SCOPE OF SPECIFICATIONS

1. TECHNICAL SPECIFICATIONS

2. CONSTRUCTION WORKS

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TOR OF ILS/DME SYSTEMS FOR RADIO NAVIGATION AIDS

SECTION 1

TECHNICAL SPECIFICATIONS

In case that proposed technical specifications are not consistent with published technical specifications on manufacturer website, AEROTHAI reserves the right to adhere to the information on the published website.

1. Definitions

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 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.
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.

2. General Requirements

2.1	Two (2) complete systems of ILS/DME (Instrument Landing System /Distance Measuring Equipment) are required at the following stations (see also APPENDIX A) :					
	Item	Airport /Runway				
	2.1.1	SUVARNABHUMI Airport /Runway 02L				
	2.1.2	SUVARNABHUMI Airport /Runway 20R				
2.2	For each ILS/DME system, the Contractor shall provide the equipment, as follows :					
	2.2.1	LOC, GP and DME equipment, including the related antenna system				
		2.2.1.1	Localizer (LOC) equipment shall be dual two-frequency (2F) transmitters and dual monitors.			
		2.2.1.2	Glide path (GP) equipment shall be dual two-frequency (2F) transmitters and dual monitors.			
		2.2.1.3	DME equipment shall be dual transponders and dual monitors.			
			2.2.1.3.1	DME equipment shall be DME/N (Narrow Spectrum Characteristics).		
			2.2.1.3.2	DME equipment shall be capable of transmitting at least 100 watts of power – the so called *"low-powered"* DME.		
			2.2.1.3.3	DME equipment shall be collocated with GP equipment. However, the identification of DME shall be synchronized with the identification of LOC.		
	2.2.2	Monitoring and control system, computers and network equipment are as specified in [6] [7] and [8], respectively.				
2.3	For each ILS/DME system, the Tenderer shall design the specifications of LOC, GP and DME equipment, and submit a supportive document (see APPENDIX C), which includes simulation results derived from standard software. The simulation results shall cover, 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 with no 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 compatible with the simulation software, the Tenderer shall convert those data to a format that can be used as software inputs, while preserving significant contents such as obstacle geometrical shapes and terrain profiles.

2. Before the supportive document explains the reasons why the Tenderer has chosen such specifications, the simulation results of the proposed ILS/DME system shall be shown 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 [3.3.3] [3.3.4] [3.3.5] and [3.3.6] for LOC equipment, and
   [4.3.3] [4.3.4] [4.3.5] and [4.3.6] for GP equipment, and
   [5.3.2] and [5.3.3] for DME equipment)

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

Item	Airport /Approach Runway	LOC Building	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 navigation aids buildings/shelters. The symbol " - " marks the places that AEROTHAI will be using an "EXISTING" ones, but the Contractor may still be responsible to renovate the buildings/shelters as stated in Section 2 : Construction Works.

2.5 The Tenderer shall design and who has become the Contractor shall also provide the related antenna supporters – *"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 longitudinal runway profile, so that the Tenderer can make a design.

In case that the Tenderer considers that a LOC Elevated Platform is unnecessary, while the antenna height exceeds 2 meters, the LOC antenna supporters shall be easy to climb and safe for maintenance (Figure 2-1b).

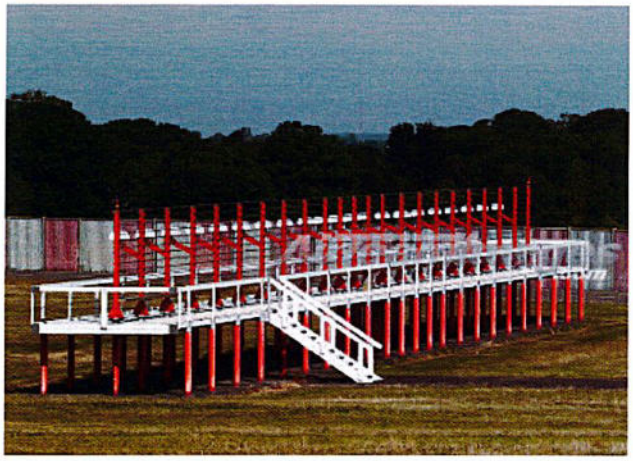


Figure 2-1 : Example of LOC antenna supporters, which the antenna height exceed 2 meters
a) LOC Elevated Platform b) LOC Support Tower

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

Remark :

1. Only if the runway profile causes the line-of-sight coverage problem between the antenna radiating element and 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].

2.6	General requirements for LOC, GP and DME equipment.			
	2.6.1	Power Supply System		
		2.6.1.1	Each unit of LOC, GP and DME equipment shall be designed to operate on a single-phase AC power system with nominal voltage and frequency in Thailand (220 VAC / 50 Hz). The tolerance of voltage and frequency will not be strictly specified.	
		2.6.1.2	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	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 main AC failure.	
		2.6.1.4	For terms and conditions of UPS & STS, consumer unit and circuit breaker (if exists), please see Section 2 : Construction Works. However, if it is not specified in the section, then it is AEROTHAI's responsibility.	
	2.6.2	*"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	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 ILS (LOC and GP) equipment and DME equipment shall be the same.		

		Even though the ILS/DME systems are in the same Facility Performance /Operational Category, AEROTHAI does not force the Tenderer to propose all those ILS/DME systems in the same model. If they are still suitable for the terrain and obstacle siting environment, the model can be differed. Therefore, LOC equipment belonging to the same Facility Performance /Operational Category may use different numbers of LOC antenna elements.
	2.6.4	The equipment shall be designed for high-reliability operation. Tenderer shall submit reliable report of performance, such as "INTEGRITY" and/or "MTBO", in the proposal. Integrity and/or MTBO of 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		

Integrity of each Facility Performance Category, is the value which is used for any one landing.

2.6.5		The information of each unit of LOC, GP and DME equipment shall be provided in "ENGLISH" language, at least, as follows:
	2.4.4.1	Names and labels of hardware assemblies
	2.4.4.2	Software menus and data [6.4.2.2]
	2.4.4.3	Technical documents and test reports [12]
2.6.6		All RF generators of LOC, GP and DME equipment shall be synthesizers.
2.6.7		Each unit of LOC, GP and DME equipment shall provide the capability of data (events) logging (such as alarm history) by themselves, not depending on a connection to the 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	If the status data of any LOC or GP or DME equipment or RCMU do not natively support "ETHERNET" format for remote control & monitoring purpose, "ADAPTERS" for converting other formats of data to the Ethernet shall be provided. Additionally, each unit of LOC, GP and DME equipment shall provide relevant spare communication ports (which may be different communication type) to address possible failures of the RCMU and/or RMM communication ports.	
	2.6.9	For each ILS/DME system, the Contractor shall provide one (1) set of Interface Control Documents (ICDs) for data format exchanges.	
	2.6.10	Environmental Conditions	
		2.6.10.1	Indoor equipment shall be designed for continuous operation under the ambient temperature range of at least 0 °C to +50 °C with a relative humidity of up to 60%.
		2.6.10.2	Outdoor equipment shall be designed to be weatherproof. (The maximum relative humidity in Thailand is approximately 85%.)
2.7	AC/DC power lines, transmission lines, communication lines (including construction works)		
	2.7.1	All AC/DC power lines, transmission lines, communication lines and all relevant installation materials (e.g. connectors, cable trays/ladders, conduits/ducts and cable ties) shall be provided by the Contractor.	
	2.7.2	All transmission lines shall be provided with RF connectors, complying with IEC 61169 international standard or other international standard. The Tenderer shall also submit the specifications of the indoor transmission lines, outdoor transmission lines, and the RF connectors in the proposal.	
	2.7.3	If the installation work is involved with the buried cables, those shall be *"underground"* type. AC power lines, transmission lines (and monitoring cables) and communication lines shall be divided into 3 groups, each of which shall be fitted in its individual *"underground"* conduit (such as HDPE or RSC) of which the inner diameter shall be wide enough for fitting all cables easily. The Tenderer shall accept this condition, the task will be inspected by AEROTHAI during site construction.	

	2.7.4	The underground cable work shall be done by the Contractor. The minimum requirements for works, shall be as follows :	
		2.7.4.1	If exists, trench and underground cable work shall be arranged as specified in Section 2 : Construction Works. In case that there is no instruction in the Section 2 : Construction Works, the trench for lying underground cables shall be dug not less than 50 cm in depth from ground surface, and wide enough to fit all conduits used in the trench, where the separation between conduits in the same trench shall be properly adjusted (about 5-10 cm). The trench basement may be covered with sand to smooth the basement level. The Tenderer shall accept this condition, the task will be inspected by AEROTHAI during site construction.
		2.7.4.2	The Contractor shall take responsibilities for any damages to existing underground cables and utilities.
	2.7.5	All AC power lines, transmission lines (and monitoring cable) and communication lines leading to the facilities shall be marked out (by the Contractor), with indicators/ labels. Additionally, route markers shall also be installed, so that the route of the buried cable is clearly visible. The Tenderer shall accept this condition, the task will be inspected by AEROTHAI during site construction.	
2.8	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	For each navigation station, the Tenderer shall design and submit conceptual/ interconnection diagram of "COMPLETE" LSP system based on the Engineering Institute of Thailand (EIT) standards for LSP design. The concept should be commonly applied to all navigation stations (LOC station and GP/DME station) as follows :	

		2.8.1.1	For AC power protection, when using a "NEW" building/shelter (not an "EXISTING" building/shelter) (see [2.4]), the Tenderer shall design and who has become the Contractor shall provide a LSP subsystem for the whole building/shelter: from LPZ 0 (Lightning Protection Zone 0), LPZ 1 to LPZ 2. The LSP subsystem shall be designed to cover a MDB unit and a consumer unit (see Figure 2-1a), except UPS&STS as they inherently contain built-in surge protections. The design shall also comply with Section 2 : Construction Work. For AC power protection, when using an "EXISTING" building/shelter, the Tenderer shall design and who has become the Contractor shall provide a LSP subsystem only for a consumer unit in LPZ 2. For telecommunication protection, the Tenderer shall design and who has become the Contractor shall provide a LSP subsystem, only for navigation equipment level, at least, antenna systems and transmission lines.
		2.8.1.2	If antenna tower is located near the building / shelter, the Tenderer shall design Air-Termination System so that it sufficiently protects roof-top construction of the building / shelter, including antenna system (if exists).
		2.8.1.3	When using a "NEW" building/shelter (see [2.4]), the Contractor shall provide both *"power line"* ground bar and *"telecom"* ground bar. When using an "EXISTING" building/shelter, The Contractor shall provide only *"telecom"* ground bar.
		2.8.1.4	The Tenderer shall submit a list of subsystems and/or devices used in the prescribed diagram. The list shall specify all brands, models and specifications and show that such specifications conform to international standards and/or the Engineering Institute of Thailand (EIT) standards.
	2.8.2	When using an "EXISTING" building/shelter, Earth-Termination System provided by the Contractor shall be bonded to the "EXISTING" Earth-Termination System of AEROTHAI with earth-resistance not exceeding 5 ohms.	

		If exists, Earth-Termination System at the field monitor antenna shall also be incorporated into the design and shall be boned to Earth-Termination System at the building/shelter. The Tenderer shall accept this condition, the task will be inspected by AEROTHAI during site construction.			
	2.8.3	Surge Protective Devices (SPDs) for a navigation equipment level Other than a LSP subsystem design described in [2.8.1.1] to [2.8.1.3], *Surge Protective Devices (SPDs)* for a navigation equipment level, shall be scope only for RF transmission line, <u>not</u> power line, as follows :			
		2.8.3.1	*"RF Transmission Line"* Surge Protector		
			2.8.3.1.1	*"RF Transmission Line"* Surge Protector shall be located at all transmission lines outside the equipment cabinet that may induce surge voltage / current to damage outdoor electronic subsystems <u>and</u> indoor navigation equipment. The surge protector shall be connected to *"telecom"* ground bar [2.8.1.3].	
			2.8.3.1.2	If any part of the navigation system contains RF transmission line with DC power, surge protectors shall be capable of passing such DC power along the transmission line.	
			2.8.3.1.3	*"RF Transmission Line"* Surge Protector shall comply with the following :	
				Item	Parameter
				(a)	The frequency range of surge protector shall be suitable for the navigation equipment. The tolerance of frequency will <u>not</u> be strictly specified.
				(b)	Impedance of surge protector shall be 50 ohms.
				(c)	Insertion Loss (IL) $\leq$0.2 dB
				(d)	Maximum Discharge Current (I_{max}) @ 8/20 μs $\geq$ 20 kA
				(e)	Lightning Impulse Current (I_{imp}) @ 10/350 μs $\geq$ 2 kA

2.9	Technical Supports For each ILS/DME system, the Contractor shall provide technical supports as follows :		
	2.9.1	The Contractor shall be responsible for all installation works.	
	2.9.2	The Contractor shall by oneself set up/configure (not as an assistant) 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	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. (The conditions of network equipment warranties are separately stated in APPENDIX D)		
	Item	Description	Warranty
	(a)	"COMPLETE" Lightning and Surge Protection (LSP) System	5 years
	(b)	LOC, GP and DME equipment (including RCMU and RSU)	5 years
	(c)	Spare Parts	5 years
	(d)	Measuring Instruments	2 years
	(e)	Computers	2 years

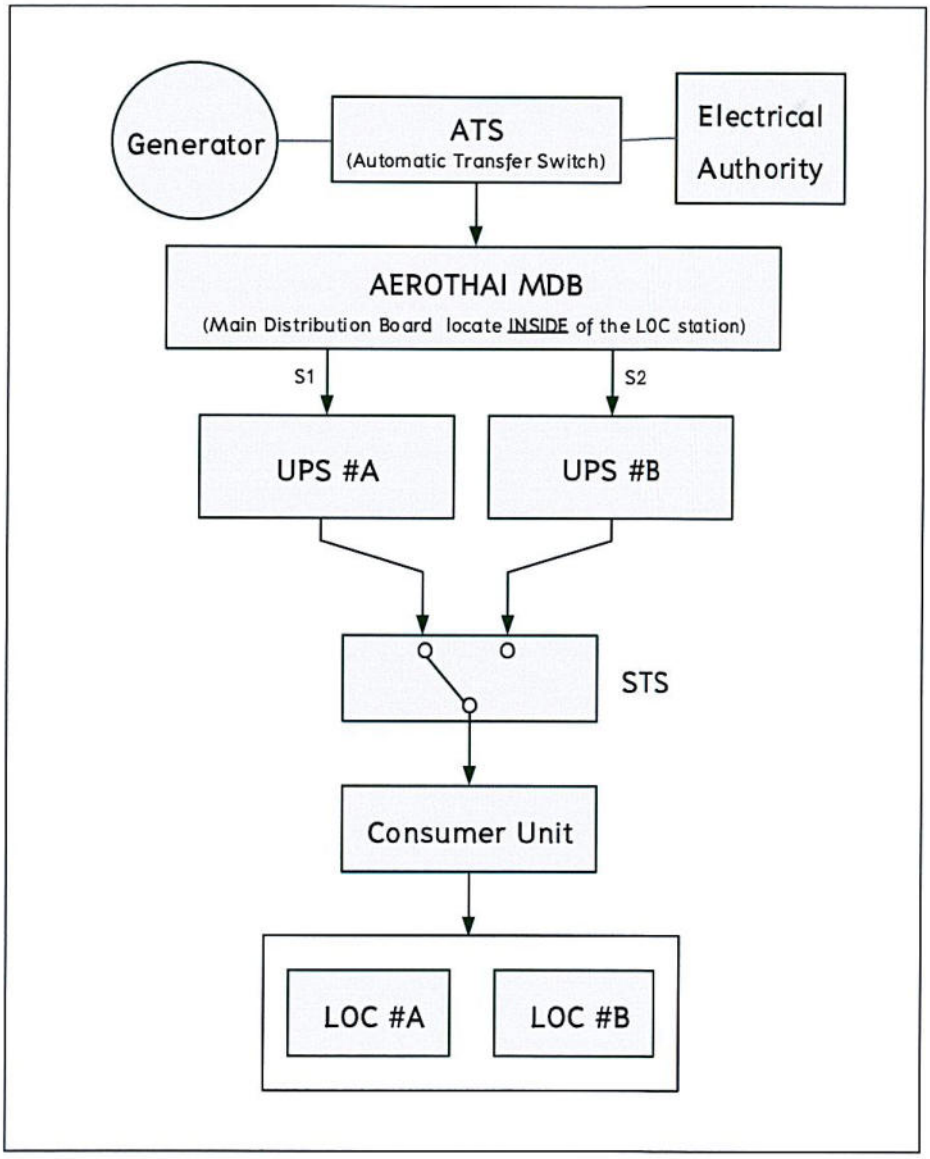


Figure 2-2a : Conceptual Diagram of Power Supply Configuration at LOC station

Remark :

1. For terms and conditions of UPS & STS, consumer unit and circuit breaker (if exists), please see Section 2 : Construction Works. However, if it is not specified in the section, then it is AEROTHAI's responsibility.
2. Fig 2-1a, is just a conceptual diagram. The actual installation work may be adapted, depending on the personnel in charge; however, it will still comply with *"EIT-Thai Electrical Code 2013"* standard.

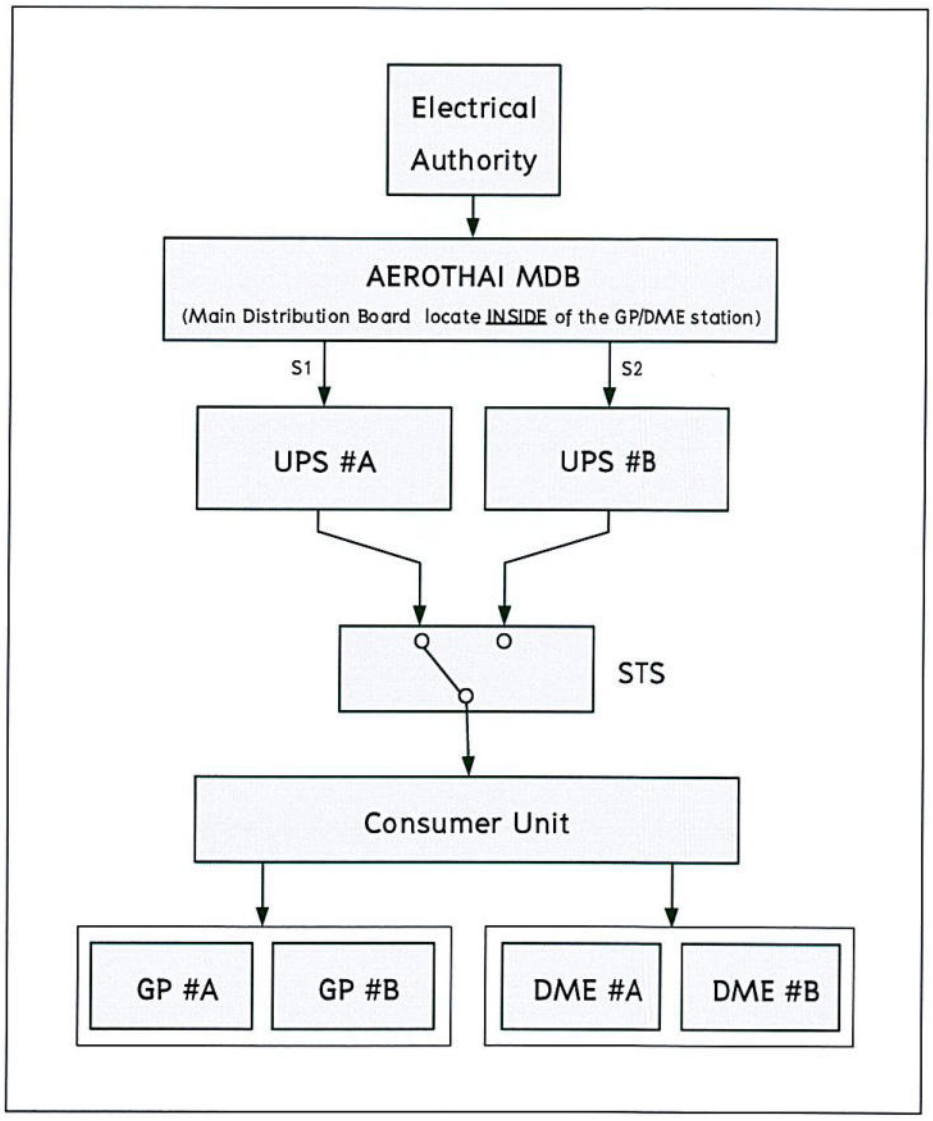


Figure 2-2b : Conceptual Diagram of Power Supply Configuration at GP/DME station

Remark :

1. For terms and conditions of UPS & STS, consumer unit and circuit breaker (if exists), please see Section 2 : Construction Works. However, if it is not specified in the section, then it is AEROTHAI's responsibility.
2. Fig 2-1b is just a conceptual diagram. The actual installation work may be adapted, depending on the personnel in charge; however, it will still comply with *"EIT-Thai Electrical Code 2013"* standard.

3. Specifications of Localizer

The specifications described below are what AEROTHAI requires. ANNEX10 / Vol. I and/or other international standard references stated at the end of each item are only for citations. The interpretations may not be exactly identical to what AEROTHAI requires.

3.1	LOC Transmitter characteristics		
	3.1.1	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	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	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	The 90 and 150 Hz modulating signals (for guidance information) shall meet the specifications as follows :	
		3.1.4.1	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	The modulation depth of 90 Hz and 150 Hz tones shall be within 20 ± 2 % [ANNEX 10 / Vol. I / Paragraph 3.1.3.5.2].
	3.1.5	The 1020 Hz modulating signal (for identification) shall meet the specifications as follows :	
		3.1.5.1	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	The modulation depth of 1020 Hz tone shall be within 10 ± 5 % [ANNEX 10 / Vol. I / Paragraph 3.1.3.9.2].

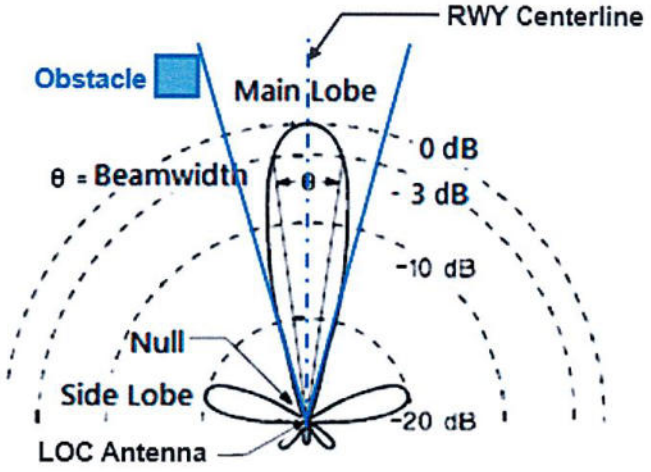
3.1.6	LOC identification signal.	
	3.1.6.1	The LOC identification signal shall employ the International Morse Code and be configurable to consist of two or three letters. It shall be preceded by the International Morse Code signal of the letter "I", and also meet the requirements specified in [ANNEX 10 / Vol. I / Paragraph 3.1.3.9].
	3.1.6.2	The identifications of LOC and DME shall be synchronized.
	3.1.6.3	The LOC identification signal shall be automatically suppressed, when the system is set to bypass (testing).
	3.1.6.4	The LOC identification code shall be configured by means of software, with no necessity for hardware settings.
3.1.7	An automatic protection shall be applied to RF power amplifiers to prevent damage in the event there is a high VSWR fault at the output of RF power amplifier.	
3.1.8	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 (b) Transmission Line for CRS SBO (c) Transmission Line for CLR CSB (d) Transmission Line for CLR SBO	
	The Tenderer shall accept this condition, the task will be inspected by AEROTHAI during site construction.	
3.1.9	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. The configuration method (by software and/or hardware) will not be strictly specified.	

3.2	LOC Monitor Characteristics			
	3.2.1	The monitoring system of LOC shall serve, at least, the following purposes.		
		3.2.1.1	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	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 is still correct. The process shall be done without turning off the equipment and without interrupting the operation of the "AERIAL" transmitter, and an indication showing the status of *"Integrity Certification"* shall also be given.	
		3.2.1.3	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	To be used as *"Fault Detection, Diagnosis and Isolation"*. LOC equipment shall be able to detect and diagnose any abnormal condition and isolate/identify the subsystem where such abnormal condition occurred.	
	3.2.2	The "INTEGRAL" monitoring system of LOC.		
		3.2.2.1	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	The "STAND-BY" monitoring system of LOC.	
	3.2.3.1	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	The "NEAR-FIELD" monitoring system of LOC.	
	3.2.4.1	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	Warning and Alarm Conditions In this context, an "ALARM" is a notification that occurs when the system operates with out-of-tolerance conditions. While, a "WARNING/ALERT" is a notification that occurs when the system operates with abnormal status but still within the tolerance. In case that the tolerance is defined by a range of numeric values, the "WARNING/ALERT" may be known as a "PRE-ALARM".	
	3.2.5.1	*"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	*"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	The monitoring system shall issue a "WARNING/ALERT" or an "ALARM", both in "AUDIBLE" and "VISUAL" mode.
3.2.6	The monitoring system shall be configurable to both "AND" and "OR" mode.	

	3.2.7	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].
3.3	LOC antenna system.	
	3.3.1	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. However, the specifications of, at least, the following attributes depend on the Tenderer's design : (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 Be reminded that the Tenderer shall submit a supportive document [2.3], which provides contents, at least, as stated in APPENDIX B. 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"*, shall also be included in the antenna system (see also [2.5]).
	3.3.2	The emission from the LOC shall be horizontally polarized. Additionally, DDM incorrectness of the vertical polarized component shall not exceed ± 0.008 DDM when an aircraft is positioned on the course line and is in a roll altitude of 20 degrees from the horizontal [ANNEX 10 / Vol. I / Paragraph 3.1.3.2.2 for Facility Performance Category II]. The Tenderer shall accept this condition, the task will be inspected by AEROTHAI during flight inspection/validation.
	3.3.3	*"Radiation Patterns"* The Tenderer shall submit *"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 <u>not</u> 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

	3.3.4	"Structure" The Tenderer shall submit "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 considerations [2.3]. "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].
	3.3.5	*"DDM Characteristics"* The Tenderer shall submit *"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 considerations [2.3]. *"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].
	3.3.6	Coverage (Usable Distance) - Power Density or Field Strength The Tenderer shall submit *"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 considerations [2.3]. *"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]
	3.3.7	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.
	3.3.8	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.
	3.3.9	The Contractor shall provide marking and lighting, which comply to [ANNEX 14 / Vol. I / Chapter 6], for denoting shelter, antenna system and obstruction light as obstacles. The Tenderer shall accept this condition, the task will be inspected by AEROTHAI during site construction.

4. Specifications of Glide Path

The specifications described below are what AEROTHAI requires. ANNEX10 / Vol. I and/or other international standard references stated at the end of each item are only for citations. The interpretations may not be exactly identical to what AEROTHAI requires.

4.1	GP Transmitter characteristics		
	4.1.1	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	The frequency channels among LOC, GP and DME system shall be paired [ANNEX10 / Vol. I – Paragraph 3.1.6.1, Table A / p. 3-103].	
	4.1.3	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	The 90 and 150 Hz modulating signals (for guidance information) shall meet the specifications as follows :	
		4.1.4.1	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	The modulation depth of 90 and 150 Hz tones shall be within 40 ± 2.5 % [ANNEX 10 / Vol. I / Paragraph 3.1.5.5.1].
	4.1.5	An automatic protection shall be applied to RF power amplifiers to prevent damage in the event there is a high VSWR fault at the output of RF power amplifier.	
	4.1.6	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	✓

		The Tenderer shall accept this condition, the task will be inspected by AEROTHAI during site construction. Remark : AEROTHAI also accepts a certain design that no GP Antenna Phaser is embedded /inserted into "Transmission Line to the Middle Antenna" [4.1.6 (b)].	
	4.1.7	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]. The Tenderer shall accept this condition, the task will be inspected by AEROTHAI during site construction.	
	4.1.8	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. The configuration method (by software and/or hardware) will not be strictly specified.	
4.2	GP Monitor Characteristics		
	4.2.1	The monitoring system of GP shall serve, at least, the following purposes.	
		4.2.1.1	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	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 is still correct. The process shall be done without turning off the equipment and without interrupting the operation of the "AERIAL" transmitter, and an indication showing the status of *"Integrity Certification"* shall also be given.

		4.2.1.3	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	To be used as *"Fault Detection, Diagnosis and Isolation"*. GP equipment shall be able to detect and diagnose any abnormal condition and isolate/identify the subsystem where such abnormal condition occurred.
	4.2.2	The "INTEGRAL" monitoring system of GP	
		4.2.2.1	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	The "STAND-BY" monitoring system of GP	
		4.2.3.1	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	The "NEAR-FIELD" monitoring system of GP.	
		4.2.4.1	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	Warning and Alarm Conditions In this context, an "ALARM" is a notification that occurs when the system operates with out-of-tolerance conditions. While, a "WARNING/ALERT" is a notification that occurs when the system operates with abnormal status but still within the tolerance. In case that the tolerance is defined by a range of numeric values, the "WARNING/ALERT" may be known as a "PRE-ALARM".	
		4.2.5.1	*"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	*"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	The monitoring system shall issue a "WARNING/ALERT" or an "ALARM", both in "AUDIBLE" and "VISUAL" mode.
	4.2.6	The monitoring system shall be configurable to both "AND" and "OR" mode.	
	4.2.7	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].	

4.3	GP antenna system	
	4.3.1	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 *"M-array"* type with clearance signals – the so called *"Capture Effect (CE) Array"*. However, the specifications of, at least, the following attributes depend on Tenderer's design : (a) "Directivity" of GP antenna elements (b) "Number" of GP antenna elements (c) "Height" of GP antenna elements (d) "Gain" of GP antenna elements Be reminded that the Tenderer shall submit a supportive document [2.3], which provides contents, at least, as stated in APPENDIX B. 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	*"Radiation Patterns"* The Tenderer shall submit *"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	*"Structure"* The Tenderer shall submit *"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 considerations [2.3]. *"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 RDH value so that AEROTHAI can compare this to the TCH value which is already calculated by AEROTHAI, stated in *"Site Survey Reports"* (APPENDIX C).
	4.3.4	*"DDM Characteristics"* The Tenderer shall submit *"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 considerations [2.3]. *"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	Coverage (Usable Distance) - Power Density or Field Strength The Tenderer shall submit *"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 considerations [2.3]. *"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	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	The Contractor shall provide Double LED obstruction lights with 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	The Contractor shall provide marking and lighting, which comply to [ANNEX 14 / Vol. I / Chapter 6], for denoting shelter, antenna system and obstruction light as obstacles. The Tenderer shall accept this condition, the task will be inspected by AEROTHAI during site construction.

5. Specifications of DME/N

The specifications described below are what AEROTHAI requires. ANNEX10 / Vol. I and/or other international standard references stated at the end of each item are only for citations. The interpretations may not be exactly identical to what AEROTHAI requires.

5.1	DME Transponder characteristics		
	5.1.1	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	The frequency channels among LOC, GP and DME system shall be paired. 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	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	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 -72.50 ± 1 dBm, where DME antenna gain and cable loss are assumed to be 14 dBi and -2 dB respectively.	
	5.1.5	For each incoming interrogation frequency drift, the bandwidth of the receiver shall meet the requirements as specified in the following :	
		5.1.5.1	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	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].
	5.1.6	For DME/N-Decoder Rejection, an interrogation pulse pair with a spacing of ± 2 μs, or more from the nominal value, shall be rejected. [ANNEX 10 / Vol. I / Paragraph 3.5.4.3.3].	

	5.1.7	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) ≤ 3 μs
		5.1.7.2	Pulse decay time (between 90% to 10% of trailing edge) ≈ 2.5 μs , but ≤ 3.5 μs
		5.1.7.3	Pulse duration (between 50% of the leading, and trailing edges) 3.5 ± 0.5 μs
		5.1.7.4	The instantaneous amplitude of the pulse shall not, at any instant between the point of the leading edge which is 95% of the maximum amplitude and the point of the trailing edge which is 95% of the maximum amplitude, fall below a value which is 95% of the maximum amplitude of the pulse.
	5.1.8	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 not exceed (12.00 ± 0.10) μs .
		5.1.8.2	The peak power of the constituent pulses of any transponder pulse pair shall not differ by more than one (1) dB.
	5.1.9	Reply delay, the interval between 50% amplitude of the leading edge of the interrogation pulse and that of the corresponding reply pulse, shall be typically 50 μs for X-channel, and shall also be decreasingly adjustable from the nominal value in order to permit aircraft interrogators to indicate "ZERO" distance at a specific point remote from the transponder site [ANNEX 10 / Vol. I / Paragraph 3.5.4.4.1 and 3.5.4.4.3]	
	5.1.10	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]. The Tenderer shall accept this condition, the task will be inspected by AEROTHAI during flight inspection/validation.	
	5.1.11	The transponder shall be capable of continuous operation at a transmission rate (the so-called *"Pulse Repetition Rate"*) as follows :	
		5.1.11.1	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	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	DME identification signal	
		5.1.12.1	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	The DME identification code shall be configured by means of software, with no necessity for hardware settings.
	5.1.13	An automatic protection shall be applied to RF power amplifiers to prevent damage in the event there is a high VSWR fault at the output of RF power amplifier.	
	5.1.14	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	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. The configuration method (by software and/or hardware) will not be strictly specified.	
5.2	DME Monitor characteristics		
	5.2.1	The monitoring system of DME shall serve, at least, the following purposes.	
		5.2.1.1	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	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 is still correct. The process may be done with turning off the equipment, AEROTHAI will not strictly require. If the process is being done, an indication showing the status of *"Integrity Certification"* shall also be given.

			5.2.1.2.1	Be able to generate, at least, both *"in tolerance"* and *"out of tolerance"* pulse pair spacing [5.2.1.3.1].
			5.2.1.2.2	Be able to generate, at least, both *"in tolerance"* and *"out of tolerance"* reply delay [5.2.1.3.2].
			5.2.1.2.3	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	Be able to provide *"Dynamic Range"* test When the power density of the actual interrogation signals at the "TRANSPONDER ANTENNA" 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 -7.50 dBm, where DME antenna gain and cable loss are assumed to be 8 dBi and -2 dB respectively.
			5.2.1.2.5	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	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	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	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	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	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)].

			5.2.1.3.5	Variation of the transponder "RECEIVER" and "TRANSMITTER" frequencies beyond the control range of the reference circuits (if the operating frequencies are not directly crystal controlled) [ANNEX 10 / Vol. I / Paragraph 3.5.4.7.2.4 d)].
		5.2.1.4		To be used as *"Fault Detection, Diagnosis and Isolation"*. DME equipment shall be able to detect and diagnose any abnormal condition and isolate/identify the subsystem where such abnormal condition occurred
	5.2.2	Warning and Alarm Conditions In this context, an "ALARM" is a notification that occurs when the system operates with out-of-tolerance conditions. While, a "WARNING/ALERT" is a notification that occurs when the system operates with abnormal status but still within the tolerance. In case that the tolerance is defined by a range of numeric values, the "WARNING/ALERT" may be known as a "PRE-ALARM".		
		5.2.2.1		*"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		The monitoring system shall issue an "ALARM", both in "AUDIBLE" and "VISUAL" mode.
	5.2.3	The monitoring system shall be configurable to both "AND" and "OR" mode.		
	5.2.4	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.		

5.3	DME antenna system	
	5.3.1	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. However, the specifications of, at least, the following attributes depend on Tenderer's design : 1. "Main Lobe Elevation" of DME antenna, 3 or 6 degrees 2. "Gain" of DME antenna Be reminded that the Tenderer shall submit a supportive document [2.3], which provides contents, at least, as stated in APPENDIX B. 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. The contractor shall provide "Lightning Rod Assembly" for the XPDR antenna 4. All antenna supporters – mast and *"GP Antenna Tower"*, shall also be included in the antenna system (see also [2.5]). 5. 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
	5.3.2	*"Radiation Patterns"* The Tenderer shall submit *"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	Coverage - Power Density or Field Strength The Tenderer shall submit *"Coverage"* from the DME antenna, from both cases that siting environment are and are not taken into account, for AEROTHAI considerations [2.3]. *"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

The specifications described below are what AEROTHAI requires. ANNEX10 / Vol. I and/or other international standard references stated at the end of each item are only for citations. The interpretations may not be exactly identical to what AEROTHAI requires.

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) 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	*"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) 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	*"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	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	The Contractor shall also provide a suitable-sized rack for mounting the *"RCMU of ILS/DME"*.
6.3	Remote Status Unit (RSU) RSU is a unit, used only to remotely monitor the equipment. It's typically located at the ATC room of the ATC tower.	
	6.3.1	*"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	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	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	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	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	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 for AEROTHAI.
6.5	A Runway Selection System (An Interlock System)		
	6.5.1	The Contractor shall provide and configure a runway selection system, including provide 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 :

1. The symbol " ✓ " marks the places that AEROTHAI require the runway selection system, typically where ILS/DME systems are installed at the same airport, on opposite ends of the same runway, or on different runways use the same paired frequencies.
2. If exists, the runway selection system shall be combined into the same unit with RSU.

	6.5.2	If exists, 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, AEROTHAI selects only some options from [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.
	6.5.3	If exists, an runway selection system shall be a single management system which is monitored and controlled by one software program and/or one hardware unit, so that an end-user can easily perform such runway selection.

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 The Contractor shall provide *"ALL in One"* desktop computers, including all attached devices complying with, at least, the following :		
	7.1.1	All components including a mouse and a keyboard shall be produced from the same manufacturer with permanent "LOGO/BRAND" on products.	
	7.1.2	Processor/Chipset	
		7.1.2.1	The number of processing unit : Core ≥ 6 cores, Thread ≥ 6 threads
		7.1.2.2	Base clock frequency ≥ 2.3 GHz
	7.1.3	RAM	
		7.1.3.1	Technology – DDR5 or better
		7.1.3.2	Capacity ≥ 8 GB
	7.1.4	One (1) Storage Drive	
		7.1.4.1	Solid State Drive ≥ 480 GB
	7.1.5	One (1) Optical Disc Drive	
		7.1.5.1	Internal or portable DVD-RW Drive, or better
	7.1.6	Graphic Controller	
		7.1.6.1	Built-in graphic or dedicated graphic controller
		7.1.6.2	Graphic memory ≥ 1.0 GB
	7.1.7	One (1) Display	
		7.1.7.1	≥ 21.5 inches LED with resolution 1920 x 1080 pixels
	7.1.8	Networking	
		7.1.8.1	Gigabit Ethernet, or better.
		7.1.8.2	Wi-Fi, at least compliant with IEEE 802.11ac 2.4 GHz / 5 GHz
	7.1.9	I/O Interface	
		7.1.9.1	Serial Port, or an adapter converting USB to Serial Port
	7.1.10	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	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).
		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	The Desktop Computer shall have a manufacturer branch office authorized representative in Thailand.	
	7.1.13	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

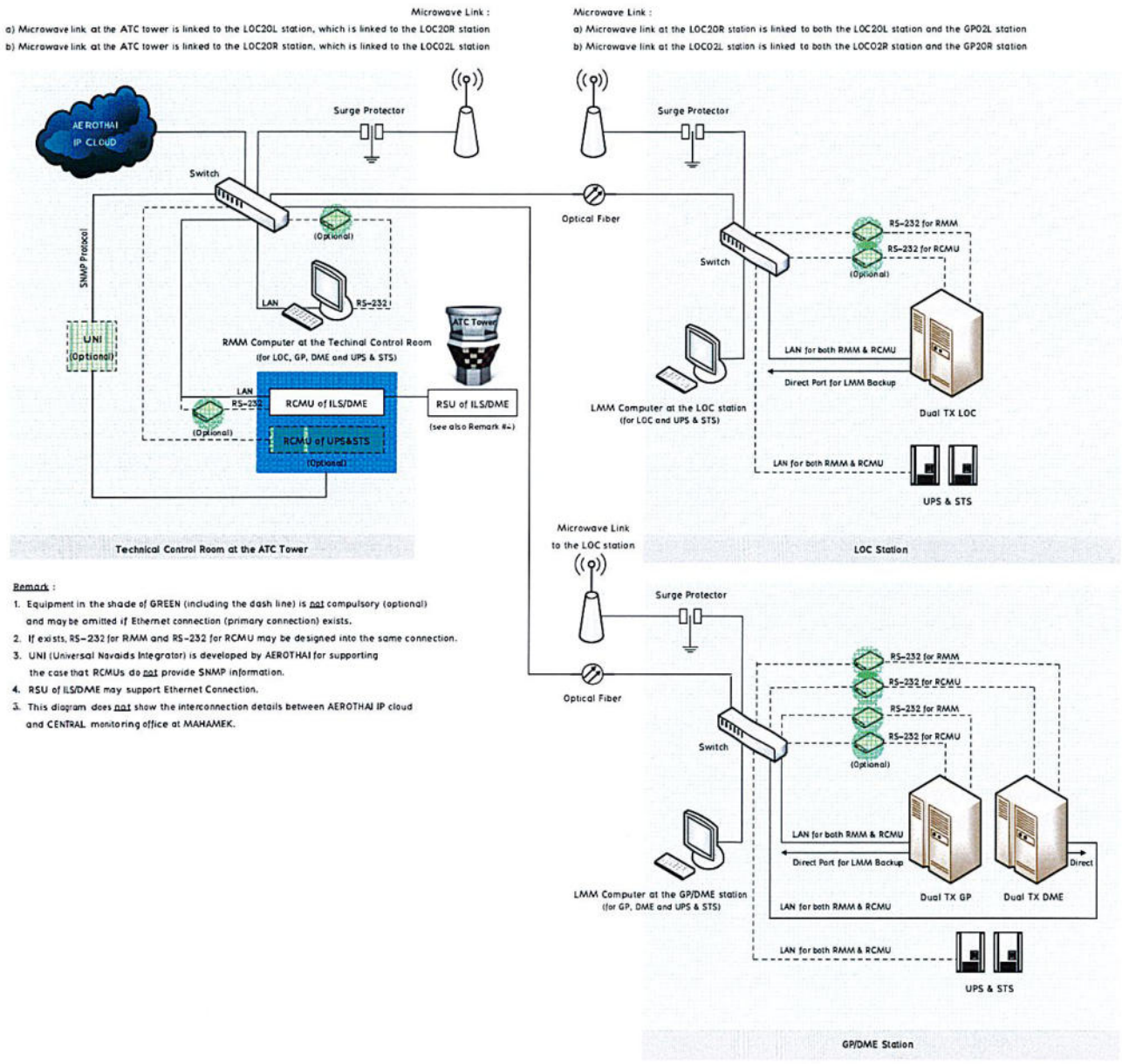
Because the details of network equipment in this section was written by the other AEROTHAI specialist, in order to preserve the contents and topic orders, all details of network equipment, including Bill of Quantities (BOQ), will be referred to the original document in APPENDIX D.

The Tenderer and who has become the Contractor shall comply to those details. Additionally, The Tenderer shall also submit a "SEPARATED" proposal, aside from the proposal for this TOR, showing that their works would comply to the Specifications of Network Equipment in APPENDIX D.

9. Intersystem Connection and Communication Diagram

<table>
<tr><td colspan="3">This section will depict intersystem connection and communication diagram among equipment, which is stated in [3] to [8]. AEROTHAI will provide "Private Network" for completion of the intersystem connection. The Tenderer and who has become the Contractor shall comply with the requirements, at least, as follows :</td></tr>
<tr><td>9.1</td><td colspan="2">For each ILS/DME system, the Tenderer shall submit the proposal of intersystem connection and communication diagram which the Tenderer can actually provide to AEROTHAI. The proposal shall also, at least, comply to AEROTHAI conceptual diagram (see Fig. 9-1).

"Intersystem Connection and Network Diagram" of the same airport/runway, in the same procurement, may be combined into the same diagram. The Tenderer can also get the routing information of microwave links from APPENDIX D.</td></tr>
<tr><td rowspan="4">9.2</td><td colspan="2">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:</td></tr>
<tr><td>9.2.1</td><td>A set of monitoring & control equipment [6][7].</td></tr>
<tr><td>9.2.2</td><td>A set of network equipment (microwave and peripheral devices) [8] [APPENDIX D] (see also [2.9.2]).</td></tr>
<tr><td>9.2.3</td><td>A set of optical fibers, stated in Section 2 : Construction Works.</td></tr>
<tr><td colspan="2">Additionally, The Contractor shall also be responsible for configuring network connections, till the "monitoring & control" system is properly functioning.</td></tr>
</table>



Remark :

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

Figure 9-1 : Intersystem connection of each ILS/DME and UPS & STS System (AEROTHAI Conceptual Diagram)

10. Requirements of Spare Parts

The Tenderer and who has become the Contractor shall comply with the requirements of spare parts, at least, as follows :	
10.1	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) and RF combining unit (CU), except LOC antenna elements. For each unit of LOC equipment, three (3) sets of double LED obstruction light with photo switch shall also be provided as the spare parts.
10.2	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) and RF combining unit (CU), except GP antenna elements. For each unit of GP equipment, two (2) sets of double LED obstruction light with photo switch shall also be provided as the spare parts.
10.3	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, except DME antenna.
10.4	For each ILS/DME system, one (1) unit of *"RCMU of ILS/DME"* shall be provided as a spare unit (see also [6.2.2]). Reminded that, If exists, *"RCMU of ILS/DME"* of the same airport/runway, in the same procurement, shall also be combined into the same unit.
10.5	For each ILS/DME system, one (1) unit of *"RSU of ILS/DME"*, shall be provided as a spare unit (see also [6.3.2]) Reminded that, If exists, *"RSU of ILS/DME"* of the same airport/runway, in the same procurement, shall also be combined into the same unit, and if exists, the runway selection system shall also be combined into the same unit with RSU.

11. Requirements of Supplements.

11.1	The Tenderer and who has become the Contractor shall comply with the basic requirements of supplements – *"Measuring Instruments"* and *"Tools & Accessories"*, at least, as follows :	
	11.1.1	The Tenderer shall submit a document confirmed by the manufacturer that the brands and models of the proposed *"Measuring Instruments"* stated in [11.2] and [11.3], support system calibration and maintenance activities. All measuring instruments shall be operated on a single-phase AC power system with nominal voltage and frequency in Thailand (220 VAC / 50 Hz). The tolerance of voltage and frequency will not be strictly specified. 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	The Tenderer shall submit a document confirmed by the manufacturer that the proposed *"Tools & Accessories"* stated in [11.4], support system calibration and maintenance activities.
11.2	For each airport/runway, the Contractor shall provide only one (1) Portable Navigational Signal Analyzer (PNSA) :	
	11.2.1	The PNSA shall be designed for measuring critical performance parameters of at least LOC, GP and DVOR equipment.
	11.2.2	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	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	An option for transferring all parameters to an external portable storage via USB in text format shall be provided.

11.3	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 .
11.4	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

12. Requirements of Technical Documents and Test Reports

The Contractor shall provide documents as follows : (All documents relating to network equipment are separately stated in APPENDIX D).		
12.1	After completion of factory acceptance test (FAT), the *"FAT Report"* shall be provided for each 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 CD/DVD (or any portable data storage device).
12.2	Before installation, the related *"Equipment Manual"* containing all information about installation, operation and maintenance procedure, shall be provided for each unit of LOC, GP and DME equipment (including RCMU and RSU).	
	12.2.1	Two (2) sets of hard copy.
	12.2.2	One (1) set of CD/DVD (or any portable data storage device).
12.3	Before installation, the related *"Assembly Drawings"* and *"Schematic Diagrams"* shall be provided for each unit of LOC, GP and DME equipment (including RCMU and RSU).	
	12.3.1	Two (2) sets of hard copy.
	12.3.2	One (1) set of CD/DVD (or any portable data storage device).
12.4	After completion of site acceptance test (SAT) and commissioning flight inspection, the *"SAT Report"* shall be provided for each ILS/DME system :	
	12.4.1	One (1) original.
	12.4.2	Two (2) sets of hard copy.
	12.4.3	One (1) set of CD/DVD (or any portable data storage device).

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

Bill of Quantities

(All quantities relating to network equipment are in APPENDIX D, and not included herein)

Item	Descriptions	Quantity	Remark
1	LOC Building GP/DME Shelter	1 x 2 1 x 2	See [2.4].
2	LOC Antenna Supporter GP Antenna Tower	as designed 1 x 2	See [2.5].
3	A Set of AC power lines A Set of Transmission lines A Set of Communication Lines A Set of Installation Materials	1 x 2 1 x 2 1 x 2 1 x 2	See [2.7.1] for each ILS/DME system
4	A Complete LSP system (with documents in the remark)	1 x 2	See [2.8] for each ILS/DME system Related documents shall be provided. a) List of a LSP subsystems and/or devices with brands, models and specifications, at a LOC station and a GP/DME station, and for each unit of LOC, GP and DME equipment
5	LOC Equipment GP Equipment DME Equipment TX Antenna System for LOC TX Antenna System for GP XPDR Antenna System for DME NF MON Antenna System for LOC NF MON Antenna System for GP NF MON Antenna System for DME	1 x 2 1 x 2 1 x 2 1 x 2 1 x 2 1 x 2 1 x 2 1 x 2 -	See [3.1] and [3.2]. See [4.1] and [4.2]. See [5.1] and [5.2]. See [3.3]. See [4.3]. See [5.3]. See [3.3]. See [4.3]. See [5.3].
6	Adapter to Ethernet Data Format	as designed	See [2.6.8], only if the status data do not natively support Ethernet format.

Item	Descriptions	Quantity	Remark
7	Double LED OBS Light for LOC (with a whole Spare Unit)	2 x (3 x 2)	See [3.3.8] and [10.1], including photo switch.
	Double LED OBS Light for GP (with a whole Spare Unit)	2 x (2 x 2)	See [4.3.7] and [10.2], including photo switch.
	Double LED OBS Light for DME (with a whole Spare Unit)	N/A	
8	RCMU of ILS/DME (with a whole Spare Unit)	2 x (1 x 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"*.
9	RSU of ILS/DME (with a whole Spare Unit)	2 x (1 x 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. If exists, the runway selection system shall also be combined into the same unit with RSU.
10	Desktop Computer for LMM (with components in the remark)	(4+1) x 1	See [6.4] and [7.1]. 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 One (1) computer shall also be provided as a spare unit for one (1) airport.
	Desktop Computer for RMM (with components in the remark)	1 x 1	

Item	Descriptions	Quantity	Remark
			(continued) 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]
11	Spare Parts for LOC Spare Parts for GP Spare Parts for DME Spare Parts for LSP	1 x 2 1 x 2 1 x 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, except antenna elements
12	Measuring Instrument (with documents in the remark)	1 x 1	See [11.1] for each airport/runway. Related documents shall be provided. a) List of Measuring Instrument with a Confirmation of Usage b) Certificates c) Test Reports d) Operation Manual e) Service Manual
	PNSA Digital Multimeter Frequency Counter RF Wattmeter for ILS RF Power Sensor for DME (or RF Power Analyzer for DME) Oscilloscope		
13	Tools & Accessories (with documents in the remark)	1 x 1	See [11.1] for each airport/runway. Related documents shall be provided. a) List of Tools and Accessories with a Confirmation of Usage
	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		
14	FAT Report (Original) FAT Report (Hard Copy) FAT Report (Soft Copy)	1 x 2 2 x 2 1 x 2	See [12.1].

Item	Descriptions		Quantity	Remark
15	SAT Report (Original)		1 x 2	See [12.4].
	SAT Report (Hard Copy)		2 x 2	
	SAT Report (Soft Copy)		1 x 2	
16	Equipment Manual for LOC	(HC)	2 x 2	See [12.2]
	Equipment Manual for GP	(HC)	2 x 2	Where HC is Hard Copy and SC is Soft Copy.
	Equipment Manual for DME	(HC)	2 x 2	
	Equipment Manual for RCMU/RSU	(HC)	2 x 2	
	ICDs for ILS/DME	(HC)	2 x 2	
	Equipment Manual for LSP	(HC)	Optional	
	Equipment Manual for LOC	(SC)	1 x 2	
	Equipment Manual for GP	(SC)	1 x 2	
	Equipment Manual for DME	(SC)	1 x 2	
	Equipment Manual for RCMU/RSU	(SC)	1 x 2	
	ICDs for ILS/DME	(SC)	1 x 2	
	Equipment Manual for LSP	(SC)	Optional	
17	Assembly Drawings for LOC	(HC)	2 x 2	See [12.3]
	Assembly Drawings for GP	(HC)	2 x 2	Where HC is Hard Copy and SC is Soft Copy.
	Assembly Drawings for DME	(HC)	2 x 2	
	Assembly Drawings for RCMU/RSU	(HC)	2 x 2	
	Assembly Drawings for LOC	(SC)	1 x 2	
	Assembly Drawings for GP	(SC)	1 x 2	
	Assembly Drawings for DME	(SC)	1 x 2	
	Assembly Drawings for RCMU/RSU	(SC)	1 x 2	
18	Schematic Diagrams for LOC	(HC)	2 x 2	
	Schematic Diagrams for GP	(HC)	2 x 2	
	Schematic Diagrams for DME	(HC)	2 x 2	
	Schematic Diagram for RCMU/RSU	(HC)	2 x 2	
	Schematic Diagrams for LOC	(SC)	1 x 2	
	Schematic Diagrams for GP	(SC)	1 x 2	
	Schematic Diagrams for DME	(SC)	1 x 2	
	Schematic Diagram for RCMU/RSU	(SC)	1 x 2	
19	A set of tables and chairs		(4+1) x 1	See [7.1.13]

Table B.1 : Topic of Supportive Document

Item	Topic	Quantity	Remark
1	A design of a complete LSP system, at least, as follows : a) AC Power Protection for a LOC station and a GP/DME station b) Telecom Protection for each unit of LOC, GP and equipment, including list of LSP subsystems and/or devices with brands, models and specifications	1 x 2	See [2.8]
2	A design of navigation equipment, at least, as follows : a) LOC, GP and DME equipment b) 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 reasons the Tenderer has chosen such specifications, shall also be concluded.	 3 x 2 2 x 2 3 x 2 2 x 2 2 x 2	See [2.3] [2.4] [2.5] [2.6.4]
3	A proposal of intersystem connection and communication diagram which the Tenderer can actually provide to AEROTHAI for each airport/runway.	1 x 1	See [9.1]

Remark : If required in APPENDIX D, the Tenderer shall also submit a "SEPARATED" supportive document for network equipment, aside from the supportive document for this TOR, showing the reasons the Tenderer has chosen such specifications of network equipment.