Voice Communication Control System Fallback and CON/TRA & Voice Recording System Specification

For

Suvarnabhumi Airport

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1. Voice Communication Control System Fallback and CON/TRA Specification

1.1 INTRODUCTION

This document provides the functional and technical specifications required by Aeronautical Radio of Thailand Ltd. (AEROTHAI), Kingdom of Thailand. for the Air Traffic Control **Voice Communication Control System (VCCS)** Fallback and CON/TRA to be installed at Suvarnabhumi Airport. The VCCS solution comprises of four (4) VCCS systems and one (1) Parallel Telephone System, serving Tower Control, Approach Control, CON/TRA, and Spare operations at Suvarnabhumi Airport, detailed below:

- **Two systems** for Fallback Tower Control VCCS and Fallback Approach Control VCCS shall operate when the Main Operation System (MOPS) VCCS is not applicable. The MOPS VCCS is AEROTHAI's operating VCCS (Legacy VCCS).
- **One system** for Contingency and training VCCS (CON/TRA) shall be used for training purposes under normal conditions and shall be operated in contingency mode when both the MOPS VCCS and the Fallback VCCS are unavailable.
- **One system** for Spare VCCS, shall be used for engineering training, troubleshooting, repair, and replacement purposes.
- **One system** for parallel telephone system shall be used to provide intercommunication between the analog telephone lines and both the MOPS VCCS (Legacy VCCS) and the VoIP telephones on the three new VCCS systems. The system shall support simultaneous incoming and outgoing calls across all connected systems.

Fallback VCCS System for Tower (As Appendix 1, 3, 8)

- 27 Controller Working Positions (CWPs)
- 120 VoIP Channels for Transmitter and Receiver Radio (As Appendix 28-31)
- 40 VoIP Telephone Channels (As Appendix 32)
- 2 GPS Master Clock and Antennas
- 27 Slave clocks
- 27 IP Phone (SIP Protocol)
- 1 Power backup system for Central Equipment
- 2 Power backup systems for CWPs

Fallback VCCS System for Approach (As Appendix 1, 4, 8)

- 33 Controller Working Positions (CWPs)
- 120 VoIP Channels for Transmitter and Receiver Radio (As Appendix 33-36)
- 90 VoIP Telephone Channels (As Appendix 37-39)
- 2 GPS Master Clock and Antennas
- 33 Slave clocks
- 33 IP Phone (SIP Protocol)
- 1 Power backup system for Central Equipment
- 2 Power backup systems for CWPs

CON/TRA VCCS System (As Appendix 1, 5, 9)

- 36 Controller Working Positions (CWPs)
- 200 VoIP Channels for Transmitter and Receiver Radio (As Appendix 40-46)
- 150 VoIP Telephone Channels (As Appendix 47-51)
- 2 GPS Master Clock and Antennas
- 36 Slave clocks
- 36 IP Phone (SIP Protocol)
- 1 Power backup system for Central Equipment
- 1 Power backup system for CWP

Parallel Telephone System (As Appendix 1, 7, 11)

- 124 interfaces of FXO Telephone Gateway (as Appendix 60–62)
- 6 interfaces of FXS Telephone Gateway (as Appendix 60–62)
- 20 interfaces of Local Battery Telephone Gateway (as Appendix 60–62)
- 2 units of Telephone Servers
- 2 units of Ethernet Switches
- 1 Power Backup System for Central Equipment

Spare Part (As Appendix 2, 6, 10, 63-66)

1.2 GENERAL

1.2.1 The tenderer must provide references for the compliance replies. These references must include; A detailed description of the functionality, Screenshots and/or samples of operational VCCS systems which have been installed with relevant documentation or reports.

1.2.2 A computer-based Voice Communication Control System (VCCS) shall be required for controlling (switching) and interfacing the intra-facility and inter-

facility voice communications used in Air Traffic Control (ATC) operations. (Detailed specifications and requirements are provided in Appendix 3-6.)

1.2.3 The system shall operate on an IP-based network using IP addresses for all devices, supporting standard IP protocols (e.g., TCP/IP, UDP), and enabling IP-based communication for both data transmission and control.

1.2.4 The voice communications employed in the Air Traffic Control comprise of the air-to-ground VHF and UHF radios as well as telephone communications. The VCCS central equipment shall be independently operated in different modules.

1.2.5 The system shall be designed to support future expansion of capacity through the addition of units or modules.

1.2.6 The VCCS architecture shall support a sufficient number of simultaneous voice paths to handle the maximum anticipated voice traffic.

1.2.7 The VCCS equipment shall support monitoring via the Simple Network Management Protocol (SNMP).

1.2.8 The system shall incorporate built-in redundancy for all vital components, features and a distributed, decentralized processing architecture with a modular design. It shall be free from any single point of failure. For safety and reliability, the interconnection between the central racks and VCCS workstation facilities shall utilize a star topology. The system shall ensure a high level of availability.

1.2.9 The system's core switches shall operate in parallel at all times to interface with Controller Working Positions (CWPs), radio, and telephone systems.

1.2.10 The manufacturing facility shall be certified to the following standards. Valid certificates from accredited bodies shall be submitted for evaluation.

- ISO 9001 Quality Management
- ISO 14001 Environmental Management
- ISO 27001 Information Security Management

1.2.11 The offered VCCS shall comply with ED-153 or ED-109A software assurance level 3 (SWAL-3) down to the architectural layer, providing an end-to-end traceability system requirements, software requirements and test cases.

1.2.12 The offered VCCS shall comply with the ED-137A to ED-137C interoperability standards for VoIP ATM components. To demonstrate compliance, tenderer shall submit, together with their tender response, the test results and test cases executed using the EUROCONTROL VOTER testing tool.

1.2.13 The tenderer must be able to provide all spare parts within 10 years after signing the contract, with AEROTHAI being responsible for the procurement.

1.2.14 In case the quantity of materials in this TOR context is not the same as the quantity of materials in Appendix 1-2, the tenderer shall provide the quantity of materials according to the quantity of materials at least specified in Appendix1-2

1.3 CONTROL WORKING POSITION (CWP)

1.3.1 General

1.3.1.1 Control Working Position (CWP) shall consist of at least the following components: a panel, a foot push-to-talk (PTT) switch, loudspeakers, a slave clock, headset/handset access, and a headset/handset.

1.3.1.2 All Controller Working Positions (CWPs) shall be capable of accessing and operating all available radio and telephone lines.

1.3.1.3 Each Controller Working Position (CWP) shall support intercom communication with other CWPs via a dedicated button on the touch screen, allowing direct connection to a predefined position.

1.3.1.4 Each CWP shall be able to communicate with each other by selecting the designated button and then calling by voice, without the need for signalling (Voice Page).

1.3.1.5 All CWP fallback systems (Tower and Approach), and the CWP CONTRA system, shall be capable of intercommunication via Intercom. (As Appendix 12)

1.3.1.6 The tenderer shall provide a Short-Term Recording function on the operating screen for each CWP, which shall include the recording of transmissions, receptions, telephone communications.

1.3.1.7 The short-term record must have a minimum duration of 30 minutes. It shall remain stored even if the CWP logout/login.

1.3.1.8 As the proposed systems may differ in size from the existing consoles, the tenderer shall be responsible for modifying the consoles as necessary to ensure proper integration and accommodation of the proposed systems.

1.3.1.9 Each CWP shall support a Back-up Emergency feature to bypass the radio server and connect to the radio for emergency transmissions

1.3.2 **Touch Screen Unit**

1.3.2.1 The touch screen size shall be at least 12.1 inches TFT-display with a resolution of at least 800x600 pixels associated with a touch-input device (TID) and dual-input power supply connector (AC, AC). (As Appendix 18)

1.3.2.2 Each access function on the touch screen shall be represented by a button clearly labelled with the corresponding facility name.

1.3.2.3 The touch screen shall support a telephone button group (for ground-to-ground communications) and a radio button group (for air-to-ground communications) on the same page.

1.3.2.4 The CWP shall support a split mode to separate radio communications to the headset and telephone communications to the handset, and a normal mode to route both radio and telephone communications to both headset and handset.

1.3.2.5 The touch screen shall display the status of radio channels (e.g., traffic, monitor, coupled) and telephone lines (e.g., busy, incoming call).

1.3.2.6 The touch screen shall enable access to at least eight (8) radio frequencies simultaneously for transmission and reception.

1.3.2.7 The frequency allocated to a radio channel shall be indicated with six (6) digits plus decimal points (e.g., "1 19.075").

1.3.2.8 Each frequency channel assigned to the CWP shall be separated and have independent RX (receive) and TX (transmit) buttons.

1.3.2.9 The main page shall provide 'RX' and 'TX' labels on buttons for each radio frequency.

1.3.2.10 Telephone communication access shall be activated via the telephone button.

1.3.2.11 The telephone button group shall integrate general control functions such as Conference, Hold, Transfer, and Divert. Each function shall be provided with a separate button

1.3.2.12 The CWP shall support a dial pad to establish telephone connections.

1.3.2.13 Telephone buttons shall include Direct Access (DA), Indirect Access (IDA), and Instantaneous Access (IA) functions.

1.3.2.14 Relief Briefing shall allow two-way communications between the instructor and the operator, typically used to pass information during shift changes.

1.3.2.15 Relief Briefing shall not interrupt the position for use in air-to-ground and ground-to-ground calls.

1.3.2.16 The Human-Machine Interface (HMI) must be user-friendly and customizable.

1.3.3 **Headset/Handset Unit**

1.3.3.1 Both radio and telephone communications shall be operated via headsets and handsets.

1.3.3.2 The headset and handset access connector panel shall be provided by the tenderer.

1.3.3.3 Each CWP shall have at least two connectors on the headset access panel, one for the operator and one for the instructor.

1.3.3.4 The socket pin assignment of the headsets and handsets at the CWP shall include, at a minimum, connections for microphone, ear-cap, and PTT switch.

1.3.3.5 The Tenderer shall provide 192 handsets with holders and 192 monaural headsets equipped with Quick Disconnect connectors. The Quick Disconnect connectors shall be compatible with AEROTHAI's existing headsets (AEROTHAI's existing headsets are Plantronics SHS 2394-01 and Plantronics SHS 2470-05 for PTT part, HW 510 for Headset part).

1.3.3.6 The instructor facility shall have the capability to override both the microphone and PTT of the controller.

1.3.3.7 The controller and the instructor ear-caps shall allow for independent volume adjustment.

1.3.3.8 With the volume control in the minimum position, the audio level shall remain sufficient for monitoring purposes.

1.3.3.9 The audio from both headset and handset accesses shall be available for recording.

1.3.4 **Foot PTT Switch**

1.3.4.1 The tenderer shall install a footswitch connector on the front of the console.

1.3.4.2 The tenderer shall provide a mounting solution or fixation device to ensure the footswitch remains stable and does not move while in use.

1.3.5 **Loudspeaker Unit**

1.3.5.1 Each CWP shall have two loudspeakers, one dedicated to radio communication and the other to telephone communication. Both shall allow manual adjustment or selection of their respective audio sources.

1.3.5.2 The loudspeaker audio level shall be adjustable by the volume control.

1.3.5.3 The volume control shall be adjustable and the audio level at minimum position shall be remain sufficient to hear for monitoring purposes.

1.4 SIDETONE GENERATION

1.4.1 The VCCS shall provide sidetone, the operator outgoing audio, which is fed back to the operator handset/headset without any interference and echo.

1.4.2 The VCCS shall provide two-possibilities for generating sidetone at the operator position:

a) **Remote sidetone**: No sidetone shall be generated within the system. However, the VCCS shall utilize attenuated audio received from the active radio receiver.

b) **Local sidetone**: The transmitted audio shall be routed back directly from the radio interface or sidetone shall be generated locally at the operator position, there shall be no delay in the audio.

1.4.3 The VCCS shall be able to adjust the sidetone level.

1.4.4 The VCCS shall be support sidetone-off mode, preventing the operator's outgoing audio from being routed back to their handset/headset.

1.5 VCCS CENTRAL EQUIPMENT

1.5.1 **Radio Part**

1.5.1.1 The selection or deselection of any radio frequency shall be accessed via a radio button assigned to the Control Working Position (CWP) for transmission and/or reception.

1.5.1.2 The presence of a received voice signal from the receivers shall be indicated (Squelch Indication).

1.5.1.3 The main and standby channels of the radio receiver shall be interlocked to ensure that only one of the channels will receive at a time, even if both channels have been inadvertently selected by the controller.

1.5.1.4 The main and standby channels of the radio transmitter shall be interlocked to ensure that only one of the channels will transmit at a time, even if both channels have been inadvertently selected by the controller.

1.5.1.5 Radio transmission shall be activated when the operator pushes the Push-To-Talk (PTT) switch, (Headset PTT switch, Handset PTT switch, or Foot PTT switch).

1.5.1.6 When more than one radio channel is selected, the operator shall be able to transmit simultaneously on all selected channels by pressing the Push-To-Talk (PTT) switch.

1.5.1.7 The system shall provide automatic muting of the receiver when the transmitter is transmitting.

1.5.1.8 Each CWP shall be able to monitor all available radio channels, even if those channels are in use at other CWPs.

1.5.1.9 The system shall support frequency cross-coupling, enabling automatic retransmission of a received signal on other pre-selected radio frequencies, allowing multiple physical frequencies to operate as a single logical frequency.

1.5.1.10 The system shall provide "PTT override" function to override another role on the same frequency.

1.5.1.11 The system shall support a coupling function that enables aircraft operating on one frequency to directly communicate (transmit and receive) with aircraft on other coupled frequencies.

1.5.1.12 The system shall provide a clear indication to the user of all frequencies that are currently operating in cross-coupled mode.

1.5.1.13 At all other Control Working Positions (CWPs) assigned to the same frequencies, a clear and distinct visual indication shall be provided on each frequency to indicate that it has been coupled at a different CWP.

1.5.1.14 When the coupling is released, the visual indication that the frequency was coupled shall be automatically removed.

1.5.1.15 The controller shall be capable of selecting at least 15 radio frequencies in a cross-coupled group.

1.5.1.16 The VCCS shall provide a Receiver Voting function (Best Signal Selection), which shall automatically select the receiver with the highest signal quality from a group of at least four (4) receivers.

1.5.1.17 During operation of the VoIP Receiver Voting function (Received Signal Strength Indicator – RSSI), the system shall allow operators to override the automatic selection and manually choose a preferred receiver.

1.5.1.18 When the Receiver Voting function is active, the VCCS shall provide automatic transmitter selection to ensure consistent and optimal communication performance.

1.5.1.19 The VCCS shall provide the capability to enable or disable the automatic transmitter selection function.

1.5.1.20 The VCCS shall provide a Simultaneous Call Transmission (SCT) function.

1.5.1.21 The VCCS shall process the SCT value received from the radio equipment and provide a visual indication of its status to the operator. Radio equipment compliant with ED-137A to ED-137C may indicate simultaneous transmission through the SCT bit in the RTP header extension.

1.5.1.22 The VCCS shall generate and display a Simultaneous Call Transmission (SCT) indication whenever two or more incoming aircraft transmissions are received concurrently.

1.5.1.23 The VCCS shall provide a Simultaneous Call Transmission (SCT) indication when incoming transmissions from aircraft occur concurrently with a transmission from a controller. The system shall be able, based on a timer, to recognize a simultaneous transmission received from another aircraft on a different receiver than the one chosen from the Best Signal Selection (BSS) or Received Signal Strength Indicator (RSSI) functionality for the first signal.

1.5.1.24 Each radio frequency shall be provided with a Main and Standby channel. There shall be a Management System Parameter to manually select the following methods for error detection during switching:

- Loop Check (PTT - SQU Loop)
- Radio Status (alarm, fail)

1.5.1.25 The system shall be capable of interfacing with the VoIP radio system (compliant with ED-137A to ED-137C Interoperability Standards for VoIP ATM Components).

1.5.1.26 In a single system, the Radio Server shall be installed separately from the Database Server and the Telephone Server. All servers shall be configured with redundancy and installed within a standard 42U 19-inch rack.

1.5.1.27 The tenderer shall provide VCCS functionality for automatic radio selection (Main/Standby) in the event of a radio alarm received via the VoIP interface compliant with ED-137A to ED-137C standards. This functionality shall be applicable to radios of any brand.

1.5.1.28 The VCCS system shall be connected to both Main and Standby VoIP Radio interfaces via two groups of network switches.

1.5.1.29 The Tenderer shall provide Radio Server in accordance with the server hardware requirements of section 1.5.4. or blade server according to standard manufacturing to perform as radio server.

1.5.2 **Telephone Part**

1.5.2.1 When selecting Direct Access (DA) line, a connection shall be established to a predetermined destination.

1.5.2.2 The identity of the Indirect Access (IDA) caller shall be generated locally and displayed on the panel.

1.5.2.3 After establishing a DA or IDA connection, and prior to the called terminal accepting the call, a ring-back tone shall be provided to the calling user.

1.5.2.4 Instantaneous Access (IA) calls shall be supported both within the VCCS system and with external systems via the designated Local Battery (LB) interface line (See Appendix 16).

1.5.2.5 The system shall support both incoming and outgoing Hotline Access calls.

1.5.2.6 The Hold function shall be supported for both DA and IDA lines. This function shall allow a user at a CWP to manage multiple incoming or outgoing calls simultaneously, while permitting only one active connection to the headset or handset at a time.

1.5.2.7 The Conference function shall be supported for both DA and IDA lines. It shall allow a user to interconnect multiple Control Working Positions (CWPs) and/or different types of lines, providing full-duplex voice communication among all participants. A dedicated Conference button shall be available.

1.5.2.8 The Transfer function shall be available for both DA and IDA. This function will enable any call made or received at a CWP to be manually redirected to any other party.

1.5.2.9 The system shall provide a feature to display missed calls on the main page of the touch screen interface.

1.5.2.10 The system shall provide the capability to enable or disable audible notification of all incoming telephone calls via a signalling tone generated by a buzzer or speaker.

1.5.2.11 It shall be possible to disable the signalling tone; however, a visual indication shall remain active on the corresponding button.

1.5.2.12 It shall be possible to adjust the volume level of the signalling tone.

1.5.2.13 The system shall be capable of interfacing with the VoIP telephony system compliant with ED-137A to ED-137C Interoperability Standards for VoIP ATM Components.

1.5.2.14 The system shall provide a real-time indication of the status of any telephone line, showing when a line is active or busy, to allow other systems and CWPs to recognize that the line is in use.

1.5.2.15 The intercom function between CWPs shall be activated with a single button press. A ringing tone shall be generated at the destination CWP to indicate the incoming intercom call.

1.5.2.16 The Tenderer shall provide a 7-digit numbering plan and routing configuration for the VoIP telephone system in accordance with AEROTHAI's requirements. (As Appendix 27)

1.5.2.17 All incoming calls to a CWP shall appear immediately in the call stack as soon as the call begins ringing, with no delay.

1.5.2.18 The SIP servers shall support parallel forking functionality, enabling simultaneous connections with at least 10 parties. (As Appendix 19- 24)

1.5.2.19 In a single system, the Telephone Server shall be installed separately from the Database Server and the Radio Server. All servers shall be configured with redundancy and installed within a standard 42U 19-inch rack.

1.5.2.20 The Tenderer shall provide Telephone Server in accordance with the server hardware requirements of section 1.5.4.

1.5.2.21 The Tenderer shall provide ninety-six (96) sets of SIP-compliant IP phones capable of connecting directly to the Telephone Server and fully operational for telephone line services without passing through the main VCCS system. (As Appendix 11)

1.5.2.22 The Tenderer shall install ninety-six (96) sets of IP phones on the CWP of each room and ensure that the equipment is ready for operation. The IP phones shall also be capable of supporting backup telephone functions in the event of failure of the main system.

1.5.2.23 The telephone server shall be capable of functioning as a SIP registrar server, proxy server, and redirect server.

1.5.3 **Database Server**

1.5.3.1 The Database Servers shall feature strong security to prevent unauthorized access and system failures.

1.5.3.2 The Tenderer shall ensure that the database server is capable of performing data backup and restore operations.

1.5.3.3 In a single system, the Database Server shall be installed separately from the Radio Server and the Telephone Server. All servers shall be configured with redundancy and installed within a standard 42U 19-inch rack.

1.5.3.4 The Tenderer shall provide Database Server in accordance with the server hardware requirements of section 1.5.4.

1.5.4 SERVER HARDWARE SPECIFICATION

1.5.4.1 The server shall be a **1U rack-mounted enterprise server**, suitable for data center deployment.

1.5.4.2 **CPU**: Dual-socket configuration supporting Intel® Xeon® Scalable processors (4th Generation or newer) or equivalent, with a minimum of 24 physical cores per CPU (total ≥48 cores), base frequency optimized for enterprise workloads (typically ≥1.8 GHz), and support for high-TDP processors (≥250 W). Higher core counts are acceptable.

1.5.4.3 **Memory**: Installed memory shall be at least 256 GB DDR5 ECC RDIMM, supporting up to 5600 MT/s (depending on CPU installed) and 8 memory channels per CPU.

1.5.4.4 **Storage**: Support hot-pluggable 2.5-inch drives, compatible with SAS HDD/SSD and/or NVMe SSD (with appropriate backplane configuration), with a minimum of 2TB usable capacity installed.

1.5.4.5 **RAID Controller**: Enterprise hardware RAID controller supporting RAID 0, 1, 5, 6, 10, 50, and 60, with cache protection or equivalent.

1.5.4.6 **Network Interface**: Minimum 2 × 1GbE onboard ports, expandable to at least 4 ports via modular or add-on network adapters, and expandable to 10/25/100 GbE.

1.5.4.7 **Management:** Integrated out-of-band remote management controller, supporting secure remote access and monitoring via HTTPS with modern TLS (TLS 1.2 or higher, TLS 1.3 preferred).

1.5.4.8 **Thermal / Cooling:** Redundant hot-swappable cooling fans with adaptive fan control, suitable for dual high-TDP CPU operation.

1.5.4.9 **Health Monitoring:** Real-time monitoring of CPU, memory, storage, temperature, cooling, power supplies, and overall system hardware health.

1.5.4.10 **Power Supply Units (PSUs):** Dual hot-pluggable redundant PSUs, rated at least 800 W or higher per unit, with 80 PLUS Platinum or higher (Titanium acceptable) efficiency.

1.5.5 TELEPHONE GATEWAY

1.5.5.1 The telephone gateway shall support bidirectional signal conversion between analog phones and SIP phones, ensuring protocol

compatibility and proper verification between analog and SIP interfaces.

1.5.5.2 The telephone gateway shall support FXO (2-wire Foreign Exchange Office) and FXS (2-wire Foreign Exchange Subscriber) interfaces, enabling direct connection to the PSTN via FXO ports and to analog telephones via FXS ports.

1.5.5.3 The 2-wire FXO and FXS interface module shall provide all necessary line signalling functionalities, including DC loop current upon off-hook status, DTMF digit generation, and ringing voltage detection.

1.5.5.4 The telephone gateway shall support Local Battery telephone (Voice Page).

1.5.5.5 The 2-wire telephone gateway module shall support an interface for connecting a 2-wire analog telephone set compliant with ITU-T Recommendation Q.23.

1.5.5.6 Each gateway module shall support a maximum of four (4) analog telephone lines, include dual Ethernet interfaces, and incorporate built-in Caller ID functionality without the need for any external device.

1.5.5.7 Faulty module(s) shall be immediately identified by the alarm indicator.

1.5.5.8 The telephone line interface module shall support audio frequency transmission within a range of at least 300 Hz to 3400 Hz.

1.5.5.9 The amplifiers of the telephone line interface module shall be adjustable in both transmit and receive directions.

1.5.5.10 The telephone gateway channels shall provide both IP-based and analog recording outputs.

1.5.5.11 The telephone gateway shall provide a user interface accessible and manageable via a networked computer.

1.5.5.12 Redundant power supplies, AC 2 Sources shall be provided.

1.5.5.13 For compatibility purposes, the module shall be of the same brand as the VCCS system.

1.5.6 **RADIO GATEWAY**

1.5.6.1 The radio gateway shall support bidirectional conversion between 4-wire (4W) analog radio and Radio over IP (VoIP), ensuring interoperability and protocol compliance. The radio gateways shall be installed at a total of six (6) radio stations. (as Appendix 15, 52-59)

1.5.6.2 One module shall support a maximum of 4 analog radio channels and include a dual Ethernet interface.

1.5.6.3 The radio gateway shall be capable of interfacing with VoIP radio systems and shall comply with the ED-137A, ED-137B, and ED-137C interoperability standards for VoIP-based Air Traffic Management (ATM) components.

1.5.6.4 Redundant power supplies, AC 2 Sources shall be provided.

1.5.6.5 The device shall support audio codecs G.711 (PCM 64 kbps) and G.729.

1.5.6.6 The device must support 4W E&M impedance of 600 Ohms.

1.5.6.7 For compatible reasons a module shall be same brand as VCCS.

1.5.7 **ETHERNET SWITCH**

1.5.7.1 The Tenderer shall provide at least twelve (12) rack-mounted network switches for interfacing with the VCCS system, these switches are intended to establish network connectivity between the system server, IP CWPs, IP Phones, and IP radios. (Details in Appendix 13),

The required switches shall be distributed as follows:

a) Four (4) switches for the Fallback Tower;
b) Four (4) switches for the Fallback Approach;
c) Four (4) switches for the CON/TRA;

1.5.7.2 The Tenderer shall provide at least eight (8) rack-mounted network switches for use in the CWP operation system, these switches shall be used to interconnect the CWP units located at Tower and Approach positions with the Fiber optic backbone connected to the Interface VCCS system. (Details in Appendix 13).

The required switches shall be allocated as follows:

a) Two (2) switches for CWP Tower T7;
b) Two (2) switches for CWP Tower T5A;
c) Two (2) switches for CWP Approach;
d) Two (2) switches for CWP CON/TRA;

1.5.7.3 The Tenderer shall provide at least two (2) rack-mounted network switches for the CWP Maintenance system, these switches shall be used to interconnect the CWP Maintenance units located in the watch room with the network switch interface of the VCCS system. (Details in Appendix 13).

1.5.7.4 The Tenderer shall provide at least two (2) rack-mounted network switches, these switches shall be used to connect the CWP Evaluation Operation (EO), installed in the EO Room, to the switch interface of the VCCS system. (Details in Appendix 13).

1.5.7.5 The Tenderer shall provide at least two (2) rack-mounted network switches, these switches shall support parallel telephone system connectivity to the new VCCS. (Details in Appendix 11).

1.5.7.6 The Tenderer shall provide at least twelve (12) rack-mounted PoE network switches for connecting the Slave Clocks. (Appendix 13)

1.5.7.7 The Tenderer shall provide at least twelve (12) rack-mounted network switches, these switches shall be used to establish network connectivity at each radio station. The distribution of switches shall be as follows: (Details in Appendix 15)

a) two (2) for TX Station, two (2) for T2 Station;
b) two (2) for Apron West Station, two (2) for Apron East Station;
c) two (2) for SMR Station, two (2) for T1 Station;

1.5.7.8 Each switch shall be equipped with a minimum of forty-eight (48) Ethernet ports

1.5.7.9 Each switch shall be configured to support IPv4 static routing capabilities.

1.5.7.10 The Tenderer shall provide stack cables with lengths appropriate to the network design, in accordance with the stack configuration requirements.

1.5.7.11 The tenderer shall ensure that all switches are configured in a stack-wise topology using the stacking cable.

1.5.7.12 All network switches shall be equipped with dual redundant power supplies.

1.5.7.13 Each switch shall be configured to support the EIGRP routing protocol to ensure high availability and efficient network performance.

1.5.7.14 The Tenderer shall ensure that all switches support Link Aggregation (LACP) and IP SLA Sender functionality.

1.5.7.15 The Tenderer shall provide SFP 1G Base-LX or better transceiver modules with a wavelength of 1,310 nm, compatible with Single-Mode Optical Fiber (SMF).

1.5.7.16 The Tenderer shall provide four (4) SFP modules of the same brand as the switch for each individual switch equipped with four (4) SFP ports (four modules per switch).

1.5.7.17 Each switch shall support the Multiple Spanning Tree Protocol (MSTP) to ensure high availability.

1.5.7.18 The switch shall support 802.1Q Tunnelling.

1.5.7.19 The Tenderer shall configure the VLAN network in accordance with Aerothai's requirements. (Details in Appendix 26)

1.5.8 **GPS MASTER CLOCK**

1.5.8.1 The master clock shall be equipped with a time display on the front panel.

1.5.8.2 The master clock shall be synchronized via a GPS receiver.

1.5.8.3 The master clock shall be able to maintain accurate time automatically without relying on a GPS receiver.

1.5.8.4 The master clock shall be capable of automatic resynchronization when the GPS signal is restored.

1.5.8.5 Each system shall be equipped with two redundant master clocks to ensure continuous and reliable time synchronization.

1.5.8.6 The Tenderer shall provide a Network Time Protocol (NTP) server to distribute accurate time signals to network devices.

1.5.8.7 The master clock shall include built-in function keys to facilitate local access to configuration settings and real-time system status information

1.5.8.8 The master clock shall indicate system status via status LEDs and text messages on the LCD panel, including Power ON, Signal Sync, No Signal, and System Error.

1.5.8.9 The master clock shall provide an accuracy of at least 50 nanoseconds RMS to UTC and support Stratum 1 operation when synchronized with multiple GNSS receivers.

1.5.8.10 The NTP unit shall be equipped with a network interface comprising at least 4 LAN ports, each supporting IPv4, IPv6, SNMP, and web-based monitoring.

1.5.8.11 The master clock shall support the following time synchronization protocols: NTP, SNTP, and PTP.

1.5.8.12 The master clock shall be equipped with redundant power supplies (dual hot-swappable).

1.5.8.13 The master clock shall use an internal high-stability oscillator, either OCXO or Rubidium, as a time source to maintain accurate timekeeping in the event of signal loss.

1.5.8.14 The master clock shall support security features including NTPv4 authentication using MD5 or SHA algorithms, and secure management interfaces such as SSH and HTTPS.

1.5.8.15 The master clock shall support signal outputs including 1PPS and 10 MHz frequency signals.

1.5.8.16 The master clock shall support handling of up to 10,000 NTP requests per second.

1.5.8.17 The master clock shall comply with the following certifications and standards: IEEE 1588 and ISO 9001 for production manufacturing.

1.5.8.18 The master clock shall support firmware updates throughout its operational lifespan.

1.5.8.19 The master clock shall be manageable via a standard web browser interface.

1.5.8.20 The master clock shall include functionality for event logging, statistical data recording, and system monitoring via software.

1.5.9 **SLAVE CLOCK**

1.5.9.1 Slave clocks shall be installed in the Control Room and the Watch Room.

1.5.9.2 All slave clocks shall maintain continuous synchronization with the master clock.

1.5.9.3 In the event of a Master Clock connection failure, each slave clock shall operate independently and maintain accurate time.

1.5.9.4 Slave clocks shall display time in a 24-hour format using six digits (HH:MM:SS).

1.5.9.5 Each slave clock shall operate independently with an internal TCXO when disconnected from the master clock and shall indicate a synchronization status.

1.5.9.6 Slave clocks shall have a black case, and a display type are LED or LCD with 3-to-5-inch diagonal dimension.

1.5.9.7 Slave clocks shall support both IPv4 and IPv6 network protocols.

1.5.9.8 Slave clocks shall be powered by 48 V PoE via an Ethernet switch.

1.5.10 POWER SUPPLY

1.5.10.1 All equipment shall be provided with a redundant power supply capable of operating with two independent AC input sources at 210–230 Vac, 50–60 Hz. The system shall continue to operate normally in the event of a voltage drop to 210 Vac.

1.5.10.2 In the event of a failure of AC power source 1, the VCCS system shall automatically switch to AC power source 2 without any interruption to system operation.

1.5.11 POWER BACKUP SYSTEM

1.5.11.1 A standard 19" 42U equipment rack shall be provided the power backup system and all related equipment, with specifications as follows:

a) Four (4) power backup systems shall be provided for the central equipment as follows: (Details in Appendix 17)
   - One (1) for the Fallback Tower System
   - One (1) for the Fallback Approach System
   - One (1) for CONTRA System
   - One (1) for the Parallel Telephone system

b) Five (5) power backup systems shall be provided for the Controller Working Positions (CWP), as follows:
   (Details in Appendix 18)
   - Two (2) for the Fallback Tower systems
   - One (1) for the Fallback Approach system
   - One (1) for the CONTRA system
   - One (1) for the Evaluation Operations (EO) Room

c) One (1) power backup system shall be provided for the spare system. (Details in Appendix 17)

1.5.11.2 The charger, inverter, and static transfer switch (STS) of the redundant power backup system shall be capable of supplying the entire system as a backup for all equipment installed on both A-side and B-side. (Details in Appendix 17,18).

1.5.11.3 The power backup system shall be designed to operate with either a 24 VDC or 48 VDC float-charged battery system, depending on the equipment requirements.

1.5.11.4 The power backup system provided by the tenderer shall be capable of supplying power for a minimum of **2 hours** in the event of failures of UPS-A, UPS-B, and the normal AC power line, ensuring uninterrupted power to the Central Equipment system and all CWP devices on both A-side and B-side.

1.5.11.5 The tenderer shall provide front-terminal VRLA batteries of the AGM type for use in the telecom system. The batteries shall be valve-regulated to control internal pressure, be non-flammable, and be certified by a recognized standard body.

1.5.11.6 The tenderer shall calculate power consumption by separating the calculations as follows:

a) Power Consumption of each type of equipment.
b) Power Consumption of VCCS system of A-Side and B-Side.
c) Power Consumption of CWP each room.
d) Overview of all devices operating from the same power supply, along with a schematic diagram of the proposed power backup system.

1.5.11.7 The tenderer shall provide a power backup system for each of the following items.

a) Each charger shall comprise of at least two rectifier modules, a Low Voltage Disconnect (LVD), temperature sensor, SNMP-based monitoring software, and an Ethernet switch. The system shall be configured as two independent systems (A-side and B-side), with each installed in separate sub-racks. Each system shall support a minimum output capacity of 3 kW at either 24 VDC or 48 VDC, powered by a nominal input of 230 VAC, 50 Hz. All equipment shall be installed in standard 19-inch racks.

b) Each inverter shall consist of at least two modules, with zero transfer time, SNMP-based monitoring software, and an Ethernet switch. The system shall comprise of two independent units (A-side and B-side), each installed in separate sub-racks, and all equipment shall be mounted in standard 19-inch racks.

Input specifications:

- Nominal input voltage: 230 VAC, 50 Hz
- Input voltage range: 180–260 VAC ±2%
- DC input: Nominal 24 VDC (range 18–34 VDC ±3%) or 48 VDC (range 36–68 VDC ±3%)

Output specifications:

- Nominal output voltage: 230 VAC, 50 Hz
- Output voltage range: 200–240 VAC ±2%
- Output power capacity: Minimum **3 kW** per system

c) Each system shall be equipped with two sets of Static Transfer Switches (STS) and Ethernet switches, one for the A-side system and one for the B-side system. The STS shall support a nominal current of **32 A**, with input/output nominal voltage of 230 VAC, 50 Hz. The typical transfer time shall be ≤ 10 milliseconds. Each unit shall be 1U in height and installed in a standard 19-inch rack.

d) The batteries used for the power backup system of four (4) Central VCCS systems and one (1) parallel telephone system shall be provided separately for each system (A-side and B-side). The total battery capacity shall be no less than **7.2 kWh**. The batteries shall meet the following specifications:

- AGM (Absorbent Glass Mat) technology
- Front terminal type, designed for operating conditions up to 35°C
- Individual battery capacity of 12 V / 150 Ah or higher
- Service life of ≥ 7 years at 35°C or better

e) The batteries used for the power backup system of five (5) CWP systems shall be provided separately for each system (A-side and B-side). The total battery capacity shall be no less than **4.2 kWh.** The batteries shall meet the following specifications:

- AGM (Absorbent Glass Mat) technology
- Front terminal type, designed for operating conditions up to 35°C
- Individual battery capacity of 12 V / 95 Ah or higher
- Service life of ≥ 7 years at 35°C or better

1.6 SYSTEM INTERCONNECTION

1.6.1 The VCCS central equipment shall be directly interfaced with a Main Distribution Frame (MDF), which shall be provided by the Tenderer. All required communication lines, as specified in Paragraph 1.5, VCCS Central Equipment.

1.6.2 Lightning protection shall be provided at the MDF for all analog telephone and analog radio gateway connections.

1.6.3 The Tenderer shall provide all necessary interconnection cabling between the CWPs and the central equipment for each system, as well as between the central equipment and all external interfaces.

1.6.4 The Tenderer shall provide interconnections between the three (3) central equipment systems: Fallback Tower, Fallback Approach, and CONTRA. The system shall support intercom functionality between all three systems. (Details in Appendix 12).

1.6.5 The Tenderer shall be responsible for connecting the existing radio and telephone lines to the proposed systems. The connection work shall be carried out at a time specified by AEROTHAI.

1.6.6 The Tenderer shall install the fiber optic system and submit a test report, including detailed loss measurements for each fiber route, as specified in Appendix 14.

a) **Core Count:** 48 cores
b) **Construction**: Multi-tube, ARSS armored, PE or LSZH outer jacket
c) **Connectors:** SC/UPC duplex with dust caps
d) **Patch Panel:** Rack-mountable, SC/UPC adapters included
e) **Conduit:** Flexible HDPE or equivalent, suitable for 48-core cable
f) **Attenuation:** ≤0.35 dB/km @1310 nm, ≤0.21 dB/km @1550 nm
g) **Temperature Range**: -40°C to +70

1.6.7 The Tenderer shall provide a parallel telephone system connection from the analog telephone line to both the existing MOPS VCCS (Legacy) and the three (3)

new VCCS systems. The connection shall utilize a 48-core Fiber optic cable with ARSS multi-tube armored construction, SC connectors, and be installed within a flexible conduit. (Details in Appendix 11)

1.6.8 The signal connection between the CWPs and the central equipment shall be implemented using 48-core Fiber optic cable with ARSS multi-tube armored construction, SC connectors, and flexible conduit. (Details in Appendix 13)

1.6.9 The Tenderer shall provide a wall-mounted metal box cabinet for module disconnection, capable of accommodating at least 220 disconnection sets (55 pcs/column). A UL-6556 floor standing cabinet shall also be provided. In addition, the Tenderer shall prepare a Krone-type back mount frame and pre-terminated cabling ready for connection to analog telephone.

1.6.10 The LAN cables and RJ-45 connectors shall be Unshielded Twisted Pair (UTP) Category 6 and shall comply with ANSI/TIA-568-C.2, ISO/IEC 11801, or a higher standard version.

1.6.11 All cables shall be clearly and completely labelled with marker strips at both ends, indicating the origin and destination of each cable.

1.7 TECHNICAL MONITORING AND CONTROL SYSTEM (TMCS)

1.7.1 The TMCS shall be utilized for monitoring, controlling, and configuring the VCCS central equipment.

1.7.2 The TMCS shall be installed in the equipment rooms.

1.7.3 The TMCS shall be capable of performing automatic backups from the main TMCS to the standby TMCS.

1.7.4 The TMCS shall be equipped with a statistical data package capable of recording and analyzing traffic loads on individual controller working positions, telephone lines, and radio channels.

1.7.5 The TMCS shall include functionalities for event logging, including PTT (Push-To-Talk), squelch (SQ), call-in, and call-out activities. The system shall support exportable log data retention for a minimum period of one (1) year.

1.7.6 The TMCS shall be capable of extracting activity and event logs from the system in an industry-standard format, without causing any disruption to the operational services.

1.7.7 All configuration data in the VCCS central equipment and TMCS shall not disappear when the VCCS central equipment is powered off.

1.7.8 In the event that the TMCS is powered off, the VCCS system shall continue to operate without any interruption to its normal functions.

1.7.9 When the TMCS application is started, the operator shall be required to enter a valid username and password to log in.

1.7.10 For security purposes, the system shall provide the capability to assign different access rights and levels of access to the system and its database, based on the roles and responsibilities of authorized personnel.

1.7.11 The access rights management function shall support the creation, updating, and modification of access credentials for both new and existing users.

1.7.12 The TMCS shall allow reconfiguration of the assigned radio channels for each CWP.

1.7.13 The TMCS shall support the reconfiguration and assignment of frequencies for newly added radio channels.

1.7.14 The TMCS shall allow reconfiguration of the assigned telephone channels for each CWP.

1.7.15 The TMCS shall allow reconfiguration of telephone button assignments and the telephone numbers assigned to each line.

1.7.16 The TMCS shall allow reconfiguration for adding or deleting CWPs, provided that the total number of CWPs does not exceed the system's maximum capacity.

1.7.17 Online reconfiguration shall not affect ongoing calls, including both radio and telephone communications.

1.7.18 The TMCS shall generate an alarm upon detection of any malfunction in the VCCS system.

1.7.19 If a malfunction of the VCCS is detected, both visual and audible alarms shall be activated on the TMCS.

1.7.20 The failure message shall include, at a minimum, the type of failure, the time of occurrence, and the equipment involved.

1.7.21 The VCCS equipment shall be delivered with all necessary VCCS software licenses included.

1.7.22 The VCCS equipment shall support monitoring of alarm status via Simple Network Management Protocol (SNMP) v2 or v3.

1.7.23 The SNMP database indicating equipment status shall, at a minimum, be stored in a Management Information Base (MIB) file and be accessible.

1.7.24 The TMCS shall be capable of remotely rebooting each CWP without affecting the operation of the overall system.

1.7.25 The TMCS shall support online reconfiguration, offline configuration, and individual system reboot without affecting the operation of other systems. In the event of a failure, alarm, or warning in any part of the system, the rest of the system shall remain unaffected. (Details Appendix 12)

1.7.26 The TMCS shall support online reconfiguration in the event of a lost VoIP radio connection and shall be capable of reassigning or restoring the missing connection without disrupting system operations. (Details Appendix 25)

1.7.27 The TMCS shall monitor the status of each CWP's radio channels, including traffic activity, monitoring, and coupling status, as well as telephone status such as call forwarding and related functions.

1.7.28 The Tenderer shall provide configuration tools that can be installed on a standalone workstation to test and validate configurations prior to deployment, with the capability to upload configurations to the live system.

1.7.29 The TMCS shall support dynamic modification of the Human-Machine Interface (HMI), including the layout configuration and the colour settings of telephone buttons.

1.7.30 Each radio channel shall support configuration of various radio modes, including Off Mode, Monitor Mode, and Traffic Mode, based on the designated operational role.

1.8 MANAGEMENT WORKSTATION

1.8.1 The Tenderer shall provide Management Client desktop PC shall be equipped with at least a display, keyboard, mouse, speaker and required software with legal licenses. Specified as follows:

a) **CPU**: Intel Core Ultra 9 or higher.

b) **RAM**: 64GB (2 x 32GB) DDR5, 5600Mhz or higher.

c) **Storage**: 2TB SSD M.2 or higher.

d) **Operating System**: Windows 11 Pro or higher (English version) or Windows server or Linux, with legal license.

e) Minimum Connectivity Requirements

- **LAN**: At least two (2) Gigabit Ethernet ports
- **Video Output**: At least two (2) HDMI ports

- **USB Ports:** At least two (2) USB ports
- **Thunderbolt:** At least one (1) Thunderbolt 4 port with support for 4K video output
- **Audio Output:** One (1) 3.5 mm stereo audio output jack

1.8.2 The Tenderer shall provide computer monitors with the following minimum specifications:

a) **Panel Size:** 27 inches

b) **Panel Type:** IPS with Anti-Glare

c) **Maximum Resolution:** 3840 × 2160 pixels (4K UHD) or higher

d) Minimum Connectivity Requirements

- HDMI Port
- DisplayPort (Version 1.4 or higher)
- Thunderbolt 4, USB-C Port
- USB Type-A Port
- Audio line-out Port

1.8.3 The Tenderer shall provide Management Client Laptop equipped with the following specifications:

a) **CPU:** Intel Core Ultra 9 or higher

b) **RAM:** 64GB (2 x 32GB) DDR5 or higher

c) **Storage:** 1TB SSD M.2 or higher

d) **Graphics:** NVIDIA GeForce RTX 4070 or higher

e) **Network Interface:** Integrated LAN 10/100/1000 Mbps or higher

f) **Battery:** 4-cell, 72Whr or higher

g) **Display:** 14.0" FHD (1920x1080) or higher resolution

h) **Operating System:** Windows 11 Pro or higher (English version) or Linux, with legal license

1.9 VCCS VOICE RECORDING

1.9.1 The input/output of any received/transmitted voice signal from/to incoming/outgoing CWP of both telephone and radio communications including relief briefing, shall be amplified, or attenuated, connected for VoIP recording, and can be combined those signals into only 1 channel for each position to the voice recorder (Position Record compliant to ED-137A to ED-137C.)

1.9.2 The input and output of any received or transmitted voice signal from or to incoming and outgoing interfaces, including both telephone and radio channels, shall be amplified or attenuated as necessary. These signals shall be connected for VoIP recording to the voice recorder, ensuring compliance with VoIP Channels/Lines Record standards as specified in ED-137A to ED-137C.

1.9.3 All cables, accessories, and tools required to connect the recorded signals specified in items 1.9.1, 1.9.2, and 1.9.3 to the voice recorder shall be provided by the tenderer.

1.10 ENVIRONMENTAL CONDITIONS

1.10.1 The VCCS equipment shall be able to operate in a controlled environment of approximately 10-40 °C and relative humidity of up to 70%.

1.11 TECHNICAL MANUAL

1.11.1 The tenderer shall provide all technical manuals of the VCCS system. (2 sets of hard copy and 2 sets of soft copy)

1.11.2 The technical manuals shall contain comprehensive instructions covering the installation, operation, maintenance, and troubleshooting of the system.

1.11.3 The Tenderer shall provide a list of all necessary standards documents and the Interface Control Document (ICD) pertaining to the information exchange between the VCCS and AEROTHAI's Communication Control and Monitoring System (CCMS).

1.11.4 The Tenderer shall provide a technical manual for the SNMP.

1.12 CON/TRA VCCS

1.12.1 Contingency Mode

1.12.1.1 In the event of a total failure of both the MOPS VCCS (Legacy) and the Fallback VCCS, the CON/TRA VCCS shall assume full responsibility for ground-to-ground and air-to-ground communications.

1.12.1.2 All components of the CON/TRA VCCS shall be completely independent and physically separated from Fallback VCCS.

1.12.2 Simulator or Training Mode

1.12.2.1 The Tenderer shall propose an appropriate Air Traffic Control (ATC) Simulator System designed to support training activities for Approach Control operation.

1.12.2.2 The Simulator System or Training system for Approach Control (CON/TRA VCCS) shall be able to accommodate the following positions:

- 26 Controller Working positions.
- 10 Pseudo Pilot Positions.
- 60 Simulated Radio Channels.
- 100 Simulated Telephone Channels.

1.12.3 TMCS shall support the setup of at least 10 pre-configured scenarios or modes.

1.13 PARALLEL TELEPHONE SYSTEM

1.13.1 The parallel telephone system shall connect to the Aerothai analog phone network, enabling two-way signal conversion: from analog to IP for the three new VCCS systems, and from IP to analog for the existing legacy VCCS system. (as Appendix 11).

1.13.2 The parallel telephone system shall support parallel forking functionality, enabling connection of at least 10 parties to the CWP. (As Appendix 19 - 24)

1.13.3 All incoming calls shall ring simultaneously on both analog and VoIP phones as soon as the call begins ringing, with no delay time.

1.13.4 The tenderer shall install the system in a standard 19-inch 42U.

1.13.5 The Parallel telephone systems shall be manageable.

1.13.6 The parallel telephone systems shall be adjustment of both input and output signal levels of the telephone line.

1.14 SPARE VCCS SYSTEM

1.14.1 The Tenderer shall provide and install a spare system identical to the main system, including server, switch, CWP, radio, telephone, interface units, and other related devices. (Appendix 2, 6, 10)

1.14.2 The Tenderer shall configure all servers and switches of the spare system to be ready for immediate use with the Fallback APP system in the event of a system failure.

1.14.3 The Tenderer shall provide two (2) steel storage cabinets with a minimum dimensions of 90 cm (W) x 45 cm (D) x 180 cm (H) for storing spare parts.

1.15 NETWORK MONITORING

1.15.1 The physical server for the network monitoring system shall be separate from the VCCS system and installed in the same rack as the Fallback Approach of the Fallback System. (Appendix 8)

1.15.2 The physical server specifications shall refer to the Server Hardware requirements specified in Section 1.5.4, but the capacity for the total array is installed ready-to-use at least 128TB.

1.15.3 The Supervision System shall be capable of monitoring the network status and the operational status of all devices within the VCCS system, as well as other relevant equipment owned by AEROTHAI.

1.15.4 The software shall provide a real-time network topology map with auto-discovery features.

1.15.5 The system shall support bandwidth and traffic monitoring per port/interface.

1.15.6 The system shall provide historical reports, logs, and graph-based analytics.

1.15.7 Supervision software shall work as descripted in ED-137C volume 5 Supervision

1.15.8 Tenderer shall install OS that run Supervision software with perpetual or open-source license.

1.15.9 The supervision system shall be accessible from both the server and the clients via either a web application or a desktop application.

1.15.10 The supervision system shall immediately notify users upon detection of any system abnormality.

1.15.11 The Tenderer shall provide a Management Desktop PC in accordance with the specifications described in Section 1.8.1.

1.15.12 The Tenderer shall provide a computer monitor that supports Network Monitoring according to the following specifications.

a) **Monitor Specs:** 43", 4K UHD minimum (3840×2160), 60 Hz, anti-glare, low blue light, PiP/PbP support.

b) **Connectivity & Mounting:** At least 2 HDMI, 1 DisplayPort, USB Hub, built-in speakers, adjustable tilt, VESA mount.

1.15.13 The Tenderer shall provide a license of supervision software with the following specifications:

a) Monitoring license at least 1000 parameters.

b) The system shall provide a monthly report in a suitable industry standard format.

c) Supervision software shall support SNMP trap receiver.

d) The system shall support monitoring via Simple Network Management Protocol (SNMPv3)

e) Ability to monitor:

- Network-connected existing AEROTHAI's devices (IP Radio, IP Telephone and etc.)
- Network Links
- Radio Gateway
- SIP Proxy/ SIP Server
- Network Equipment (Switch, Router)

2. Voice Recording System Scope of Technical Specification

2.1 INTRODUCTION

2.1.1 Scope of Requirement

This document provides a functional and technical specification which sets out the requirements of Aeronautical Radio of Thailand Ltd. (AEROTHAI) for an Air Traffic Control Recording System to be installed as a New System, Fallback Tower System, Fallback Approach System, CON/TRA System and Spare System at **Suvarnabhumi Air Traffic Control Tower**. The Digital Recording and Replay System shall be a fully IP Recording System and completely redundant, with two systems interfacing and recording all the sources. Voice Recording System Equipment details as Table 1

- Channels VoIP Recording based on ED-137 Standard
- Channels Analog Audio Recording conversion to IP
- Channels VGA, DVI, DisplayPort, Video streams or solutions sending video format for Screen Recording
- Archive Media Units should be NAS or SAN
- Fabric Switch for SAN
- Dual Network Switch for Recording System and Analog Voice Gateway
- Workstation Units shall at least included CPU, Display, Wireless Mouse & Keyboard and Speaker for Workstation
- LCD+KVM over IP Slideway shall support at least 8 computers/devices per Unit
- Rack Mouse Speaker Support shall be provided for each Recorder Unit
- All main equipment parts shall be supplied in the quantities specified in Table 1, with all spare parts in Table 2 matching the model of the corresponding operating parts in Table 1.

Item	Equipment	Fallback TWR+APP System	CON/TRA System	Spare System	Data Center	Total
1	Recorder Server Unit	2 Units	2 Units	2 Units	-	6 Units
2	Analog Voice Gateway to VoIP ED-137	480 Chs	240 Chs	128 Chs	-	848 Chs
3	VoIP and VoIP ED-137 License	1024 Chs	512 Chs	256 Chs	-	1,792 Chs
4	Video Recording	2 Chs	2 Chs	2 Chs	-	6 Chs
5	Archive Unit (NAS)	2 Units	2 Units	2 Units	-	6 Units
6	Network Switch (Recording System and Analog Voice Gateway)	2 Units	2 Units	2 Units	-	6 Units
7	Network Switch (Storage Data Center)	-	-	-	2 Units	2 Units
8	Workstation Unit (CPU & Display)	3 Sets	3 Sets	3 Sets	-	9 Units
9	LCD+KVM Over IP	1 Unit	1 Unit	1 Unit	1 Unit	4 Units
10	Rack Mount Speaker	2 Sets	2 Sets	2 Sets		6 Units
11	AC Power Distribution	2 Units	2 Units	2 Units	2 Units	8 Units
12	Storage Center (SAN)	-	-	-	2 Units	2 Units
13	Fabric Switch for SAN	-	-	-	2 Units	2 Units
14	Management Server for SAN	-	-	-	1 Unit	1 Unit
15	Cable and Network Tester	-	-	-	1 Unit	1 Unit
16	Ambient Unit	60 Chs	36 Chs	10 Chs	-	106 Chs

Voice Recording System Table 1

Item	Spare Part List	Total	Unit
1	Archive Unit (NAS)	2	Ea.
2	Network Switch (Recording System and Analog Voice Gateway)	2	Ea.
3	LCD+KVM Over IP	3	Ea.
4	Rack Mount Speaker	2	Ea.
5	AC Power Distribution	4	Ea.
6	Recorder PSU	4	Ea.
7	Recorder RAID Controller	2	Ea.
8	Recorder Storage HDD/SSD	8	Ea.
9	Archive Unit (NAS) HDD/SSD	8	Ea.
10	Network Switch PSU	4	Ea.
11	Ambience Unit Over VoIP (Mic+Gateway)	48	Channels

Voice Recording System Table 2