SCOPE OF SPECIFICATIONS

1. TECHNICAL SPECIFICATIONS

2. CONSTRUCTION WORKS

TABLE OF CONTENTS

TOR OF ILS/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.
ICAO Doc 9157	Aerodrome Design Manual Part 6 : Frangibility, First Edition – 2006, Amendment 1.
FAA Order 6750.16E	Siting Criteria for Instrument Landing Systems, April 10, 2014.
FAA Order 8200.1D	United States Standard Flight Inspection Manual (USSFIM) with CHG 1, April 2015.
[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]	Two (2) complete systems of ILS/DME (Instrument Landing System /Distance Measuring Equipment) are required at the following airport /runway (see also APPENDIX A) :					
	Item	Airport /Runway				
	2.1.1	SUVARNABHUMI Airport /Runway 02L				
	2.1.2	SUVARNABHUMI Airport /Runway 20R				
2.2 [CO]	For each ILS/DME system, the Tenderer shall propose the equipment, as follows :					
	2.2.1 [CO]	LOC, GP and DME equipment, including their respective antenna systems				
		2.2.1.1 [ET]	Localizer (LOC) equipment shall consist of dual two-frequency (2F) transmitters and dual monitors.			
		2.2.1.2 [ET]	Glide path (GP) equipment shall consist of dual two-frequency (2F) transmitters and dual monitors.			
		2.2.1.3 [ET]	Distance Measuring Equipment (DME) shall consist of dual transponders and dual monitors.			
			2.2.1.3.1 [ET]	DME equipment shall be DME/N (Narrow Spectrum Characteristics).		
			2.2.1.3.2 [ET]	DME equipment shall be capable of transmitting at least 100 watts of power – the so called *"low-powered"* DME.		
			2.2.1.3.3 [ET]	DME equipment shall be collocated with GP equipment. However, the identification of DME shall be synchronized with the identification of LOC.		
	2.2.2 [CO]	Monitoring and control system, computers and network equipment are as specified in [6] [7] and [8], respectively.				
[CO]	The equipment shall be finalized and <u>not</u> in prototype form at the time the Tenderer submits the proposal.					
2.3 [ET]	For each ILS/DME system, the Tenderer shall design the specifications of LOC, GP and DME equipment and submit a supporting document (see APPENDIX B), which contains simulation results, at least, as follows :					
	Item	Parameter			LOC	GP	DME
	2.3.1	Radiation Patterns (Require only the case of flat terrain without obstacles)			✓	✓	✓
	2.3.2	Structure with respect to LOC course or GP path			✓	✓	-

	2.3.3	DDM Characteristics with respect to LOC azimuth or GP elevation	✓	✓	-
	2.3.4	Coverage (Usable Distance) Power Density or Field Strength	✓	✓	✓

Remark :

1. For the simulation results of [2.3.1], the Tenderer shall submit only the results of *"flat terrain without obstacles"* scenario, but for those of [2.3.2] [2.3.3] and [2.3.4], the Tenderer shall submit the results of both *"flat-terrain without obstacle"* scenario and *"terrain and obstacle"* scenario which uses the data from *"Site Survey Reports"* (APPENDIX C) as software inputs.

   The obstacles include not only buildings but also positioned aircrafts at the specific coordinates if such aircrafts affect the radiated guidance (navigation) signal.

   In case that the *"terrain and obstacle"* data provided by AEROTHAI are not directly compatible with the simulation software, the Tenderer may convert those data into a format that is usable by the software, provided that the significant contents -- such as obstacle geometry and terrain profiles -- is preserved.

2. The simulation results of the proposed ILS/DME system shall demonstrate that it is suitable for *"Site Survey Reports"* (APPENDIX C) and also meets flight test requirements and tolerances as stated in [Doc 8071 / Table I-4-7, Table I-4-8 and Table I-3-3 respectively]
   (see also [3.3.2] [3.3.3] [3.3.4] and [3.3.5] for LOC equipment, and
   [4.3.2] [4.3.3] [4.3.4] and [4.3.5] for GP equipment, and
   [5.3.2] and [5.3.3] for DME equipment)

2.4 [CO] The Contractor shall provide the LOC shelters and GP/DME shelters, including complete construction described in Section 2 : Construction Works. AEROTHAI has already designed the shelters based on Frangibility Standard [Doc 9157, Part 6 – Frangibility / Chapter 5 or 6].

Item	Airport /Approach Runway	LOC Shelter	GP/DME Shelter
2.4.1	SUVARNABHUMI Airport /Runway 02L	✓	✓
2.4.2	SUVARNABHUMI Airport /Runway 20R	✓	✓

Remark :
The symbol " ✓ " marks the places that the Contractor shall provide LOC shelters and GP/DME shelters.

2.5 [ET] The Tenderer shall design, and who has become the the Contractor shall then provide the associated antenna supporters -- namely, *"LOC Antenna Supporter"* and/or *"GP Antenna Tower"* (including complete construction), which shall comply with Frangibility Standard [ANNEX 14 / Vol. I / Paragraph 9.9.3] and [Doc 9157, Part 6 – Frangibility / Chapter 5 or 6]. AEROTHAI will provide all necessary *"Site Survey Reports"* (APPENDIX C), including the runway profile, to support the Tenderer's design process.

If the LOC antenna height exceeds 2 meters and the Tenderer considers that an LOC elevated platform is unnecessary, the LOC antenna supporters may alternatively be a "TOWER" type (Figure 2-1b), and shall be easy to climb and safe for maintenance activities.

Figure 2-1 : Example of LOC antenna supporters, which the antenna height exceeds 2 meters
a) LOC Elevated Platform b) LOC Support Tower

Item	Airport /Runway	LOC Ant Supporter	GP Ant Tower
2.5.1	SUVARNABHUMI Airport /Runway 02L	as designed	as designed
2.5.2	SUVARNABHUMI Airport /Runway 20R	as designed	as designed

Remark :

1. Only if the runway profile causes the line-of-sight coverage problem between the antenna radiating element and threshold crossing height (TCH), which makes aircraft receiver unable to capture the "COURSE (CRS)" energy, the LOC antenna array may be installed on an elevated platform [FAA Order 6750.16E / Chapter 2 / 5. Siting Requirements / e. Elevation].
2. The height of LOC antenna shall be designed to be as low as possible; however, the simulation results of the coverage (usable distance) shall still meet flight test requirements and tolerances [2.3.4].

2.6 [CO]	General requirements for LOC, GP and DME equipment.			
	2.6.1 [CO]	Power Supply System		
		2.6.1.1 [ET]	Each unit of LOC, GP 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).	
		2.6.1.2 [ET]	Each unit of LOC, GP 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.	
		2.6.1.3 [ET]	Each unit of LOC, GP 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.	
	2.6.2 [ET]	*"Signal-in-space quality"* of ILS shall at least comply with current Operational Category as follows :		
		Item	Airport /Runway	Operational Category
		2.6.2.1	SUVARNABHUMI Airport /Runway 02L	Cat II
		2.6.2.2	SUVARNABHUMI Airport /Runway 20R	Cat II
		"Low-powered" DME transponder, shall not contribute to the overall system error more than $\pm 0.5\,\mu s$ ($\approx$ 75 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 $\pm$ 185 m (0.1 NM) to the overall system error [ANNEX 10 / Vol. I / Paragraph 3.5.4.5.2 and 3.5.4.5.1.2].		
	2.6.3 [ET]	For each ILS/DME system, the Contractor shall provide ILS (LOC and GP) equipment that is certified for Facility Performance/Operational Category not lower than those stated in [2.6.2], the brand of the ILS (LOC and GP) equipment and DME equipment shall be the same. If the ILS/DME systems are the same Facility Performance/Operational Category, AEROTHAI forces the Tenderer to propose all such ILS/DME systems in the same specifications.		

2.6.4 [ET]	The equipment shall be designed for high-reliability operation. Tenderer shall submit a reliable report of performance, such as "INTEGRITY" and/or "MTBO", as part of the proposal. Integrity and/or MTBO of the ILS equipment shall be greater than the following [ANNEX 10 / Vol. I / Paragraph 3.1.3.12 and 3.1.5.8] :	

		LOC		GP	
Facility Cat	Service Level	Integrity	MTBO	Integrity	MTBO
I	2	$1-(1.0\times10^{-7})$	MTBO 1000	$1-(1.0\times10^{-7})$	MTBO 1000
II	3	$1-(0.5\times10^{-9})$	MTBO 2000	$1-(0.5\times10^{-9})$	MTBO 2000
IIIA	3				
IIIC	4		MTBO 4000		

The integrity of each Facility Performance Category refers to the value which is applicable to any one landing.

2.6.5 [ET]	The information of each unit of LOC, GP and DME equipment shall be provided in "ENGLISH" language, not to be mixed with other languages, at least, as follows:	
	2.6.5.1	Names and labels of hardware assemblies
	2.6.5.2	Software menus and data [6.4.2.2]
	2.6.5.3	Technical documents and test reports [12]
2.6.6 [ET]	All RF generators of LOC, GP and DME equipment shall be synthesizers.	
2.6.7 [EC]	Each unit of LOC, GP 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.	
	2.6.7.1	All data (event) logs shall be marked with *"Date & Time"*.
	2.6.7.2	*"Date & Time"* of the equipment shall be adjustable to be at the present time.
2.6.8 [ET]	If the status data of any LOC or GP 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 LOC, GP 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.	

	2.6.9 [EC]	For each ILS/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).	
	2.6.10 [CO]	Environmental Conditions	
		2.6.10.1 [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%.
		2.6.10.2 [ET]	Outdoor equipment shall be designed to be weatherproof. (The maximum relative humidity in Thailand is approximately 85%.)
2.7 [CO]	AC/DC power lines, transmission lines, communication lines (including construction works)		
	2.7.1 [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).	
	2.7.2 [ET]	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 Site Acceptance Test (SAT).	
	2.7.3 [EC]	If the installation work involves buried cables, they shall be of the *"underground"* type. AC power lines, transmission lines (and monitoring cables) and communication lines 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.	
	2.7.4 [CO]	The Contractor shall carry out the underground cable work, at least, as follows :	
		2.7.4.1 [CO]	Trenching and underground cable work shall be carried out in accordance with Section 2 : Construction Works.
		2.7.4.2 [CO]	The Contractor shall take responsibilities for any damages to existing and/or nearby underground cables and utilities.

	2.7.5 [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.	
2.8 [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) However, a LSP system relating to network equipment are separately stated in APPENDIX D.		
	2.8.1 [ET]	For each type of navigation station (LOC station or GP/DME station), the Tenderer shall summarize all LPS subsystems stated in [2.8.1.1] and [2.8.1.2] into "ONE" interconnection diagram, which shall include : a) AC power protection, as designed by AEROTHAI (Section 2 : Construction Works) b) Telecommunication protection, as designed by the Tenderer	
		2.8.1.1 [CO]	For AC power protection from LPZ 0 (Lightning Protection Zone 0) to LPZ 2, AEROTHAI designed the entire system, as detailed in Section 2 : Construction Works. The Tenderer are required to adhere to these specifications.
		2.8.1.2 [CO]	For telecommunication protection from antenna systems to RF transmission lines, the Tenderer shall design and who has become the Contractor shall provide a LSP subsystem.
			2.8.1.2.1 [ET] : The Tenderer shall design Air-Termination System to protect roof-top structure of the building/shelter, If the building/shelter is near the antenna.
			2.8.1.2.2 [ET] : The Tenderer 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.

			2.8.1.2.3 [ET]	The Tenderer shall design the Earth-Termination System for all antenna systems, including the field monitor antenna. The Earth-Termination System for the antenna systems shall be bonded to the Earth-Termination System of AEROTHAI [2.8.1.1] 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.
		[ET]	The Tenderer shall submit a list of, at least, major subsystems and/or devices of [2.8.1.2] to AEROTHAI. The proposed details regarding brands and models may be omitted.	
2.9 [CO]	Technical Supports For each ILS/DME system, the Contractor shall provide technical supports as follows :			
	2.9.1 [CO]	The Contractor shall be responsible for all installation works.		
	2.9.2 [CO]	The Contractor shall by oneself set up/configure (not only assist) all units of the ILS/DME system until the results of "COMMISSIONING" flight inspection and/or validation meet the requirements of the Civil Aviation Authority of Thailand (CAAT).		
2.10 [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 ILS/DME system.			

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

3. Specifications of Localizer

[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	LOC Transmitter characteristics		
[CO]	3.1.1 [ET]	The system shall operate with horizontal polarization in the frequency band of 108 MHz to 111.975 MHz, with 50 KHz spacing between channels [ANNEX10 / Vol. I – Paragraph 3.1.3.2.1 and 3.1.3.2.2].	
	3.1.2 [ET]	The frequency channels among LOC, GP and DME system shall be correlated [ANNEX10 / Vol. I – Paragraph 3.1.6.1, Table A / p. 3-103].	
	3.1.3 [ET]	Where two radio frequency carriers -- "COURSE (CRS)" and "CLEARANCE (CLR)", are used, the frequency tolerance of radio frequency carrier shall not exceed ± 0.002% Additionally, the nominal band occupied by these carriers shall be "SYMMETRICAL" about the assigned frequency. With all tolerances applied, the frequency separation between the carriers shall not be less than 5 kHz nor more than 14 kHz. [ANNEX 10 / Vol. I / Paragraph 3.1.3.2.1].	
	3.1.4 [CO]	The 90 and 150 Hz modulating signals (for guidance information) shall meet the specifications as follows :	
		3.1.4.1 [ET]	The frequency tolerance of 90 or 150 Hz tones shall be within ± 1.5% [ANNEX 10 / Vol. I / Paragraph 3.1.3.5.3 b) for Facility Performance Category II]
		3.1.4.2 [ET]	The modulation depth of 90 Hz and 150 Hz tones shall be adjustable, at least, between the limits of 18% and 22% [ANNEX 10 / Vol. I / Paragraph 3.1.3.5.2].
	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 3.1.3.9.2].
		3.1.5.2 [ET]	The modulation depth of 1020 Hz tone shall be adjustable, at least, between the limits of 5% and 15% [ANNEX 10 / Vol. I / Paragraph 3.1.3.9.2].
	3.1.6 [CO]	LOC identification signal.	
		3.1.6.1 [ET]	The LOC identification signal shall employ the International Morse Code and be configurable to consist of two or three letters. It shall be preceded by the International Morse Code signal of the letter "I", and also meet the requirements specified in [ANNEX 10 / Vol. I / Paragraph 3.1.3.9].

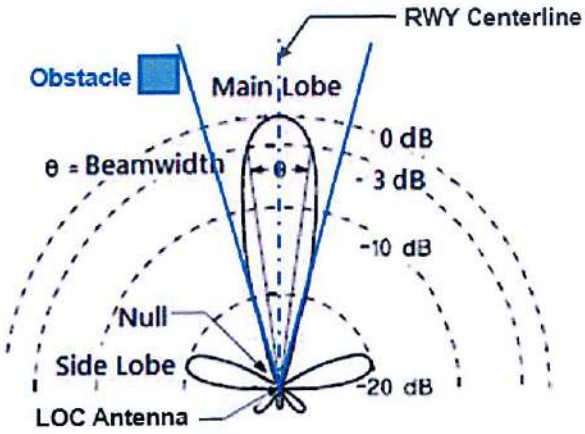
		3.1.6.2 [EC]	The identifications of LOC and DME shall be synchronized.
		3.1.6.3 [EC]	The LOC identification signal shall be automatically suppressed, when the system is set to bypass (testing) mode.
		3.1.6.4 [EC]	The LOC identification code shall be configurable by means of software only, with no necessity 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 CRS CSB (Course Carrier Plus Sideband Signal)
		(b)	Transmission Line for CRS SBO (Course Sideband Only Signal)
		(c)	Transmission Line for CLR CSB (Clearance Carrier Plus Sideband Signal)
		(d)	Transmission Line for CLR SBO (Clearance Sideband Only 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]	LOC parameters which affect the LOC guidance signal shall be mainly adjustable by software. However, some parameters may be additionally adjusted by hardware, if necessary. Additionally, LOC transmitter shall be configurable to operate in hot-standby or cold-standby mode.	

3.2	LOC Monitor Characteristics		
[CO]	3.2.1	The monitoring system of LOC 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 shall be done without turning off the equipment and without interrupting the operation of the "AERIAL" transmitter. 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).
		3.2.1.3 [ET]	To ensure that the LOC signal is still radiated within the conditions or tolerances specified in [ANNEX 10 / Vol. I / Paragraph 3.1.3.11.2], the monitoring system of LOC shall provide at least the following :
			3.2.1.3.1 "INTEGRAL" monitoring system [3.2.2].
			3.2.1.3.2 "STAND-BY" monitoring system [3.2.3].
			3.2.1.3.3 "NEAR-FIELD" monitoring system [3.2.4].
		3.2.1.4 [EC]	To be used as *"Fault Detection"*. LOC equipment shall be able to detect and initiate an appropriate *"notification"* and/or *"action"*, if any related abnormal condition occurs.
	3.2.2	The "INTEGRAL" monitoring system of LOC.	
	[CO]	3.2.2.1 [ET]	The integral monitoring system for the "AERIAL" transmitter shall provide, at least, the critical parameters as follows :

Item	Parameter
(a)	CRS RF Level
(b)	CLR RF Level
(c)	CRS Centerline DDM
(d)	CRS Centerline SDM
(e)	CRS Width DDM
(f)	CLR Width DDM
(g)	CRS Ident (at least status)
(h)	CRS & CLR Frequency Difference

	3.2.3 [CO]	The "STAND-BY" monitoring system of LOC.	
		3.2.3.1 [ET]	The stand-by monitoring system for the "STAND-BY" transmitter shall provide, at least, the critical parameters as follows :
			Item Parameter (a) CRS RF Level (b) CLR RF Level (c) CRS Centerline DDM (d) CRS Centerline SDM
	3.2.4 [CO]	The "NEAR-FIELD" monitoring system of LOC.	
		3.2.4.1 [ET]	The near-field monitoring system shall provide, at least, the critical parameters as follows :
			Item Parameter (a) Centerline RF Level (b) Centerline DDM (c) Centerline SDM
	3.2.5 [CO]	Warning and Alarm Conditions 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".	
		3.2.5.1 [EC]	*"Alarm Limits"* of the monitored parameters stated in [3.2.2.1] [3.2.3.1] and [3.2.4.1], if exist, shall be adjustable to be equal to their respective alarm limit values [ANNEX 10 / Vol. I / Paragraph 3.1.3.11.2].
		3.2.5.2 [EC]	*"Pre-Alarm Limits"* of the monitored parameters stated in [3.2.2.1] [3.2.3.1] and [3.2.4.1], if exist, shall be adjustable to be equal to 75% of their respective alarm limit tolerances [ANNEX 10 / Vol. I / Attachment C /Paragraph 2.8.4.7].
		3.2.5.3 [EC]	The monitoring system shall issue a "WARNING/ALERT" or an "ALARM", both in "AUDIBLE" and "VISUAL" mode.
	3.2.6 [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.	

	3.2.7 [ET]	For LOC, the maximum period allowing the system to radiate out-of-tolerance signal including period(s) of zero radiation (detected by the "INTEGRAL" monitoring system), shall be as short as practicable, not exceed 2 seconds under any circumstances [ANNEX 10 / Vol. I / Paragraph 3.1.3.11.3.1 and 3.1.3.11.3.2 for Facility Performance Category II]. The maximum period shall also be adjustable, at least, from 0 to 2 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 3.1.3.11.4].  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Factory Acceptance Test (FAT).
3.3	LOC 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 near-field monitoring (MON) antenna system. The TX antenna system shall be *"Log-Periodic Dipole (LPD)"* type.
	[EC]	After site installation, the Contractor shall also conclude the specifications of, at least, the following attributes : (a) "Directivity" of LOC antenna elements (b) "Number" of LOC antenna elements (c) "Spacing and Height" of LOC antenna elements (d) "Aperture Type" of LOC antenna elements (e) "Gain" of LOC antenna elements and/or array
		 Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Site Acceptance Test (SAT).

		Remark : 1. AEROTHAI will provide all necessary *"Site Survey Reports"* (APPENDIX C) of each ILS/DME system so that the Tenderer can make the design. If AEROTHAI does not specify vehicle/aircraft classes or critical/sensitive areas as described in [ANNEX 10 / Vol. I / Attachment C /Figure C-3 and Table C-1], The Tenderer shall design and who has become the Contractor shall provide "Aperture Type" of LOC antenna array with the best performance. 2. The TX antenna system shall be capable of radiating the LOC signal throughout the LOC frequency band (108 – 111.975 MHz) 3. All antenna supporters – mast and LOC elevated platform or LOC support tower, shall also be included in the antenna system (see also [2.5]).
	3.3.2 [ET]	*"Radiation Patterns"* The Tenderer shall submit the*"Radiation Patterns"* from the LOC antenna array (resulting from all antenna elements) and verify that the proposed LOC antenna system is suitable for the terrain and obstacle siting environment described in *"Site Survey Reports"* (APPENDIX C). AEROTHAI requires the simulation results only the case of flat terrain without obstacles scenario [2.3]. For each ILS/DME system, the 3dB CRS CSB horizontal beamwidth of LOC shall not subtend a horizontal angle, as opposed to the center of LOC antenna array, wider than double of the worst-case angle between obstacles and runway centerline.  Figure 3-1a : Criteria for proposing beamwidth of LOC

	3.3.3 [ET]	"Structure" The Tenderer shall submit the "Structure" from the LOC antenna array (resulting from all antenna elements), from both cases that siting environment are and are not taken into account, for AEROTHAI's consideration [2.3]. The "Structure" shall comply with [ANNEX 10 / Vol. I / Paragraph 3.1.3.4] [ANNEX 10 / Vol. I / Attachment C / Note to 2.1.2.5, Figure C-1 and Figure C-2] and [Doc 8071 / Table I-4-7].
	3.3.4 [ET]	*"DDM Characteristics"* The Tenderer shall submit the *"DDM Characteristics"* from the LOC antenna array (resulting from all antenna elements), from both cases that siting environment are and are not taken into account, for AEROTHAI's consideration [2.3]. The *"DDM Characteristics"* shall comply with [ANNEX 10 / Vol. I / Paragraph 3.1.3.7.4] [ANNEX 10 / Vol. I / Attachment C / Figure C-9] and [Doc 8071 / Table I-4-7].
	3.3.5 [ET]	*"Coverage (Usable Distance) - Power Density or Field Strength"* The Tenderer shall submit the *"Coverage (Usable Distance)"* from the LOC antenna array (resulting from all antenna elements), from both cases that siting environment are and are not taken into account, for AEROTHAI's consideration [2.3]. The *"Coverage (Usable Distance)"* shall comply with [ANNEX 10 / Vol. I / Paragraph 3.1.3.3] [ANNEX 10 / Vol. I / Attachment C / Figure C-7A and C-8A] and [Doc 8071 / Table I-4-7]. Additionally, the power of CLR signal shall be appropriately adjusted in order that the "CRS-to-CLR" signal ratio within the front CRS sector shall not be less than 10 dB for Facility Performance Category II [ANNEX 10 / Vol. I / Paragraph 3.1.3.3.4] Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the flight inspection/validation.
	3.3.6 [EC]	The Contractor shall install the near-field monitoring antenna system at a specific distance, which complies with the manufacturer installation manual, from the center of LOC antenna array.
	3.3.7 [ET]	The Contractor shall provide Double LED obstruction lights with photo switches as follows : Item Installation Position (a) At the top of both sides of LOC antenna array (2 sets). (b) At the top of near-field monitoring antenna (1 set).

		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.
	3.3.8 [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 Glide Path

[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	GP Transmitter characteristics		
[CO]	4.1.1 [ET]	The system shall operate with horizontal polarization in the frequency band of 328.6 MHz to 335.4 MHz, with 150 KHz spacing between channels [ANNEX10 / Vol. I – Paragraph 3.1.5.2.1 and 3.1.5.2.2].	
	4.1.2 [ET]	The frequency channels among LOC, GP and DME system shall be correlated [ANNEX10 / Vol. I – Paragraph 3.1.6.1, Table A / p. 3-103].	
	4.1.3 [ET]	Where two radio frequency carriers ("COURSE (CRS)" and "CLEARANCE (CLR)") are used, the frequency tolerance of radio frequency carrier shall not exceed ± 0.002% Additionally, the nominal band occupied by these carries shall be "SYMMETRICAL" about the assigned frequency. With all tolerances applied, the frequency separation between the carriers shall not be less than 4 kHz nor more than 32 kHz. [ANNEX 10 / Vol. I / Paragraph 3.1.5.2.1].	
	4.1.4 [CO]	The 90 and 150 Hz modulating signals (for guidance information) shall meet the specifications as follows :	
		4.1.4.1 [ET]	The frequency tolerance of 90 or 150 Hz tones shall be within ± 1.5 % [ANNEX 10 / Vol. I / Paragraph 3.1.5.5.2 b) for Facility Performance Category II]
		4.1.4.2 [ET]	The modulation depth of 90 and 150 Hz tones shall be adjustable, at least, between the limits of 37.5 % and 42.5 % [ANNEX 10 / Vol. I / Paragraph 3.1.5.5.1].
	4.1.5 [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).	
	4.1.6 [EC]	GP Antenna Phasers To compensate for inequality of "ELECTRICAL" length of each transmission line fed into the GP antenna, GP Antenna Phaser shall be embedded/inserted into each RF transmission line -- output of *"The GP Distribution Unit (DU)"*, at least, as follows :	

Item	Name of the Transmission Line	GP Ant Phaser
(a)	Transmission Line to the Upper Antenna	✓
(b)	Transmission Line to the Middle Antenna	as designed
(c)	Transmission Line to the Lower Antenna	✓

Remark :
AEROTHAI also accepts some certain designs that,
(a) No GP Antenna Phaser is embedded /inserted into *"Transmission Line to the Middle Antenna"* [4.1.6 (b)], or
(b) GP Antenna Phasers are alternatively adjusted by means of software.

Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the site installation.

4.1.7 [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/inserted into each RF transmission line of [4.1.6].

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.

4.1.8 [EC] GP parameters which affect the GP guidance signal shall be mainly adjustable by software. However, some parameters may be additionally adjusted by hardware, if necessary.

Additionally, GP transmitter shall be configurable to operate in hot-standby or cold-standby mode.

4.2	GP Monitor Characteristics			
[CO]	4.2.1	The monitoring system of GP shall serve, at least, the following purposes.		
	[CO]	4.2.1.1 [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.	
		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 shall be done without turning off the equipment and without interrupting the operation of the "AERIAL" transmitter. 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).	
		4.2.1.3 [ET]	To ensure that the GP signal is still radiated within the conditions or tolerances specified in [ANNEX 10 /Vol. I /Paragraph 3.1.5.7.1], the monitoring system of GP shall provide at least the following :	
			4.2.1.3.1	"INTEGRAL" monitoring system [4.2.2].
			4.2.1.3.2	"STAND-BY" monitoring system [4.2.3].
			4.2.1.3.3	"NEAR-FIELD" monitoring system [4.2.4].
		4.2.1.4 [EC]	To be used as *"Fault Detection"*. GP equipment shall be able to detect and initiate an appropriate *"notification"* and/or *"action"*, if any related abnormal condition occurs.	
	4.2.2	The "INTEGRAL" monitoring system of GP		
	[CO]	4.2.2.1 [ET]	The integral monitoring system for the "AERIAL" transmitter shall provide, at least, the critical parameters as follows :	
			Item	Parameter
			(a)	CRS RF Level
			(b)	CLR RF Level
			(c)	Path DDM (relative to 0 DDM)
			(d)	Path SDM
			(e)	Width DDM
			(f)	CRS & CLR Frequency Difference

	4.2.3 [CO]	The "STAND-BY" monitoring system of GP	
		4.2.3.1 [ET]	The stand-by monitoring system for the "STAND-BY" transmitter shall provide, at least, the critical parameters as follows :
			Item — Parameter (a) — CRS RF Level (b) — CLR RF Level (c) — Path DDM (relative to 0 DDM) (d) — Path SDM
	4.2.4 [CO]	The "NEAR-FIELD" monitoring system of GP.	
		4.2.4.1 [ET]	The near-field monitoring system shall provide, at least, the critical parameters as follows :
			Item — Parameter (a) — Path RF Level (b) — Path DDM (c) — Path SDM
	4.2.5 [CO]	Warning and Alarm Conditions 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".	
		4.2.5.1 [EC]	*"Alarm Limits"* of the monitored parameters stated in [4.2.2.1] [4.2.3.1] and [4.2.4.1], if exist, shall be adjustable to be equal to their respective alarm limit values [ANNEX 10 / Vol. I / Paragraph 3.1.5.7.1].
		4.2.5.2 [EC]	*"Pre-Alarm Limits"* of the monitored parameters stated in [4.2.2.1] [4.2.3.1] and [4.2.4.1], if exist, shall be adjustable to be equal to 75% of their respective alarm limit tolerances [ANNEX 10 / Vol. I / Attachment C /Paragraph 2.8.4.7].
		4.2.5.3 [EC]	The monitoring system shall issue a "WARNING/ALERT" or an "ALARM", both in "AUDIBLE" and "VISUAL" mode.
	4.2.6 [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.	

	4.2.7 [ET]	For GP, the maximum period allowing the system to radiate out-of-tolerance signal including period(s) of zero radiation (detected by the "INTEGRAL" monitoring system), shall be as short as practicable, not exceed 1 second under any circumstances [ANNEX 10 / Vol. I / Paragraph 3.1.5.7.3.1, 3.1.5.7.3.2 for Facility Performance Category II]. The maximum period shall also be adjustable, at least, from 0 to 1 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 3.1.5.7.4].  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Factory Acceptance Test (FAT).
4.3	GP antenna system	
[CO]	4.3.1 [ET]	The Tenderer shall design and who has become the Contractor shall provide both the transmitting (TX) antenna system and near-field monitoring (MON) antenna system. The TX antenna system shall be array type with clearance signals – the so called *"Capture Effect (CE)"*.
	[EC]	After site installation, the Contractor shall also conclude the specifications of, at least, the following attributes : (a) "Directivity" of GP antenna elements (b) "Number" of GP antenna elements (c) "Height" of GP antenna elements (d) "Gain" of GP antenna elements and/or array
		 Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Site Acceptance Test (SAT). Remark : 1. AEROTHAI will provide all necessary *"Site Survey Reports"* (APPENDIX C) of each ILS/DME system so that the Tenderer can make the design. 2. The TX antenna system shall be capable of radiating the GP signal throughout the GP frequency band (328.6 – 335.4 MHz) 3. All antenna supporters -- mast and GP antenna tower, shall also be included in the antenna system (see also [2.5]).

	4.3.2 [ET]	*"Radiation Patterns"* The Tenderer shall submit the*"Radiation Patterns"* from the GP antenna array (resulting from all antenna elements) and verify that the proposed GP antenna system is suitable for the terrain and obstacle siting environment described in *"Site Survey Reports"* (APPENDIX C). AEROTHAI requires the simulation results only the case of flat terrain without obstacles scenario [2.3].
	4.3.3 [ET]	*"Structure"* The Tenderer shall submit the *"Structure"* from the GP antenna array (resulting from all antenna elements), from both cases that siting environment are and are not taken into account, for AEROTHAI's consideration [2.3]. The *"Structure"* shall comply with [ANNEX 10 / Vol. I / Paragraph 3.1.5.4] [ANNEX 10 / Vol. I / Attachment C / Note to 2.1.2.5, Figure C-1 and Figure C-2] and [Doc 8071 / Table I-4-8]. Additionally, the Tenderer shall also submit a simulated TCH and/or RDH value (for each GP/DME station) to verify that the simulated value still meets the requirements specified in [ANNEX 10 / Vol. I / Paragraph 3.1.5.1.4, 3.1.5.1.5 or 3.1.5.6].
	4.3.4 [ET]	*"DDM Characteristics"* The Tenderer shall submit the *"DDM Characteristics"* from the GP antenna array (resulting from all antenna elements), from both cases that siting environment are and are not taken into account, for AEROTHAI's consideration [2.3]. The *"DDM Characteristics"* shall comply with [ANNEX 10 / Vol. I / Paragraph 3.1.5.3.1, 3.1.5.6 and Attachment C / Figure C-11] and [Doc 8071 / Vol. I / Table I-4-8]
	4.3.5 [ET]	*"Coverage (Usable Distance) - Power Density or Field Strength"* The Tenderer shall submit the *"Coverage (Usable Distance)"* from the GP antenna array (resulting from all antenna elements), from both cases that siting environment are and are not taken into account, for AEROTHAI's consideration [2.3]. The *"Coverage (Usable Distance)"* shall comply with [ANNEX 10 / Vol. I / Paragraph 3.1.5.3] [ANNEX 10 / Vol. I / Attachment C / Figure C-10] and [Doc 8071 / Table I-4-8].
	4.3.6 [EC]	The Contractor shall install the near-field monitoring antenna system at a specific distance, which complies with the manufacturer installation manual, from the center of GP antenna tower.

	4.3.7 [ET]	The Contractor shall provide Double LED obstruction lights <u>with</u> photo switches as follows : Item Installation Position (a) At the top of GP antenna tower (1 set). (b) At the top of near-field monitoring antenna (1 set). 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.
	4.3.8 [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. 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.

5.1	DME Transponder characteristics		
[CO]	5.1.1 [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].	
	5.1.2 [ET]	The frequency channels among LOC, GP and DME system shall be correlated. Additionally, the interrogation and reply frequencies of DME shall also be paired. [ANNEX10 / Vol. I – Paragraph 3.1.6.1, 3.5.3.3.4, Table A / p. 3-103].	
	5.1.3 [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].	
	5.1.4 [ET]	For *"low-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 -93 ± 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 -93 ± 1 dBW/m^2 is approximately -72.45 ± 1 dBm, where DME antenna gain and cable loss are assumed to be 14 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).	
	5.1.5 [CO]	For each incoming interrogation frequency drift, the bandwidth of the receiver shall meet the requirements as specified in the following :	
		5.1.5.1 [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].
		5.1.5.2 [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).	
	5.1.6 [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].	
	5.1.7 [ET]	Pulse shape shall meet the requirements of [ANNEX 10 / Vol. I / Paragraph 3.5.4.1.3].	
		5.1.7.1	Pulse rise time (between 10% to 90% of the leading edge) $\leq 3\ \mu s$
		5.1.7.2	Pulse decay time (between 90% to 10% of trailing edge) $\approx 2.5\ \mu s$, but $\leq 3.5\ \mu s$
		5.1.7.3	Pulse duration (between 50% of the leading, and trailing edges) $3.5 \pm 0.5\ \mu s$
		5.1.7.4	The instantaneous amplitude of the pulse shall <u>not</u>, 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.
	5.1.8 [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].	
		5.1.8.1	Pulse pair spacing shall be <u>not</u> exceed $(12.00 \pm 0.10)\ \mu s$.
		5.1.8.2	The peak power of the constituent pulses of any transponder pulse pair shall <u>not</u> differ by more than one (1) dB.
	5.1.9 [ET]	Reply delay, the interval between 50% amplitude of the leading edge of the interrogation pulse <u>and</u> 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 "<u>ZERO</u>" 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.	
	5.1.10 [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.	

	5.1.11 [CO]	The transponder shall be capable of continuous operation at a transmission rate (the so-called *"Pulse Repetition Rate"*) as follows :	
		5.1.11.1 [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].
		5.1.11.2 [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].
	5.1.12 [CO]	DME identification signal	
		5.1.12.1 [ET]	The DME identification signal shall employ the International Morse Code and be configurable to consist of two or three letters. It shall be preceded by the International Morse Code signal of the letter "I", and also meet the requirements specified in [ANNEX 10 / Vol. I / Paragraph 3.5.3.6].
		5.1.12.2 [EC]	The DME 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).
	5.1.13 [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).	
	5.1.14 [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.	
	5.1.15 [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. Additionally, DME transponder shall be configurable to operate in hot-standby or cold-standby mode.	

5.2	DME Monitor characteristics			
[CO]	5.2.1 [CO]	The monitoring system of DME shall serve, at least, the following purposes.		
		5.2.1.1 [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.	
		5.2.1.2 [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).	
			5.2.1.2.1 [EC]	Be able to generate, at least, <u>both</u> *"in tolerance"* <u>and</u> *"out of tolerance"* pulse pair spacing [5.2.1.3.1].
			5.2.1.2.2 [EC]	Be able to generate, at least, <u>both</u> *"in tolerance"* <u>and</u> *"out of tolerance"* reply delay [5.2.1.3.2].
			5.2.1.2.3 [EC]	Be able to select /adjust the deviated frequency of simulated interrogation signals, at least, ± 100 KHz and ± 900 KHz [5.1.5].
			5.2.1.2.4 [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 [5.1.4] 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 -1.45 dBm, where DME antenna gain and cable loss are assumed to be 14 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.
			5.2.1.2.5 [EC]	Be able to provide *"Transmission Rate"* test The DME transponder shall be capable of continuous operation at a transmission rate, complying with [5.1.11].

		5.2.1.3 [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 :	
			5.2.1.3.1 [EC]	Spacing error of transmitted pulse pair exceeds ± 1.0 μs [ANNEX 10 / Vol. I / Paragraph 3.5.4.7.2.4 c)].
			5.2.1.3.2 [EC]	Reply delay error exceeds ±0.5 μs for *"low-powered"* DME. [ANNEX 10 / Vol. I / Paragraph 3.5.4.7.2.2 b)].
			5.2.1.3.3 [EC]	A fall of 3 dB or more in transmitted power output. [ANNEX 10 / Vol. I / Paragraph 3.5.4.7.2.4 a)].
			5.2.1.3.4 [EC]	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 [ANNEX 10 / Vol. I / Paragraph 3.5.4.7.2.4 b)].
		5.2.1.4 [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.	
	5.2.2 [CO]	Warning and Alarm Conditions 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".		
		5.2.2.1 [EC]	*"Alarm Limits"* of the monitored parameters stated in [5.2.1.3.1] to [5.2.1.3.4], if exist, shall be adjustable to be equal to their respective alarm limit values [ANNEX 10 / Vol. I / Paragraph 3.1.5.7.1].	
		5.2.2.2 [EC]	The monitoring system shall issue an "ALARM", both in "AUDIBLE" and "VISUAL" mode.	
	5.2.3 [ET]	The monitoring system shall be configurable to either single or dual monitor system. When dual monitor system is configured, the decision logic of "AND" and "OR" mode shall also be available.		

	5.2.4 [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).
5.3	DME antenna system	
[CO]	5.3.1 [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 TX antenna system shall be *"Uni-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. AEROTHAI will provide all necessary *"Site Survey Reports"* (APPENDIX C) of each ILS/DME system so that the Tenderer can make the design. 2. The XPDR antenna system shall be capable of radiating the DME signal throughout the DME frequency band (960 – 1215 MHz) 3. All antenna supporters -- mast and GP antenna tower, shall also be included in the antenna system (see also [2.5]).

		4. The Contractor shall mount the XPDR antenna on the *"GP Antenna Tower"*, at the appropriate height, but lower than the top of the *"GP Antenna Tower"*. Therefore, double LED obstruction light with photo switch shall not be provided for DME 5. The contractor shall not provide *"Lightning Rod Assembly"* for the XPDR antenna.
	5.3.2 [ET]	*"Radiation Patterns"* The Tenderer shall submit the *"Radiation Patterns"* from the DME antenna and verify that the proposed DME antenna is suitable for the terrain and obstacle siting environment described in *"Site Survey Reports"* (APPENDIX C). AEROTHAI requires the simulation results only the case of flat terrain without obstacle scenario [2.3]
	5.3.3 [ET]	Coverage - Power Density or Field Strength The Tenderer shall submit the *"Coverage"* from the DME antenna, from both cases that siting environment are and are not taken into account, for AEROTHAI considerations [2.3]. The *"Coverage"* shall comply with [ANNEX 10 / Vol. I / Paragraph 3.5.3.1.2.2 and 3.5.4.1.5.2] [ANNEX 10 / Vol. I / Attachment C / Figure C-20] and [Doc 8071 / Table I-3-3].

6. Specification of Monitoring and Control System

[CO]	A complete *"monitoring & control"* system of each ILS/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.		
6.1	Local Control and Monitoring Unit (LCMU)		
[CO]	LCMU is a "BUILT-IN" unit, used to locally monitor and control the equipment. It's typically embedded into each unit of LOC, GP and DME equipment.		
	6.1.1 [ET]	*"LCMU of LOC"*, *"LCMU of GP"* and *"LCMU of DME"* shall provide, at least, the functions, as described in Table 6.1.	
6.2	Remote Control and Monitoring Unit (RCMU)		
[CO]	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.		
	6.2.1 [ET]	*"RCMU of LOC"*, *"RCMU of GP"* and *"RCMU of DME"* shall provide, at least, the functions, as described in Table 6.1.	
	6.2.2 [EC]	RCMU of [6.2.1] shall be combined into the same unit – *"RCMU of ILS/DME"*. If exists, *"RCMU of ILS/DME"* of the same airport /runway, in the same procurement, shall also be combined into the same unit.	
	6.2.3 [ET]	The Contractor shall also provide a suitable-sized rack for mounting the *"RCMU of ILS/DME"*.	
6.3	Remote Status Unit (RSU)		
[CO]	RSU is a unit, used only to remotely monitor the equipment. It's typically located at the ATC room of the ATC tower.		
	6.3.1 [ET]	*"RSU of LOC"*, *"RSU of GP"* and *"RSU of DME"* shall provide, at least, the functions, as described in Table 6.1.	
	6.3.2 [EC]	RSU of [6.3.1] shall be combined into the same unit – *"RSU of ILS/DME"*. If exists, *"RSU of ILS/DME"* of the same airport/runway, in the same procurement, shall also be combined into the same unit.	

6.4 [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 each LOC or GP/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.		
	6.4.1 [ET]	LMM and RMM computer shall provide, at least, the functions, as described in Table 6.1.	
	6.4.2	LMM and RMM computer shall be a desktop computer, complying with [7.1].	
		6.4.2.1 [EC]	One (1) LMM computer shall be provided for one (1) LOC station. One (1) LMM computer shall be provided for one (1) GP/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.
		6.4.2.2 [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.
6.5 [CO]	A Runway Selection System (An Interlock System)		
	6.5.1 [ET]	The Contractor shall provide and configure a runway selection system (including the Interface Control Documents (ICDs)), in order to ensure that only one ILS/DME system shall radiate at a time. When switching from one ILS/DME system to another system, radiation from both shall be suppressed for not less than 20 s [ANNEX 10 / Vol. I / Paragraph 3.1.2.7.1] and [FAA Order 6750.16E/ Chapter 1/ Paragraph 15].	

Item	Airport /Runway	Interlock
(a)	SUVARNABHUMI Airport /Runway 02L	✓
(b)	SUVARNABHUMI Airport /Runway 20R	

Remark :
The symbol " ✓ " marks the places that AEROTHAI require the runway selection system.

Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Site Acceptance Test (SAT).

	6.5.2 [ET]	A runway selection system shall be failsafe designed – Failure of any interlock component to include the interfacility connection must ensure *"no change"* in radiating status [FAA Order 6750.16E/ Chapter 1/ Paragraph 15/ item a (2) (c)]. When a failure occurs as prescribed above, the design of the runway selection system shall also allow AEROTHAI personnel to dismiss that faulty runway selection system, and return to the condition that both ILS/DME systems are operated independently.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Site Acceptance Test (SAT).
	6.5.3 [EC]	A runway selection system shall be a single management system which is monitored and controlled by only one software program and/or only one hardware unit, so that an end-user can easily perform such runway selection.  Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Site Acceptance Test (SAT).

[CO] Table 6.1 : Functions of monitoring & control unit

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

7. Specifications of Computer.

7.1	Desktop Computer		
[CO]	The Contractor shall provide *"ALL in One"* desktop computers, including all attached devices complying with, at least, as follows :		
	7.1.1 [ET]	All components including a mouse and a keyboard shall be produced from the same manufacturer with permanent "LOGO/BRAND" on products.	
	7.1.2 [ET]	Processor/Chipset	
		7.1.2.1	The number of processing unit : Core ≥ 6 cores, Thread ≥ 6 threads
		7.1.2.2	Base clock frequency ≥ 1.2 GHz
		7.1.2.3	Maximum single-core clock frequency ≥ 4.5 GHz
	7.1.3 [ET]	RAM	
		7.1.3.1	Technology – DDR5 or better
		7.1.3.2	Capacity ≥ 8 GB
	7.1.4 [ET]	One (1) Storage Drive	
		7.1.4.1	Solid State Drive ≥ 480 GB
	7.1.5 [ET]	One (1) Optical Disc Drive	
		7.1.5.1	Internal or portable DVD-RW Drive, or better
	7.1.6 [ET]	Graphic Controller	
		7.1.6.1	Built-in graphic or dedicated graphic controller
		7.1.6.2	Graphic memory (including the memory allocated from RAM) ≥ 1.0 GB
	7.1.7 [ET]	One (1) Display	
		7.1.7.1	≥ 21.5 inches LED with resolution 1920 x 1080 pixels
	7.1.8 [ET]	Networking	
		7.1.8.1	Gigabit Ethernet, or better
		7.1.8.2	Wi-Fi, at least compliant with Wi-Fi 5 (IEEE 802.11ac) 2.4 GHz / 5 GHz
		7.1.8.3	Bluetooth
	7.1.9 [ET]	I/O Interface	
		7.1.9.1	Serial Port, or an adapter converting USB to Serial Port
	7.1.10 [ET]	One (1) Keyboard and One (1) Mouse	
		7.1.10.1	Each key shall be permanently printed with both Thai and English characters.

	7.1.11 [EC]	Operation System, Drivers and Software	
		7.1.11.1	The operating system shall be "WINDOWS-BASED".
		7.1.11.2	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).
		7.1.11.3	The recovery CD/DVD (or any portable data storage devices) and the user's license for the software shall be provided for AEROTHAI.
	7.1.12 [EC]	The Desktop Computer shall have a manufacturer branch office authorized representative in Thailand.	
	7.1.13 [EC]	One (1) set of office table and chair shall be provided for one (1) desktop computer (not including the spare computers).	

8. Specifications of Network Equipment

[CO] All details of network equipment (microwave and peripheral devices), will be referred to the original document in APPENDIX D. However, the bill of quantities for the Network Equipment are again summarized in APPENDIX B.

9. Intersystem Connection and Network Diagram

[CO]	This section will depict intersystem connection and network diagram among equipment, which is stated in [3] to [8]. The Tenderer and who has become the Contractor shall comply with the requirements, at least, as follows :	
9.1 [EC]	For each ILS/DME system, the *"Intersystem Connection and Network Diagram"* ([Fig. 9-1] and APPENDIX D) shall be used as guidelines. After site installation, the Contractor shall submit the revised diagram that reflects the actual installation condition to AEROTHAI. *"Intersystem Connection and Network Diagram"* of the same airport/runway, in the same procurement, may be combined into the same diagram. Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the Site Acceptance Test (SAT).	
9.2 [CO]	Be reminded that, for each ILS/DME system, the Contractor shall provide the equipment in order to fulfill a complete *"monitoring & control"* system as follows:	
	9.2.1 [CO]	A set of monitoring & control equipment [6][7].
	9.2.2 [CO]	A set of network equipment (microwave and peripheral devices) [8] and APPENDIX D.
	9.2.3 [CO]	A set of optical fibers, stated in Section 2 : Construction Works.
[CO]	For this procurement, the Contractor shall also be responsible for configuring network connections, till the *"monitoring & control"* system is properly functioning [2.9].	

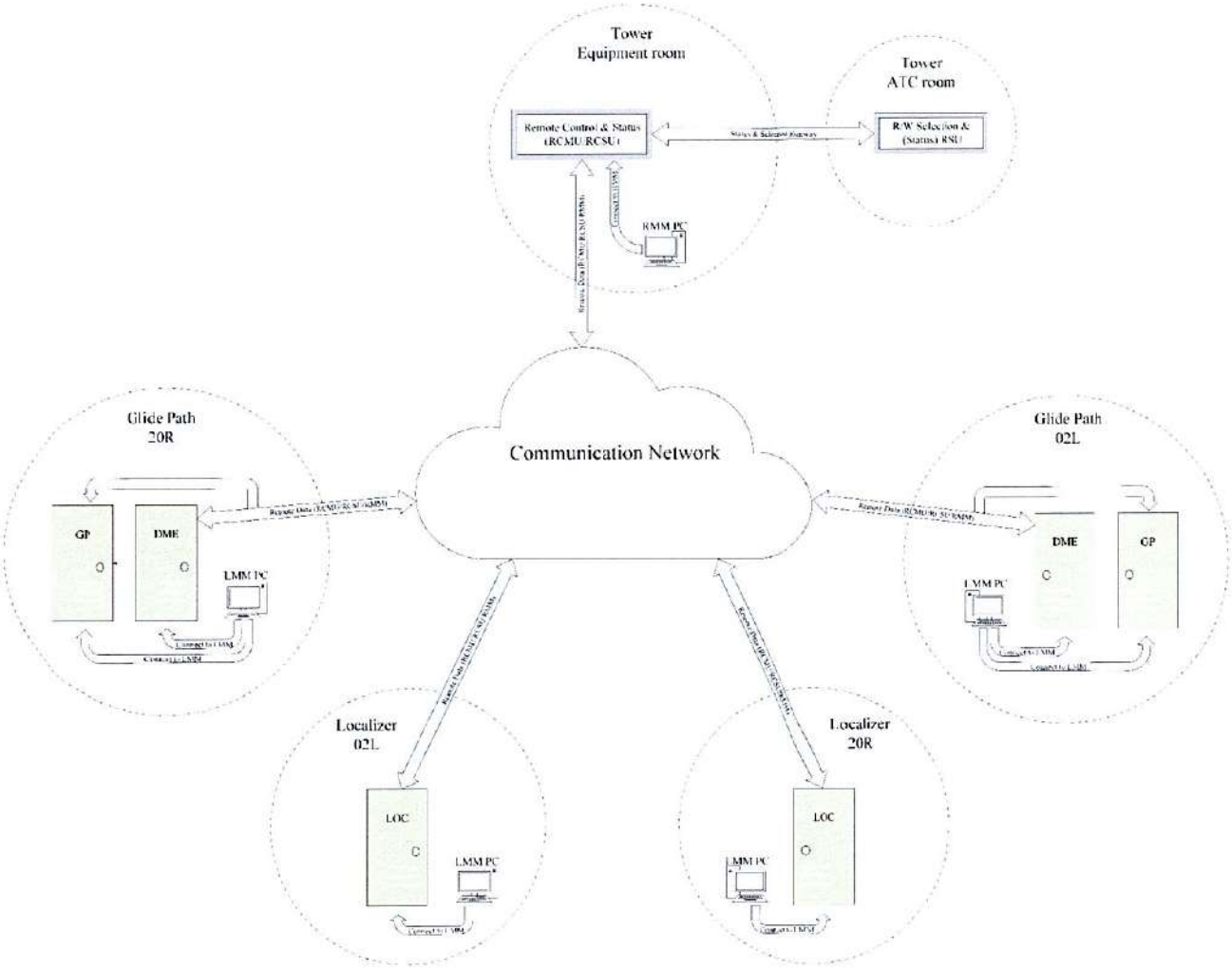


Figure 9-1 : Intersystem connection for both ILS/DME system
(AEROTHAI Conceptual Diagram)

10. 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 :

10.1 [EC] For each unit of the LOC equipment, LOC 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), RF combining unit (CU), and LOC antenna system. When the spare parts of the LOC antenna system are as follows :

Item	Spare Parts
(a)	Two (2) sets of Transmitting (TX) Antenna Element
(b)	One (1) set of Near-Field Monitoring Antenna, only for the Runway 02L

For each unit of the LOC equipment, one (1) set of double LED obstruction light with photo switch shall also be provided as the spare parts.

10.2 [EC] For each unit of the GP equipment, GP 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 assembly (CCAs), and any other common subsystem, such as backplanes, RF transfer switches, RF distribution unit (DU), RF combining unit (CU), and GP antenna system. When the spare parts of the GP antenna system are as follows :

Item	Spare Parts
(a)	One (1) set of Transmitting (TX) Antenna Element
(b)	One (1) set of Near-Field Monitoring Antenna, only for the Runway 02L

For each unit of the GP equipment, one (1) set of double LED obstruction light with photo switch shall also be provided as the spare parts.

10.3 [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, only for the Runway 02L not including *"Lightning Rod Assembly"* for the XPDR antenna.

10.4 [EC]	For this procurement, one (1) unit of *"RCMU of ILS/DME"* shall be provided as a spare unit (see also [6.2.2]). Reminded that, *"RCMU of ILS/DME"* shall be combined into the same unit.
10.5 [EC]	For this procurement, one (1) unit of *"RSU of ILS/DME"*, shall be provided as a spare unit (see also [6.3.2]) Reminded that, *"RSU of ILS/DME"* shall be combined into the same unit.
10.6 [EC]	For this procurement, one (1) unit of *"the runway selection system (the interlock system)"* shall also be provided as a spare unit (see also [6.5.1]).

11. Requirements of Supplements.

11.1 [CO]	The Contractor shall submit the basic requirements of supplements – *"Measuring Instruments"* and *"Tools & Accessories"*, at least, as follows :	
	11.1.1 [EC]	The Contractor shall submit a list of *"Measuring Instruments"* [11.2] and [11.3], 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.
	11.1.2 [EC]	The Contractor shall submit a list of *"Tools & Accessories"* [11.4], 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).	
11.2 [CO]	For each airport/runway, the Contractor shall provide only one (1) Portable Navigational Signal Analyzer (PNSA) :	
	11.2.1 [EC]	The PNSA shall be designed for measuring critical performance parameters of at least LOC, GP and DVOR equipment.
	11.2.2 [EC]	In case of measuring the LOC or GP parameters, the PNSA function shall provide selectable capturing capability such as *"CRS Only"*, *"CLR Only"* or *"CRS & CLR"*, so that engineer staffs can easily diagnose which group of the ILS signals cause distortion in the ILS "COMPOSITE" signal.
	11.2.3 [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.
	11.2.4 [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.	

11.3 [EC]	For each airport/runway, 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 ILS (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 [5.1.9] 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 .
	Each unit of *"Measuring Instruments"* shall have an authorized representative in Thailand.
	Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI during the site installation.
11.4 [EC]	For each airport/runway, 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 [5.1.14] (c) A set of RF sampler elements for LOC and GP (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.

12. Requirements of Technical Documents and Test Reports

[CO]	The Contractor shall provide documents as follows : (All documents relating to network equipment (APPENDIX D) are also included herein.)		
	12.1 [EC]	After completion of factory acceptance test (FAT), the *"FAT Report"* shall be provided for <u>each</u> ILS/DME system :	
		12.1.1	One (1) original.
		12.1.2	Two (2) sets of hard copy.
		12.1.3	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).	
	12.2 [EC]	Before site installation, the related *"Equipment Manual"* containing all information about installation, operation and maintenance procedure, shall be provided for each unit of LOC, GP, DME, RCMU, RSU and Network Equipment.	
		12.2.1	Two (2) sets of hard copy.
		12.2.2	One (1) set of soft copy.
		Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI before site installation.	
	12.3 [EC]	Before site installation, the related *"Assembly Drawings"* and *"Schematic Diagrams"* shall be provided for each unit of LOC, GP, DME, RCMU, RSU and Network Equipment.	
		12.3.1	Two (2) sets of hard copy.
		12.3.2	One (1) set of soft copy.
		Even though the Tenderer accepts this condition, the task will again be inspected by AEROTHAI before site installation.	
	12.4 [EC]	After completion of site acceptance test (SAT) and commissioning flight inspection, the *"SAT Report"* shall be provided for <u>each</u> ILS/DME system, The document shall include information about LOC, GP, DME, RCMU, RSU and Network Equipment.	
		12.4.1	One (1) original.
		12.4.2	Two (2) sets of hard copy.
		12.4.3	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 ILS/DME Systems

Item	Airport / Approach Runway	Airport Operator	Regional Control Center	Frequency /Channel		
				LOC (MHz)	GP (MHz)	DME (CH.)
1.	Suvarnabhumi International Airport /RWY 02L	AOT	CENTER	108.7	330.5	24X
2.	Suvarnabhumi International Airport /RWY 20R			111.7	333.5	54X

APPENDIX B

Supporting Documents and Bill of Quantities

The Tenderer shall submit the supporting documents as stated in Table B.1, and who has become the Contractor shall provide the quantities as stated in Table B.2 :

Table B.1 : Supporting Documents

Item	Topic	Quantity	Remark
1	A summary of the complete LSP system, which is "ONE" interconnection diagram for each type of navigation station (LOC station or GP/DME station), that covers the details, at least, as follows : a) AC power protection, as designed by AEROTHAI b) Telecommunication protection, as designed by the Tenderer (not stated in Section 2 : Construction Works) Additionally, list of major LSP subsystems and/or devices for telecommunication protection shall also be submitted.	2 (1 for LOC 1 for GP/DME)	See [2.8.1] [2.8.1.2]
2	A design of navigation equipment, at least, as follows : a) Brand and models of the LOC, GP and DME equipment b) Specifications of LOC antenna supporter and GP antenna tower c) Simulation results of [2.3], d) Performance report of LOC and GP equipment, such as "INTEGRITY" and/or "MTBO" e) Frangibility test or evaluation report of sample, related to LOC antenna supporter and GP antenna tower, by a method complying with Frangibility Standard [Doc 9157, Part 6 – Frangibility / Chapter 5 or 6]. However, the Tenderer shall not submit the report related to GP/DME shelters, because AEROTHAI has already designed and evaluated GP/DME shelter, based on such Frangibility Standard. Then the justification for the Tenderer's chosen specifications shall also be submitted.	 3 2 6 2 2	See [2.3] [2.4] [2.5] [2.6.4]

Table B.2 : Bill of Quantities for ILS/DME systems and Network Equipment

Item	Descriptions	Quantity	Remark
1	LOC Shelter	2	See [2.4].
	GP/DME Shelter	2	The quantities are already stated in BOQ of section 2: Construction Works
2	LOC TX Antenna Supporter	2	See [2.5].
	LOC NF Antenna Supporter	2	
	GP TX Antenna Tower	2	
	GP NF Antenna Supporter	2	
	DME XPDR Antenna Supporter	2	
3	A Set of AC power lines	2	See [2.7.1] for each ILS/DME system.
	A Set of Transmission lines	2	
	A Set of Communication Lines	2	
	A Set of Installation Materials	2	
4	A Complete LSP system for LOC	2	See [2.8.1.2] for each LOC or GP/DME station.
	A Complete LSP system for GP/DME	2	
5	A summary of the LOC specifications with the key attributes	1	See [3.3.1]
	A summary of the GP specifications with the key attributes	1	See [4.3.1]
	A summary of the DME specifications with the key attributes	1	See [5.3.1]
6	LOC Equipment	2	See [3.1] and [3.2].
	GP Equipment	2	See [4.1] and [4.2].
	DME Equipment	2	See [5.1] and [5.2].
	TX Antenna System for LOC	2	See [3.3] and [10.1].
	- Elements as spare units	4 El.	
	TX Antenna System for GP	2	See [4.3] and [10.2].
	- Elements as spare units	2 El.	
	XPDR Antenna System for DME	2	See [5.3] and [10.3].
	- A whole spare unit	1	
	NF MON Antenna System for LOC	2	See [3.3] and [10.1].
	- A whole spare unit	1	
	NF MON Antenna System for GP	2	See [4.3] and [10.2].
	- A whole spare unit	1	

Item	Descriptions	Quantity	Remark
7	Adapter to Ethernet Data Format	as designed	See [2.6.8], only if the status data do not natively support the Ethernet format.
8	Double LED OBS Light for LOC - A whole spare unit Double LED OBS Light for GP - A whole spare unit Double LED OBS Light for DME	6 2 4 2 N/A	See [3.3.7] and [10.1], including photo switch. See [4.3.7] and [10.2], including photo switch.
9	RCMU of ILS/DME - A whole spare unit	1 1	See [6.2] and [10.4]. If exists, RCMU of ILS/DME of the same airport/runway, in the same procurement, shall also be combined into the same unit. The Contractor shall also provide a suitable-sized rack for mounting the *"RCMU of ILS/DME"*.
10	RSU of ILS/DME - A whole spare unit	1 1	See [6.3] [6.5] and [10.5]. If exists, RSU of ILS/DME of the same airport/runway, in the same procurement, shall also be combined into the same unit.
11	Runway Selection System - A whole spare unit	1 1	The runway selection system may not need to be combined into the same unit with the RSU.
12	Desktop Computer for LMM - A whole spare unit (with components in the remark)	4 1	See [6.4.2.1]. One (1) LMM computer shall be provided for one (1) LOC station and one (1) GP/DME station One (1) RMM computer shall be provided for one (1) airport
	Desktop Computer for RMM (with components in the remark)	1	

Item	Descriptions	Quantity	Remark
			One (1) computer shall also be provided as a spare unit for one (1) airport. 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) A Set of Table and Chair [7.1.13]
13	Digital Microwave Radio ODU Digital Microwave Radio IDU Antenna Dish (Frequency Range 7-8 GHz) Rectifier 48 Volt Layer 2 Ethernet switch	8 8 8 8 8	See Appendix D /[4.1.1] See Appendix D /[4.2] See Appendix D /[4.1.2] See Appendix D /[4.3] See Appendix D /[4.4]
14	A design of *"Intersystem Connection and Network Diagram"*, including frequency allocation of each microwave routing, shall be submitted before site installation. After site installation a revised version of the the diagram shall again be submitted.	2	See [9.1] and Appendix D / [5.1] *"Intersystem Connection and Network Diagram"* of the same airport / runway, in the same procurement, may be combined into the same diagram.
15	Spare Parts for LOC Spare Parts for GP Spare Parts for DME Spare Parts for LSP	2 2 2 N/A	See [10.1] [10.2] and [10.3]. 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].

Item	Descriptions	Quantity	Remark
16	Measuring Instrument (with documents in the remark) PNSA Digital Multimeter Frequency Counter RF Wattmeter for ILS RF Power Sensor for DME (or RF Power Analyzer for DME) Oscilloscope	1	See [11.1.1][11.2] and [11.3] for each airport/runway. 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
17	Tools & Accessories (with documents in the remark) A Set of Watt Elements A Directional Coupler for DME A Set of Sampler Elements for LOC and GP 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	1	See [11.1.2] and [11.4] for each airport/runway. 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)
18	FAT Report (Original) FAT Report (Hard Copy) FAT Report (Soft Copy)	2 4 2	See [12.1].
19	SAT Report (Original) SAT Report (Hard Copy) SAT Report (Soft Copy)	2 4 2	See [12.4]. for <u>each</u> ILS/DME system (including RCMU, RSU and Network Equipment).
20	Equipment Manual for LOC (HC) Equipment Manual for GP (HC) Equipment Manual for DME (HC) Equipment Manual for RCMU/RSU (HC) Equipment Manual for Network (HC) ICDs for ILS/DME (HC) Equipment Manual for LSP (HC)	4 4 4 4 3 4 Optional	See [12.2] and [2.6.9]. Where HC is Hard Copy and SC is Soft Copy. See [Appendix D /[6]] The Equipment Manual of Network Equipment, shall be comprised of those, stated in [Item 13]

Item	Descriptions		Quantity	Remark
	Equipment Manual for LOC	(SC)	2	
	Equipment Manual for GP	(SC)	2	
	Equipment Manual for DME	(SC)	2	
	Equipment Manual for RCMU/RSU	(SC)	2	
	Equipment Manual for Network	(SC)	3	
	ICDs for ILS/DME	(SC)	2	
	Equipment Manual for LSP	(SC)	Optional	
21	Assembly Drawings for LOC	(HC)	4	See [12.3]
	Assembly Drawings for GP	(HC)	4	Where HC is Hard Copy and SC is Soft Copy.
	Assembly Drawings for DME	(HC)	4	
	Assembly Drawings for RCMU/RSU	(HC)	4	
	Assembly Drawings for Network	(HC)	3	
	Assembly Drawings for LOC	(SC)	2	
	Assembly Drawings for GP	(SC)	2	
	Assembly Drawings for DME	(SC)	2	
	Assembly Drawings for RCMU/RSU	(SC)	2	
	Assembly Drawings for Network	(SC)	3	
22	Schematic Diagrams for LOC	(HC)	4	
	Schematic Diagrams for GP	(HC)	4	
	Schematic Diagrams for DME	(HC)	4	
	Schematic Diagrams for RCMU/RSU	(HC)	4	
	Schematic Diagrams for Network	(HC)	3	
	Schematic Diagrams for LOC	(SC)	2	
	Schematic Diagrams for GP	(SC)	2	
	Schematic Diagrams for DME	(SC)	2	
	Schematic Diagrams for RCMU/RSU	(SC)	2	
	Schematic Diagrams for Network	(SC)	3	
23	A set of tables and chairs		5	See [7.1.13]