประกันความชำรุดบกพร่อง)	
3.	DOPPLER VHF OMNI RANGE (DVOR) EQUIPMENT [E]		
	3.1	System Accuracy	
	3.1.1	Azimuth accuracy shall be better than $\pm 1$ degree on ground measurement.	
	3.1.2	Azimuth stability shall be better than $\pm 0.5$ degree measured at a monitor.	
	3.2	The dual DVOR equipment shall comprise, but not limited to:	
	3.2.1	Dual carrier transmitters;	
	3.2.2	Dual sideband transmitters;	
	3.2.3	Dual monitors;	
	3.2.4	DVOR test generator;	
	3.2.5	Antenna Switching Unit;	
	3.2.6	Antenna System.	
	3.3	Carrier Transmitter	
	3.3.1	Frequency band	- 108 MHz to 117.975 MHz
	3.3.2	Operating frequency	- 113.10 MHz for Betong Airport
	3.3.3	Frequency stability	- $\pm 0.002\%$ from the operating frequency
	3.3.4	Output power	- at least 100 watts (adjustable)
	3.3.5	Carrier modulation:	
		3.3.5.1	Reference frequency - 30 Hz $\pm 0.2\%$
		3.3.5.2	Modulation depth - 30% (adjustable)
		3.3.5.3	Identification frequency - 1020 Hz $\pm 50$ Hz
		3.3.5.4	Identification modulation Depth - 10% (adjustable)
		3.3.5.5	Speech channel filter - band pass at the range of 300 to 3000 Hz within 3 dB relative to the level at 1000 Hz
		3.3.5.6	Speech modulation depth - up to 30% (the transmission of speech shall not interfere in any way with basic navigation function (adjustable)
	3.3.6	The Identification unit shall be able to generate any three letters International Morse Code for both DVOR and DME equipment.	
	3.3.7	The setting up of DVOR Identification code shall be computerized.	

	3.3.8	The DME Identification shall be generated on every fourth DVOR Identification cycle.
	3.3.9	Protection shall be provided for the RF amplifier from damage caused by open or short circuit of the output.
	3.3.10	<b>One (1) set</b> Thrulines (line sections) with plug-in elements shall be equipped at RF power output of the transmitters. <b>One (1)</b> RF Wattmeter shall be provided for RF power reading. Type, model and diagram shall be submitted in the Proposal. <i>Thrulines (line sections) with plug-in elements shall be housed in the cabinet (s)</i>
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	<b>Four (4) sets</b> Thrulines (line sections) with plug-in elements shall be equipped at each RF power output of the transmitters. At least <b>Four (4) set</b> of RF Wattmeter shall be provided for RF power reading. Type, model and diagram shall be submitted in the Proposal. <i>Thrulines (line sections) with plug-in elements shall be housed in the cabinet (s)</i>
3.5	Monitor	
	3.5.1	The DVOR Monitor system shall be capable continuous monitoring fault (s) detection and producing alarm signal (s) for the following conditions occurs:
	3.5.1.1	A change in excess of 1 degree of the bearing information transmitted by the DVOR equipment;
	3.5.1.2	Reference signal 30 Hz modulation depth exceeds $\pm$ 2% from the nominal value;
	3.5.1.3	Sub-carrier 9960 Hz modulation depth exceeds $\pm$ 2% from the nominal value;
	3.5.1.4	Sub-carrier 9960 Hz deviation ratio exceeds 16 $\pm$ 1.
	3.5.2	The bearing alarm limit shall be adjustable with the step of not more than 0.1 degree.
	3.5.3	The carrier RF level alarm limit shall be adjustable when the carrier level decreases at least 20 - 50% 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.
	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	Due to difficult terrain at Betong Airport, At least two (2) Counterpoise edge Monitor (including RF surge protection) shall be provided for installation on the top of counterpoise edge that is monitoring the radiated composite signal. <b>Monitor type, and model shall be submitted in the Proposal.</b>
	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 method of sideband feed lines fabrication and any other adjustment procedures shall be described in <b>DVOR/DME installation and equipment instruction manuals</b> (in clause 9.2).
	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.
	<b>4. DISTANCE MEASURING EQUIPMENT (DME) [E]</b>	
	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 1,215 MHz
	4.2.2	Operating channel - CH 78X for Betong Airport
	4.2.3	Transmitter characteristics
	4.2.3.1	The radio frequency of operation shall not vary more than $\pm 0.002\%$ from the assigned frequency.
	4.2.3.2	Pulse shape and spectrum of pulse modulated signal shall meet the requirements for DME/N in ICAO Annex 10 Vol. I Paragraph 3.5.4.1.3. 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	The power amplifier of the transponder shall provide full peak output power of <b>not less than 1000 watts</b> to the antenna.

		4.2.3.6	DME equipment shall provide/embed the coupling port for measuring peak output power (External tool) <u>without</u> shutdown/turn OFF the equipment.
		4.2.3.7	Dead time, short distance echo suppression and long distance echo suppression shall be adequately adjustable for each DME station installed, in order to prevent any undesired signal degrading the system performance.
		4.2.3.8	The transmitter shall operate at a transmission rate, including randomly distributed pulse pairs and distance reply pulse pairs, of not less than 700 pulse pairs per second except during identity. <i>Note.— Operating DME transponders with quiescent transmission rates close to 700 pulse pairs per second will minimize the effects of pulse interference, particularly to other aviation services such as GNSS.</i>
		4.2.3.9	The maximum transmission rate shall be at least 4800 PPS.
		4.2.3.10	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 <sup>2</sup> 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 $\pm 2 \mu\text{s}$ 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	To be used as ensuring the transponder signal within the tolerance [ANNEX 10 / Vol. I / Paragraph 3.5.4.7.2]. The monitor system shall initiate an appropriate “WARNING” or “ALARM” indication & sound if any related abnormal condition occurs.
		4.3.2.1	Spacing error of transmitted pulse pair exceeds $\pm 1.0 \mu\text{s}$
		4.3.2.2	Reply delay error exceeds $\pm 1.0 \mu\text{s}$ for high powered DME.
		4.3.2.3	Transmitting pulse count (Pulse Repetition Frequency) falls below 700 pps.
		4.3.2.4	Continuous or loss of identification.
		4.3.2.5	A fall of 3 dB or more in transmitted power output
		4.3.2.6	A fall of 6 dB or more in the minimum transponder receiver sensitivity provided that this is not due to the action of the receiver automatic gain reduction circuits.
		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 transmitting pulse spacing error (in 4.3.2.1) or reply delay error (in 4.3.2.2).
		4.3.4	The Monitors shall be configurable such that both monitors are monitoring the operating (on-antenna) and standby (on-dummy) transponder simultaneously.
		4.3.5	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.
		4.3.6	Alarm history shall be provided to identify the parameter that has deviated beyond the alarm limit and caused the alarm.
		4.3.7	Test signal generator output shall be selected, The channel frequency deviation of $\pm 100 \text{ kHz}$ and $\pm 900 \text{ kHz}$ of the transponder receiver can be tested.
		4.3.8	Test signal generator (interrogation) output level shall be adjustable at least from -91 dBm to -20 dBm at the transponder antenna connector.

	4.3.9	Test signal generator PRF shall be adjustable nearly 700 to at least 4800 PPS.
	4.3.10	At least the following Transponder and Monitor parameters shall be available for display at the designated control points:
	4.3.10.1	Reply delay;
	4.3.10.2	Reply pulse pair spacing;
	4.3.10.3	Reply efficiency;
	4.3.10.4	Transmit power;
	4.3.10.5	Transmitter pulse count;
	4.3.10.6	Identification.
	4.3.11	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 <b>Appendix B</b> .
	4.4.2	The Antenna shall be capable of radiating DME signal throughout the DME frequency band (960 MHz to 1,215 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 <b>+9 dBi</b> .
	4.4.4	<b>One (1) set</b> 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). <b>Type and model shall be submitted in the Proposal.</b>

<b>5.</b>	<b>CONTROL AND MONITORING [E]</b>	
	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		<b>One (1) sets</b> 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 10.
	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	One (1) sets of Desktop Computer shall be provided as part of the Local Control Unit for DME. The Desktop Computer for DME shall be provided separately from the Desktop Computer for DVOR. The Desktop Computer specifications are specified in clause 10.
	5.2.5	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	Visual and audible alarm with an alarm silence control;
	5.4.2.3	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	<b>One (1) sets</b> of Desktop Computer shall be provided as part of the DVOR/DME RMM. The Desktop Computer Specifications are specified in clause 10.	
	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.	

<b>6.</b>	<b>INTERSYSTEM CONNECTION</b>		
6.1	The DVOR/DME System shall be connected with RCSU (Provided by the contractor), RCMS and CCMS (provided by AEROTHAI) to send update information.		
6.2	The DVOR/DME 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-RCMS, CCMS information exchange.		
6.4	The Contractor shall provide a list of all necessary standards documents and Interface Control Documents (ICDs) with regards to the DVOR/DME-RCMS and CCMS information exchange.		

<b>7.</b>	<b>SUPPLEMENTS</b>		
7.1	Portable Navigational Signal Analyzer (PNSA) [E]		
	7.1.1	<b>One (1) set</b> 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	<b>One (1) sets</b> 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. <b>Remark :</b> "SINGLE" system configuration means "SINGLE" transmitter and "SINGLE" monitor.
	7.3	DVOR Antenna Spare Part	
		7.3.1	<b>One (1) Set</b> of carrier antenna spare part and <b>Four (4) set</b> of sideband antenna spare part shall be provided
		7.3.2	The carrier and sideband antenna spare parts shall consist of the antenna element, antenna cover, RF feeding cable and RF cable lightning protection kit.
	7.4	DME Spare Parts	
		7.4.1	<b>One (1) sets</b> of DME spare parts shall be provided.
		7.4.2	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). <b>Remark :</b> "SINGLE" system configuration means "SINGLE" transmitter and "SINGLE" monitor.

7.5	DME Antenna Spare Part
7.5.1	<b>One (1) set</b> of DME antenna spare part shall be provided.
7.5.2	The DME antenna spare parts shall consist of the antenna, RF feeding cable and RF cable lightning protection kit.
7.6	RCSU and RSU Spare Parts
	<b>One (1) sets</b> of RCSU and RSU spare parts for DVOR/DME systems shall be provided.
7.7	Double LED obstruction lighting Spare Parts (in clause 3.5.12 and 4.4.4)
	<b>One (1) set</b> of Double LED obstruction lighting equipment for DVOR/DME systems shall be provided as spare parts.
7.8	The contractor shall provide manufacturer's certification for availability of spare parts for <b>ten (10) year</b> from the expiration of the warranty period. <b>The tenderer shall submit this certificates in the proposal.</b>

<b>8.</b>	<b>TOOLS FOR INSTALLATION AND MAINTENANCE</b>
	<b>One (1) set</b> shall provide. Each set comprises:
8.1	The contractor shall provide at least waveform analysis tools, thruline wattmeter, digital multi-meter, portable RF power analysis, frequency counter and additional tools <b>that complies with manufacturer standard</b> for DVOR/DME system installation, Maintenance and hardware adjustment. <b>The contractor shall provide list of recommend installation and Maintenance tools from manufacturer.</b>
8.2	Extension cards (if any) 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 cablings, cable trays, cable ladder, connectors, cable ties and conduits shall be provided.
<b>9.</b>	<b>TECHNICAL DOCUMENTS AND TEST REPORTS [E]</b>
	The Contractor shall provide the following documents:
9.1	<b>One (1) sets</b> for hard copy and <b>Two (2) DVD sets</b> for <b>mechanical and electrical DVOR/DME drawings and whole network diagrams</b> 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;

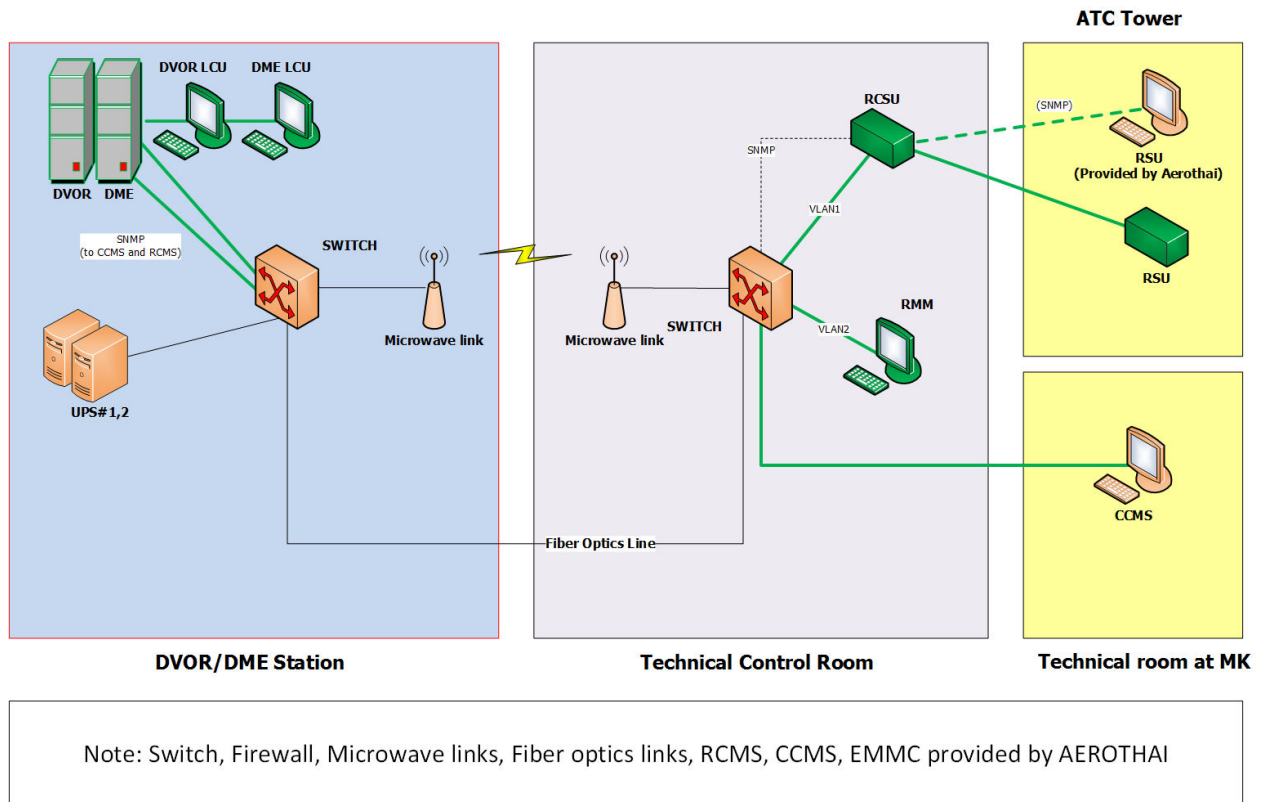
9.2	Two (2) sets for hard copy and Three (3) sets for DVD, of DVOR/DME installation and equipment instruction manuals, setting out in detail the procedures for operation, routine maintenance, troubleshooting of the equipment, test and alignment procedures, including schematics and inter-cabling diagrams;
9.3	Two (2) sets for hard copy and Three (3) sets for DVD, of 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 One (1) hard copies of Factory Acceptance Test (FAT) report shall be provided at the factory after the completion of FAT.
9.5	One (1) original and Two (2) sets hard copies of Site Acceptance Test (SAT) report shall be provided at the site after the completion of the commissioning flight check.
9.6	One (1) original and Two (2) sets hard copies of Function Unit Test (FUT) report shall be provided at the site before the completion of the installation.

<b>10. DESKTOP COMPUTER</b>	
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.	
10.1	All components shall be produced form the same manufacturer with permanent logo/brand on products.
10.2	All in one computer
10.3	Processor/ Chip set
	10.3.1 $\geq 4$ Core or $\geq 8$ Thread
	10.3.2 Base clock frequency $\geq 3.2$ GHz
10.4	RAM
	10.4.1 Technology – DDR3 or better
	10.4.2 Capacity – $\geq 8$ GB
10.5	One (1) Hard disk Drive
	SATA or better Capacity – $\geq 2.0$ TB or Solid State Device $\geq 240$ GB
10.6	One (1) Optical Disc Drive
	Internal DVD/RW Drive

10.7	Graphic Controller	
		Built-in graphic or Dedicated graphic controller with $\geq$ 1 GB memory
10.8	One (1) Display	
		$\geq$ 19 inches LED with resolution 1920 x 1080 pixels
10.9	Networking	
		10/100/1000 Mbps Ethernet
10.10	One (1) Keyboard and One (1) Mouse	
		Each key shall be permanently printed with both Thai and English characters
10.11	Operation System/ Software	
	10.11.1	Shall be installed with the Desktop Computer
	10.11.2	Capable of operating with the software of the proposed DVOR/DME System.
	10.11.3	Recovery DVD with a copyright shall be provided
10.12	The operating system and license which is suitable for compute operating shall be provided.	
10.13	One (1) set of Office table and chair which is suitable for computer operation shall be provided.	
10.14	The Desktop Computer shall have a manufacturer branch office authorized representative in Thailand.	
10.15	The DVD for software driver shall be provided with the product.	

### 11. CONCEPTUAL DIAGRAM OF INTERSYSTEM CONNECTION AND COMMUNICATION

#### 11.1 DVOR/DME Diagram for Betong Airport.



## 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 <sub>max</sub>	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.

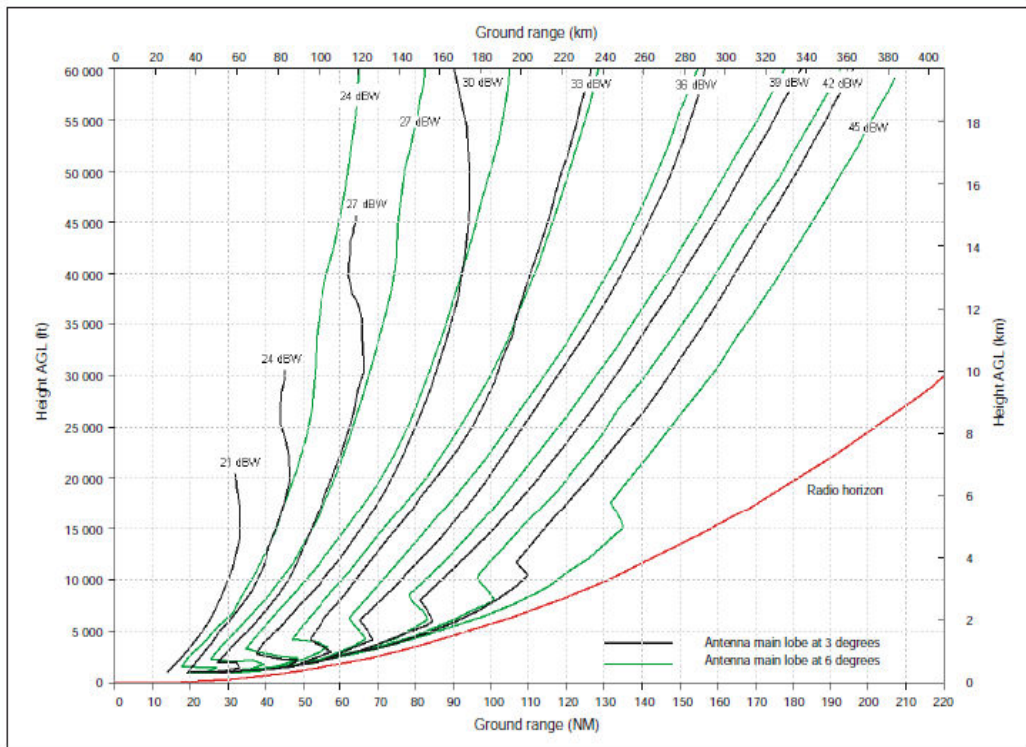


Figure C-20 of [ANNEX 10 / Vol. I / Attachment C / Paragraph 7.2.1]. Necessary EIRP of DME transponder to achieve a power density of  $-89 \text{ dBW/m}^2$  (at airborne receiver) as a function of height above and distance from the DME. The above figure is based on the following example,

1. Airborne receiver sensitivity :  $-120 \text{ dBW}$
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 :  $-111 \text{ dBW}$

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

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APPENDIX C: Location

DVOR/DME	Location
- Betong Airport	5 ° 47' 7.71" N 101 ° 8 ' 38.64" E (ค่าพิกัดในเบื้องต้น)

**GUIDELINE FOR “Bill of Materials and Services”**

ITEM	Description	Quantity	Remark	Reference Clause
<b>EQUIPMENT</b>				
1	DVOR Equipment	1		3
	DME Equipment	1		4
2	DVOR Antenna System	1	Complete antenna system including Antenna mast, RF surge protection, obstruction lighting	3.3, 3.4
	DME Antenna System	1		4.4
3	Counter Poise Edge Monitor Antenna System	2	Due to difficult terrain at Betong Airport, At least two (2) Counterpoise edge Monitor (including RF surge protection)	3.5.11
4	Thruline (line sections) with plugin elements for carrier power reading	1		3.3.10
	RF power meter for thruline (carrier)	1		3.3.10
	Thruline (line sections) with plugin elements for sideband power reading	4		3.4.4
	RF power meter for thruline (sideband)	4		3.4.4
5	DVOR/DME Lightning Protection System	1		2.15
6	Double LED OBS Light for DME	1	Including photo switch	4.4.4
7	DVOR LCU Computer	1		5.1.4
	DME LCU Computer	1		5.2.4
	DVOR/DME RMM Computer	1		5.5.6
	Table and Chair for both LCU computer	1		10.13

ITEM	Description	Quantity	Remark	Reference Clause
<b>SPARE PART</b>				
8	Spare Part for DVOR Equipment	1	one complete unit which is under single system configuration	7.2
	Spare Part for DME Equipment	1	one complete unit which is under single system configuration	7.4
	Spare Part for DVOR carrier antenna	1	Spare parts shall consist of the antenna element, antenna cover, RF feeding cable and RF cable lightning protection kit.	7.3.1
	Spare Part for DVOR sideband antenna	4	Spare parts shall consist of the antenna element, antenna cover, RF feeding cable and RF cable lightning protection kit.	7.3.1
	Spare Part for DME antenna	1	Spare parts shall consist of the antenna, RF feeding cable and RF cable lightning protection kit.	7.5
	Spare Part for RCSU	1	100 % Whole unit	7.6
	Spare Part for RSU	1	100 % Whole unit	7.6
	Spare Part for Double LED OBS Light	1		7.7
10	List of recommend installation and Maintenance tools	1		8.1
	Portable Navigational Signal Analyzer (PIR)	1		7.1
	Waveform analysis tools (Oscilloscope)	1		8.1
	Thru-line wattmeter	1	Include Directional Coupler	8.1
	Digital multi-meter	1		8.1
	Portable RF power analysis	1		8.1
	Frequency counter	1		8.1
	Local Network Equipment	Recommend		6

ITEM	Description	Quantity	Remark	Reference Clause
	External Connector	Recommend		2.13.7
	Other equipment	Recommend		
	Accessories	Recommend		
<b>DOCUMENTS</b>				
11	Mechanical and electrical DVOR/DME drawings and whole network diagrams	1 (H), 2 (S)	“H” Stand for Hard Copy “S” Stand for Soft copy	9.1
	DVOR/DME installation and equipment instruction manuals	2 (H), 3 (S)		9.2
	DVOR/DME component part lists	2 (H), 3 (S)		9.3
	ICDs for DVOR/DME	1		6.4

**Project Name**

Procurement for Betong DVOR/DME

**Date**

February 21, 2019

Version 1.0

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# Attachment