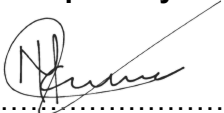
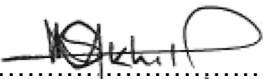


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N. Kunene	S. Mkhithi	M. Mathabatha
LDE: C&I Engineer	C&I Engineering Manager	Engineering Manager
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PART 3: SCOPE OF WORK

Document reference	Title	No of pages
C3.1	This cover page.	1
C3.2	<i>Employer's Works Information.</i>	6
	<i>Contractor's Works Information</i> (insert at award stage or delete if not applicable).	9
	Total number of pages	30

C3.1: EMPLOYER'S WORKS INFORMATION

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1 Description of the works

1.1 Executive overview

The current (phase 2 areas) Public Address (PA) system at Camden Power Station is deficient and this poses a safety risk to all employees at Camden Power station. During Camden Return-To-Service (RTS) the project of installing a PA system was not completed on all the areas and over time there have been new developments (i.e., new CMD Office, Canteen Park homes and now new ash dam) which required a PA system for emergencies and public announcements. PA system assessment done by Eskom Telecommunication revealed that the current PA system installed is not EN54 (European Norm Standard) compliant, hence not compliant with the current PA System Eskom standard. The following has been deemed to be non-compliant:

- The Main Head End Equipment had no certificates to prove compliance to EN54.
- The bi-directional and horn speakers are non-compliant as per EN-54 requirements as they do not have ceramic terminals.
- The ceiling speakers are non-compliant, they do not have a fire-dome, with ceramic connectors and thermal fuses.
- Cable is not fire retardant and did not conform to cabling standards for fire-alarm evacuation standards which require the cable to maintain integrity for a minimum period of 30 minutes if exposed to 830⁰C of extreme heat or fire at the distance of 1 metre away from the cable.

This forms part of an emergency system which needs to be available to all personnel during emergency announcements and evacuations. The project entails the design, supply, installation and commissioning of the new PA System, terminal equipment, distributed power amplifiers, Loudspeakers, power cabling, fibre cabling and associated racking as indicated in Limit of Supply and Services (LOSS) in Appendix D.

For cost breakdown, this project was divided into phase 1 and phase 2. PA system phase 1 has been completed and this technical specification revision includes changes done with respect to phase 2 scope of work.

1.2 Employer's objectives and purpose of the works

The objectives of the works are as follows:

- (1) The objective of this project is to install the PA system in areas that aren't covered, to ensure coverage in the whole Camden Power Station perimeter.
- (2) Upgrade the existing PA System terminal equipment and cabling to ensure compliance to Eskom Standard and EN 54 part 4, 16 & 24.
- (3) Interface all the system to the new Main PA System Console at Admin Building.

1.3 Interpretation and terminology

1.3.1 Abbreviations

The following abbreviations are used in this Works Information:

Abbreviation & Acronyms	Description
BGM	Background Music
C&I	Control and Instrumentation
CMD	Construction Management Department
EDWL	Engineering Design Work Lead
ECM	Engineering Change Management
EN	European Norm
EOD	Electrical Operating Desk
FAT	Factory Acceptance Test
GenTLC	Generation Technical Life Cycle
ISO	International Standard
IP	Ingres Protection
PA	Public Address
PS	Power Station
PSM	Power Station Manager
ROC	Required Operational Capability
RTS	Return To Service
OHSAct	Occupational, Health and Safety Act
SIT	Site Integration Test
SANS	South African National Standard
SHE	Safety, Health & Environmental
SRD	Stakeholders Requirements Definition
SPL	Sound Pressure Level
UPS	Uninterrupted Power Supply
mV	Mill-Volts
μV	Micro Volts
VDSS	Vendor Documentation Submittal Schedule

1.3.2 Definitions

Definition	Description
Amplifier	A device which raises the voltage or current generated by a low-level device such as a microphone to the level necessary to operate the loudspeaker(s). Amplifiers normally have an output voltage of 100 volts
Background Music	Refers to the playing of music at a low level to produce a comfortable working ambiance. The volume level at which BGM should be played is important to its effectiveness and should ideally

Definition	Description
	be adjusted so that should the music stop it is not immediately noticeable.
Controlled disclosure	Controlled disclosure to external parties (either enforced by law, or discretionary).
Loudspeaker	A device which converts electrical energy produced by the amplifier into sound energy. For paging and emergency announcements purposes, they mostly fall under these categories: • Ceiling type loudspeakers are usually built into wall mounting cabinets and baffles designed for ceiling mounting. This type of loudspeaker is typically used in indoor environments such as offices, passageways, shops and waiting rooms. • Horn type loudspeakers are typically used in industrial environments such as workshops, factories, warehouses and for outdoor installations. • Bidirectional speakers • Cabinet Speakers- Wall/surface mount speakers typically used escape stairs, storerooms, and kitchens.
Microphone	A device which converts sound energy into electrical energy. The output voltage is very low and typically ranges between 0.0001 volts and 0.005 volts (100µV and 5.0mV).
System	An integrated set of constituent pieces that are combined in an operational or support environment to accomplish a defined objective. These pieces include people, hardware, software, firmware, information, procedures, facilities, services, and other support facets.
Sound Pressure Level	It is a measure of the ability to convert electrical energy into sound energy. The SPL generated by a loudspeaker varies over a wide range and there are many factors which determine the SPL. Quoted SPL figures are usually referenced to an input power of 1 watt and measured at 1 metre. The RMS sound pressure expressed in dB are 20 microPa (The lowest threshold of hearing for 1 kHz). As points of reference, zero dB-SPL equals the threshold of hearing, while 140dB-SPL equals irreparable hearing damage.

Definition	Description
Quiescent Condition	Functional condition characterised by the absence of the voice-alarm, fault-warning, disabled and test conditions
Voice Alarm Condition	Alert signal, evacuate signal, recorded or live emergency signal broadcast in at least one emergency loudspeaker zone.
Zone	Is a demarcated area.

1.4 Applicable standards (latest versions applicable)

- (1) Eskom QM-58: Supplier Contract Quality Requirements Manual
- (2) Eskom 240-161708025: Generic Public Address Systems Technical Specification Standard.
- (3) Eskom 240-56227443: Requirements for Control and Power Cables for Power Stations Standard.
- (4) Eskom 240-170000103: Lithium Iron Phosphate Batteries Standard.
- (5) Eskom 240-56360086: Stationary Vented Nickel Cadmium Batteries Standard.
- (6) Eskom 240-56360034: Stationary Vented Lead Acid Batteries Standard.
- (7) Eskom 240-56176852: Essential Power Supplies for Power Stations Standard.
- (8) BS EN 54-4: Fire detection and fire alarm systems - Part 4: Power supply equipment.
- (9) Eskom 240-109607332: Plant Labelling Standard.
- (10) Eskom 240-56355815: Control & Instrumentation Field Enclosures and Cable Termination Standard.
- (11) Eskom 240-76992014: Technical Document and Record Management Work Instruction.
- (12) Eskom 240-86973501: Engineering Drawing Standard- Common Requirements.
- (13) Eskom 240-56227516: LV Switchgear and Control Gear Assemblies and Associated Equipment for Voltage up to and including 1000V AC and 1500V Standard.
- (14) Eskom 240-55714363: Coal Fired Power Stations Lighting and Small Power Installation Standard.
- (15) Eskom 240-56356396: Earthing and Lightning Protection Standard.
- (16) SANS 10142-1: The wiring of premises.
- (17) 32-373 IT and OT Third Party and Remote Access Standard Rev 5.
- (18) Eskom 240-56355910 Management of Plant Software Standard.
- (19) Eskom 240-79669677 Demilitarized Zone Designs for Operational Technology.
- (20) Eskom 240-55410927 Cyber Security Standard for Operation Technology.

2 Engineering and the *Contractor's* design

2.1 *Employer's* design

2.1.1 Project Execution Phases

The project execution is divided into two phases as illustrated below in table 1.

Table 1: Project Execution Phases

PHASE	DESCRIPTION	TIMELINE
Phase 1	Complete detailed design for phase 1, Installation on the new areas interfacing to the phase 1 PA System Manager at Admin Building	Completed
Phase 2	Complete detailed design for phase 2, Replacement and installation of PA system Terminal Equipment (Horn, Ceiling & Box speakers) on the plant, new ash dam and coal truck weigh bridge.	April 2024-March 2025

The objective of the project is to prioritise areas that that were not covered on PA system phase 1.

Phase 2 areas are indicated in Table 2. Phases 1 and 2 are shown in the Figure 1 and 2 below respectively.



Figure 1: Camden Site Layout phase 1.

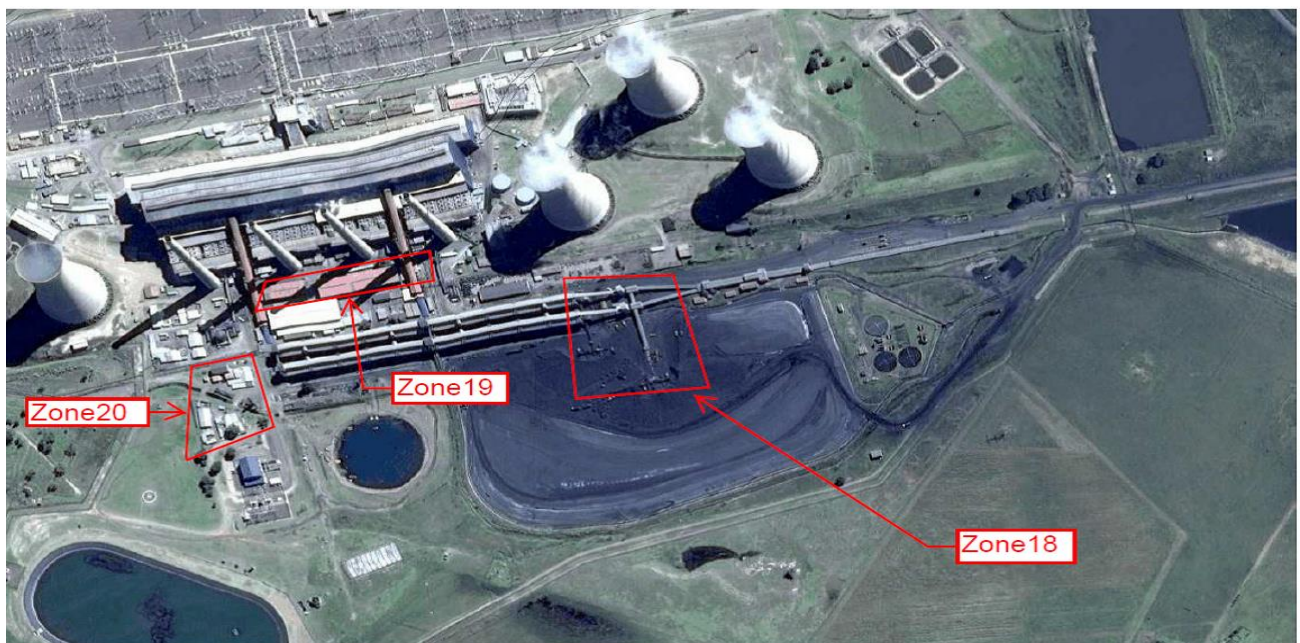


Figure 2: Camden Site Layout Phase 2.

Phase 2

Scope of Work (SOW) includes the design, procurement, installation, testing, commissioning, handover, and maintenance of the new Public Address (PA) System that is compliant with the applicable SANS, EN and Eskom standards. The scope of work is as follows:

- Detailed Design (using Eskom templates provided in appendix F), supply, install and commission the complete EN-54 compliant PA system inclusive of: Terminal equipment (Speakers & amplifiers),

terminal equipment cabling, power supply requirements, UPS supply requirements, interface with existing Phase 1 system manager requirement and required Optic Fibre communication links for Phase 2 areas.

- Supply, Install and commission Optic Fibre Network link including all accessories required to ensure communication link at the plant (units 1 – 8) and coal truck weigh bridge.
- Existing Ash handling overhead Optic Fibre Network shall be utilised for communication link between the PA system at the new ash dam and the existing phase 1 PA system Manager at the station's admin building (Blue building).
- Supply, Install and commission overhead Optic Fibre Network link (600 m) T-offing from the new ash dam maintenance yard to the main overhead Optic Fibre line including all accessories required to ensure communication link.
- Interface all terminal equipment to the existing phase 1 PA System Manager at Admin Building.
- The system must be interfaceable to Phase 1 system.

2.1.2 Operating Philosophy

The current operational philosophy will be used. The PA system is used for emergency addressing during emergencies (i.e., fire, bomb threats, etc.). There are two types of siren / pre-recorded sound alarms for fire and emergency evacuations. Background Music (BGM) is bypassed during announcements or on activation of the alarms. The procedure of how to operate the PA system is highlighted in the 240-31708091 Emergency Alarm PA System Testing Rev 02 work instruction. The system operation is tested once a week to ensure system availability on all areas.

2.1.3 Loudspeaker Zones

The table below indicate the zones of the loudspeaker areas.

Table 2: Load speaker zones

Phase 2 areas zones-Current PA System	
Zone 5	Unit 1 (0,12, 29, 36 and 48 m Level)
Zone 6	Unit 2 (0,12, 29, 36 and 48 m Level)
Zone 7	Unit 3 (0,12, 29, 36 and 48 m Level)
Zone 8	Unit 4 (0,12, 29, 36 and 48 m Level)
Zone 9	Unit 5 (0,12, 29, 36 and 48 m Level)
Zone 10	Unit 6 (0,12, 29, 36 and 48 m Level)
Zone 11	Unit 7 (0,12, 29, 36 and 48 m Level)
Zone 12	Unit 8 (0,12, 29, 36 and 48 m Level)

Zone 18	Coal truck weigh bridge
Zone XX	New Ash Dam

Parts of the *works* which the *Contractor* is to design.

- (1) The *Contractor* provides the whole of the *works* as defined in section 0 of the Works Information except where explicitly stated otherwise.

2.1.4 General Requirements for the *Works*

- (1) Camden Public Address Upgrade Project requirements are detailed in the Works Information and the following Works Information appendices:
 - i. Appendix A: Phase 2 circuit (CCT) layout drawings
 - ii. Appendix B: Phase 2 Loudspeaker Zone
 - iii. Appendix C: Existing Fibre Optic Layout Drawings
 - iv. Appendix D: Limits of Supply and Services (LOSS)
 - v. Appendix E: List of Applicable Standards
 - vi. Appendix F: Applicable Eskom Drawing Templates
 - vii. Appendix G: Vendor Document Submittal Schedule (VDSS)
 - viii. Appendix H: Phase 2 UPS Load Calculations
 - ix. Appendix I: Ash dam overhead fibre optic layout
 - x. Appendix J: Phase 2 Cable Schedule
- (2) The *Contractor* designs, supplies, installs, and commissions a de-centralised system of distributed power amplifiers and speakers for all the areas as indicated in **Appendix B** for this **Phase 2** of the project.
- (3) The *Contractor* is responsible for the de-commissioning of all the existing outdated terminal equipment in Phase 2 as indicated on LOSS in **Appendix D**.
- (4) The design, installation, testing, and commissioning is in accordance with SANS 7420-19.
- (5) The *Contractor* as part of the *works* provides a detailed design report for this **Phase 2** prior to execution of the *works* during the detail design scope freeze as stipulated on the VDSS for it to be review by the *Employer*.
 - a. All the documents required to be submitted by the *Contractor* during the design freeze shall be supplied as part of design data pack.
 - b. The detailed design report shall be in line with Eskom detailed design report template (240-49910707) attached in **Appendix E**.
- (6) All terminal equipment installations are required to comply with Emergency Preparedness Public Address System – For Large Area Deployment Standard, 240-64720986 in **Appendix E**.
- (7) All terminal equipment installed in the hazardous classified areas shall comply with the Camden Power Station Classification of Hazardous Areas, 0044 593 in **Appendix E**.

- (8) The *Contractor* provides the *Employer* with a recommended spares holding schedule including minimum and maximum stock hold as indicated on VDSS in **Appendix G**.

2.1.5 Terminal Equipment Functional Requirements

(1) **PA System Manager**

- i. The Contractor designs, supplies, installs, and commissions a PA system compliant with Emergency Preparedness Public Address System – For Large Area Deployment Standard, 240-64720986 in Appendix E. The system shall be an independent system of modular design to facilitate future expansion/alteration to the design.
- ii. The system manager (installed during PA system phase 1) must be able to cover all the areas for Phase 1 and Phase 2 of the current project.
- iii. The system manager shall be capable of monitoring all de-centralised zones centrally and logging all events from phase 1 including phase 2 areas.
- iv. The system continuously monitors amplifiers and loudspeaker lines for fault conditions.
- v. The monitoring functions, as a minimum, include:
 - Detection of open circuit loudspeaker lines on each connected zone.
 - Detection of short circuit loudspeaker lines on each connected zone.
 - Detection of earth leakage faults on loudspeakers on each connected zone.
 - Detection of microphone capsule failure.
 - Power amplifier failure detection.
- vi. The presence of any fault condition causes the illumination of the “fault” LED on the front of the system manager amplifier. The fault is also indicated by a buzzer / tone which is activated on a pre-assigned microphone.
- vii. Equipment housing shall be as per 240-64720986 _Emergency Preparedness Public Address System – For Large Area Deployment in Appendix E.

(2) **Fireman Microphones**

- i. A Fireman's microphone (installed in Phase 1) which is located in the Emergency Preparedness centre (EP centre), shall have a priority status and be capable of overriding any other broadcast.
- ii. The Fireman's microphone shall also have a functionality of being able to affect an all-call broadcast in the event of the failure of the system manager.

(3) **Power Amplifiers**

- i. Power amplifiers shall be available in various modules, e.g., 60, 120, 240, 360, etc watt RMS, as may be dictated by the loudspeaker load. Amplifiers shall be sized for maximum 80% of rated load, to allow for future additional loudspeakers.
- ii. The *Contractor* to install new distributed power amplifier at the ash dam to avoid crosstalk and signal distortion due to long distance between ash dam and admin building.

- iii. LEDs shall be provided on the front panel of each amplifier to indicate power on, amplifier fault and over temperature.
- iv. If any zone requires more power than can be delivered by a single amplifier it shall be possible to configure the system to allocate more than one power amplifier to that zone. It should be noted that parallel connection of amplifiers to achieve higher power, is not acceptable.
- v. Each power amplifier is equipped with a slot for various input modules.
- vi. Each amplifier, irrespective of its rated power, is provided with an integral line output transformer designed to operate on the 50, 70 or 100-volt line output. All loudspeaker outputs are terminated on a chassis mounted socket and associated plug assembly.
- vii. Amplifier frequency response shall cover the following range 50Hz to 20kHz $\pm 3\text{dB}$ to within $\pm 5\%$ variance.
- viii. Distortion is maintained at less than 1% at the rated output of the amplifier at a reference frequency of 1kHz and the signal to noise ratio shall be better than 80dB.
- ix. The standby amplifier is automatically switched into service in the event of a failure. The amplifiers are rated the same or higher wattage as the highest-powered amplifier in the group it serves.

(4) Loudspeakers

- i. The *Contractor* implements the applicable type of loudspeakers for all the areas i.e., Plant (units 1-8), new ash dam and coal truck weigh bridge, as listed in Appendix B. The following types of speakers are to be used:
 - a. Ceiling mount speakers
 - Ceramic connecting terminal with fuse-able links.
 - Rated power of 6W (100V Line).
 - Sound pressure level of $\pm 90\text{dB}$ at 6W, 1m/1kHz.
 - Approximate frequency response of $\pm 50\text{Hz} - 20\text{kHz}$.
 - b. Wall mount speaker
 - Ceramic connecting terminal with fuse-able links.
 - Rated power of 6W (100V Line).
 - Sound pressure level of $\pm 95\text{dB}$ at 6W, 1m/1kHz.
 - Frequency response of $\pm 100\text{Hz} - 20\text{kHz}$.
 - c. Bi-Directional Speaker
 - Ceramic connecting terminal with fuse-able links.
 - Rated power of 12W (100V Line).
 - Sound pressure level of $\pm 97\text{dB}$ at 10W, 1m/1kHz.
 - Frequency response of $\pm 150\text{Hz} - 15\text{kHz}$.
 - d. Outdoor Horn Speaker
 - Oval aluminium structure with polyurethane resin paint to ensure weather proofing and corrosion resistance.
 - IP 65 Rating for dust and weatherproof characteristics.

- Rated power of 15W (100V) Line.
 - Sound pressure level of +/- 113db at 10W, 1m/1kHz.
 - Frequency response of +/- 500Hz – 7kHz.
- ii. The sound pressure level shall be at least 10dB above the ambient SPL of each area as indicated in **Appendix A & B** and stipulated in SANS 7420-19. The *contractor* is responsible to take sound level measurement for all the areas using a calibrated decibel meter to validate the chosen sound level in **Appendix A & B**.
- iii. The distance between the centres of the loudspeakers is not greater than
- a. 6 m for unidirectional loudspeakers.
 - b. 12m for bidirectional loudspeakers.

(5) Volume controls

- i. Each loudspeaker zone is fitted with a volume control unit.

2.1.6 Field Cabling & Associated Infrastructure

- (1) The design, supply, installation, termination, labelling, testing, and commissioning of all signal cabling, power supply cables, control system communication bus cabling with is required to comply with Eskom Standard Document: 240-56227443_Requirements for Control and Power Cables for Power Stations Standard as found in **Appendix E**. As part of the *works* the *Contractor* supply and install PH120 as the minimum speaker cabling as highlighted in 240-64720986 _Emergency Preparedness Public Address System – For Large Area Deployment in **Appendix E**
- (2) The *Contractor* designs, supplies, installs, and commissions a fibre optic network for all areas covering the PA system phase 2 as indicated in 240-46264031_Fibre-Optic Design Standard **Appendix E**.
- (3) The new 600 m overhead fibre optic network shall be connected between ash dam maintenance yard and the existing network of Ash handling plant overhead optic fibre comms as per attached fibre network layout drawings attached in **Appendix C**. The specification of the fibre as provided below in **Table 3**.

Table 3: Fibre Optic Specification

Fibre Type	Single-Mode (G652D type)
Number of Cores	4
Core Diameter	9 µm
Cladding	125 µm
Bandwidth	> 100 Mbps
Distance	> 500 m

- (4) All cabling is required to be suitably protected against mechanical damage, chemicals, dust build-up and heat.
- (5) Cables are required to only be terminated in instruments, or other approved equipment.
- (6) No intermediate cable joints are permitted.
- (7) Cables are required to be routed separately from electrical power cables and crossovers that bring signal and power cables into close proximity shall be made at right angles.
- (8) The *Contractor* makes use of existing routes as far as possible. Where not possible the *Contractor* will advise the *Employer* on the best routes.
- (9) The *Contractor* provides for all field cables and any power cabling required as part of the *works* and is responsible for trenching where it is required.
- (10) The *Contractor* provides 10% spare installed capacity in all multi-core cables, rounded up.

2.1.7 Earthing and lightning protection

- (1) The *Contractor* is responsible for the correct earthing, lightning, and electrical protection concept for reliable and safe operation of the terminal equipment. This shall be in accordance with Eskom standard, Document: 240-56356396_Earthing and Lightning Protection Standard in **Appendix E**.
- (2) Surge protection is included in all the circuits to protect the I/O from damage due to lightning.
- (3) All field control and instrumentation cables as well as data link cables shall be earthed.
- (4) All metal instrument casings are properly earthed (grounded) to the earth mat to avoid any electromagnetic interference.

2.1.8 System Interface

- (1) The *Contractor* ensures that all the terminal equipment (speakers) and distributed power amplifiers are interfaced to the existing phase 1 PA System Manager.
- (2) The *Contractor* ensures that all the terminal equipment (speakers) in the ash plant are connected to the ash plant distributed power amplifiers and both are interfaced to the existing phase 1 PA System Manager.

2.1.8.1 Voice Evacuation Frame Specifications for Interface.

- (1) Main control units are incorporated with voice evacuation and public address system functionality.
- (2) Has up to 4 amps (1-zone - 1 amp, 4 AB-zones or 3 AB zones + standby amp).
- (3) Has up to 3 amps (8 zones switching between 2 amps + standby amp or 8 zones freely assignable to 1 of 2 amps).
- (4) Has VX-3016F: up to 2 amps (16 switched zones + standby amp or 2x 8 switched zones).
- (5) All indications and controls are according to EN54-16.
- (6) Operation and audio signal status indication per amplifier.
- (7) Fault status indication for each speaker line.
- (8) Input DSP: 3-point filters (PEQ/HPF/LPF/High shelving/Low shelving), feedback suppressor, voice-controlled broadcast (VOX) and compressor.
- (9) Output DSP: 6-point filters (PEQ/HPF/LPF/High shelving/Low shelving/All pass/Notch/Horn EQ), compressor and delay.
- (10) Ambient Noise Control (ANC).

Specifications	VX-3004F	VX-3008F	VX-3016F
Power Source	20 - 33 V DC, removable terminal block (4 pins)		
Speaker Line	4 channels (with AB LINE speaker out) 1 Earth terminal	8 channels 1 Earth terminal	16 channels 2 Earth terminals
LAN A, B	Max. Voltage/Current: 100 Vrms, 5 Arms; Connector: Removable terminal block (17 pins) x 1; Fault detection system: short circuit, Open circuit, Ground fault, Method: Impedance or End of line Number of Connectors: 2 (LAN A, LAN B); Network I/F: 100BASE-TX; Network Protocol: TCP, UDP, ARP, ICMP, RTP, IGMP, FTP, HTTP, NTP; Spanning tree Protocol: RSTP; Audio Transmission System: TOA Packet Audio (*1); Audio Encoding Method: PCM; Audio Sampling Frequency: 48 kHz, Audio Quantifying Bit number: 16 bits; Connection Device: other VX-3004F, VX-3008F, VX-3016F, NX-300 and Switching HUB, Connector: RJ45 connector; Connection; Number of Stages of Cascade Connection: Up to 7		
RS Link A, B	Number of Connectors: 2 (RS LINK A, RS LINK B), Audio input level; 0 dB (*2); Connector: RJ45 connector		
DS Link	Connection Device: DS LINK of Power supply units; Connector: RJ45 connector		
Analog Link	Number of Connectors: 1 input, 1 output; Connection Device: VX-3004F, VX-3008F, VX-3016F; Connector: RJ45 connector		
Control Input 1,2	16 inputs, no-voltage make contact input, open voltage: 24 V DC; short-circuit current: 2 mA. Fault Detection System: Short circuit, Open circuit; Method: Voltage detect; Connector: RJ45 connector		
Emergency Control IN	Input 2: Isolated voltage input, -24 to +24 V; Connector: RJ45 connector		
VOX Function	Threshold: -60 to 0 dB (1 dB steps); Hysteresis: 0 to +10 dB; Hold time: 10 ms – 10 s, Settable for each audio input		
Control Output 1,2	General outputs: 8 with CONTROL OUTPUT 1; Exclusive outputs: 3 with CONTROL OUTPUT 2; GENERAL FAULT, CPU FAULT, CPU OFF No-voltage make contact, electrical contact output, control current: 10 mA; withstand voltage: 28 V DC; Connector: RJ45 connector		
ATT/Control Output	8 outputs, no-voltage make contact, relay contact (NC, NO, C), control current: 2 mA to 5 A; withstand voltage: 125 V AC, 40 V DC; Connector: Removable terminal block (12 pins) x 2	16 outputs, no-voltage make contact, relay contact (NC, NO, C), control current: 2 mA to 5 A; withstand voltage: 125 V AC, 40 V DV; Connector: Removable terminal block (12 pins) x 4	
DSP	Feedback suppression, Equalizer/Filter, Compressor, Delay and Ambient Noise Control (ANC)		
Audio Input 1,2,3,4	4 inputs (Line: -20 dB (*2)/ MIC: -60 dB (*2) / ANC sensor (changeable with setting software); Gain Control: volume adjustable with volume control (internal front panel) -∞ to 0 dB; Input Impedance: 47kΩ electronically balanced; Phantom power supply: 24 V DC, can be set with setting software; Connector: Removable terminal block (6 pins x2)		
Program Timer	Weekly program method; Daily program: 50 events, 10 types; Holiday program: 50 types		
Standby Amplifier	Input: 1, Output: 1; Max. Voltage/Current: 100 Vrms, 5 Arms; Connector: Removable terminal block (2 pins) x 2		
Module (*3)	Number of modules: 4	Number of modules: 3	Number of modules: 2
Extension Amplifier	-	Input: 2, Output: 2, Max. Voltage/Current: 100 Vrms, 5 Arms, Connector: Removable terminal block (2 pins) x 4	Input: 1, Output: 1; Max. Voltage/Current: 100 Vrms, 5 Arms; Connector: Removable terminal block (2 pins) x 2
Dimensions (W x H x D)	483 x 132.6 x 345 mm		
Weight	7.6 kg	7.9 kg	8.1 kg

2.1.8.2 Digital Power Amplifier Module Specifications for Interface.

- (1) Low loss modular class D amplifiers.
- (2) Modules to be mounted in the Frame.
- (3) Three different power levels: 150 W, 300 W or 500 W.
- (4) Can easily be removed or replaced by unplugging them, no need for special tools.
- (5) Dust filter, easy to clean.
- (6) 100 /70/50 V output without transformer resulting in light-weight units.
- (7) Fuse easily accessible from rear.

Specifications	VX-015DA	VX-030DA	VX-050DA
Applicable Model	Applicable Model		
Power Source	31 V DC (operating range: 20 - 33 V DC); DC power in: M4 screw terminal, distance between barriers: 11 mm		
Amplification System Class D	Class D		
Power Consumption	1.3 W (standby mode), 14 W (no audio input), 40 W (1/8 rated output), 190 W (rated output) at 31 V DC, output voltage selection switch: 100 V	1.3 W (standby mode), 14 W (no audio input), 65 W (1/8 rated output), 375 W (rated output) at 31 V DC, output voltage selection switch: 100 V	1.3 W (standby mode), 16 W (no audio input), 100 W (1/8 rated output), 590 W (rated output) at 31 V DC, output voltage selection switch: 100 V
Rated Output Power	150 W (at 100 V line) 105 W (at 70 V line) 75 W (at 50 V line) (At min. impedance & max. capacitive load) (At AC mains: 187 - 253 V)	300 W (at 100 V line) 210 W (at 70 V line) 150 W (at 50 V line) (At min. impedance & max. capacitive load) (At AC Mains: 187 - 253 V)	500 W (at 100 V line) 350 W (at 70 V line) 250 W (at 50 V line) (At min. impedance & max. capacitive load) (At AC Mains: 187 - 253 V)
Output Voltage	100 V (70 V, 50 V: selectable)		

Min. Resistive Load	67 Ω (100 V), 47 Ω (70 V), 33 Ω (50 V)	33 Ω (100 V), 23 Ω (70 V), 17 Ω (50 V)	20 Ω (100 V), 14 Ω (70 V), 10 Ω (50 V)
Max. Capacitive Load	0.5 μ F		
Input	DA CONTROL LINK: Nylon connector (15 pins)		
Output	DA CONTROL LINK: Nylon connector (2 pins)		
Frequency Response	40 Hz - 20 kHz: - 5 to +1 dB (at 100 V line, 30 dB (*1) output)		
Distortion	1 % or less (at 100 V line, A-weighted)		
Signal to Noise Ratio	100 dB or more (at 100 V line, A-weighted)		
Dimensions (W x H x D)	82.8 x 91 x 358.2 mm		
Weight	1.3 kg		1.4 kg

2.1.8.3 Line Output Module Specifications for Interface.

- (1) Line output module to be mounted in the VX-3000 frame.
- (2) Outputs audio signals at the line level from the VX-3000 Frame to an external device.

Specifications	VX-300LO
Applicable Model	VX-3004F, VX-3008F, VX-3016F
Power Source	Supplied from the VX-3000 Frame (DA CONTROL LINK)
Current Consumption (*1)	Max. 2 mA (Current through DC POWER IN)
Input	DA CONTROL LINK: Connector (15 pins)
Audio Output (*1)	1 Channel Output signal level: 0 dB (*2) Adjustable range of the volume control: $-\infty$ to 0 dB Output method: 10 k Ω , transformer-balanced Applicable load impedance: 2 k Ω or more Frequency Response: 40 Hz - 20 kHz $\pm$ 1 dB Distortion: 1 % or less (0 dB (*2) output, 1 kHz) Signal to Noise Ratio: 60 dB or more Removable terminal block (3 pins)
Finish	Surface-treated steel plate
Dimensions (W x H x D)	76 x 39 x 33.2 mm
Weight	56 g

2.1.8.4 Preamp Matrix Panel Specification for Interface.

- (1) Preamplifier matrix panel enabling the additional audio inputs, control inputs and control outputs to the VX-3000 system.
- (2) Equipped with 8 audio inputs with volume controls, 20 control inputs and 10 control outputs.
- (3) Provides unicast audio streaming functionality.
- (4) Unicast audio streaming is possible among VX-3000PMs.
- (5) 1 unit can be connected to a single VX-3000 Frame and a maximum of 40 units can be configured per system.

Specifications	VX-3000PM
Power Source	20 – 33 V DC, removable terminal block (2 pins)
Current Consumption	0.33 A at 33 V DC input, 0.35 A at 24 V DC input
LAN A, B	Number of Connectors: 2 (LAN A, LAN B) Network I/F: 100BASE-TX Network Protocol: TCP, UDP, ARP, ICMP, RTP, IGMP, HTTP Spanning tree Protocol: RSTP Audio Transmission System: TOA Packet Audio (*1) Audio Encoding Method: PCM Audio Sampling Frequency: 48 kHz Audio Quantifying Bit Number: 16 bits Connection Device: VX-3004F, VX-3008F, VX-3016F, NX-300, VX-3000CT, VX-3000PM, Switching HUB Connector: RJ45 connector Connection Cable: Category 5 twisted pair cable (CAT5) or greater Maximum Cable distance: 100 m
Audio Input	8 inputs Input Level: Input 1 - 4: -60 dB (*2)/ -40 dB (*2)/ -20 dB (*2)/0 dB (*2) selectable, input impedance 600 Ω , transformer-balanced. Input 5, 6: -20 dB (*2), input impedance 10 k Ω , unbalanced.

	Input 7, 8: 0 dB (*2), input impedance 10 kΩ, unbalanced. Frequency Response: -60 dB (*2): 200 Hz - 10 kHz, -2 dB ±3 dB -40 dB (*2)/ -20 dB (*2)/ 0dB (*2): 100 Hz - 15 kHz, -2 dB ±3 dB Distortion: 1% or less Signal to Noise Ratio: 60 dB or more Removable terminal block (6 pins x 2, 4 pins x 2) Only Input 1 is used in common with the front-mounted ø6.3 mm phone jack
Control Input	20 channels, no-voltage make contact input, open voltage: 30 V DC, short-circuit current: 2 -10 mA. Connector: Removable terminal block (10 pins x 2, 12 pins x 2)
Control Output	Channels 1 - 5, relay (a contact), withstand voltage: 30 V DC, control current: 1 A Channels 6 - 10, open collector output (polarized), withstand voltage: 30 V DC control current 100 mA. Connector: Removable terminal block (10 pins) x 2
Indicators	Signal Indicator (Green) x 8, Run (Green) x 1, LINK/ACT (Green) x 2
Volume Control	8 channels
Operation	Input level setting switch x 1, IP address setting switch x 1
Dimensions (W x H x D)	482 x 44 x 292.4 mm
Weight	3.2 kg

2.1.8.5 Control Panel Specification for Interface.

- (1) Control panel with 9 function keys and 8 volume control knobs for easy operation.
- (2) Function keys are used for public address operation such as the activation of general broadcast.
- (3) Volume controls allow volume level adjustment of the VX-3000 Frame's audio input or audio output (assignable).
- (4) Up to 2 units can be connected to a single VX-3000 Frame.

Specifications	VX-3000CT
Power Source	20 – 33 V DC, removable terminal block (4 pins)
Current Consumption	0.09 A at 33 V DC input, 0.11 A at 24 V DC input
LAN A, B	Number of Connectors: 2 (LAN A, LAN B) Network I/F: 100BASE-TX Network Protocol: TCP, ARP, ICMP, HTTP Connection Device: VX-3004F, VX-3008F, VX-3016F, NX-300, VX-3000CT, VX-3000PM, Switching HUB Connector: RJ45 connector Connection Cable: Category 5 twisted pair cable (CAT5) or greater Maximum cable distance: 100 m
Panel Indicator	Power (Green) x 1, Run (Green) x 1, Link/ACT (Green) x 2, Signal (Green) x 8, Fault (Yellow) x 1, Status (Green/Yellow) x 9, Select (Green) x 9
Volume Control	8 channels
Operation	Function key x 9, Reset Key x 1, IP address setting switch x 1
Dimensions (W x H x D)	482 x 44 x 315.2 mm
Weight	3 kg

2.1.8.6 Power Supply Manager Specifications for Interface.

- (1) DC power supply to all system components.
- (2) Automatically switch to auxiliary battery power if the AC power supply is down.
- (3) Combination of two built-in power source units with a high-performance charger (VX-3000DS only)
- (4) VX-3000DS (CE, CE-GB version): EN 54-4 certified, Certificate No: 1134-CPR-137

Specifications	VX-3000DS	VX-3150DS
Power Source	220 – 230 V AC, 50/60 Hz	
Power Consumption	2800 W max in total (at rated output with charging), 650 W max in total, 350 W max each (EN 60065)	1460 W max in total (at rated output with charging), 460 W max in total
DC Power Output (AC mode)	Rated output: 2300 W (total DC power output), Peak output: 2780 W (total DC power output)	Rated output: 1140 W (total DC power output), Peak output: 1280 W (total DC power output)
DC Power Output	8 x 31 V (19 – 33 V) 25 A max. each, M4 screw terminal, distance between barriers: 11 mm 3 x 31 V (19 – 33 V) 5 A max. each, removable terminal block (3 x 2 pins) 1 x 24 V (16 – 25 V) 0.3 A max., removable terminal block (1 x 2 pins)	
Charging Method	Temperature compensated trickle charging	
Charging Output Voltage	27.3 V ± 0.3 V (at 25 °C), Temperature correction coefficient: -40 mV/ °C	
Battery Connection	1 pair of positive and negative terminals; Applicable cable diameter: AWG 6 – AWG 0 (AWG 1/0) (16 mm 2 – 50 mm 2) Line resistance within 4 mΩ/ total	
Control Connector	RJ45 female connector for connecting the system and cascade connection, Shielded Twisted-pair straight cable (TIA/EIA-568A standard)	
DS LINK IN/OUT	Type of control signal: Battery check, AC power status, DC power status, charging circuit failure, battery failure, and communication	

Panel Indicator	AC power IN 1, IN 2 (Green)	AC power IN (Green)
	Charging (Green), Battery power (Green), Battery connects (Green), Battery condition (Green)	
Dimensions (W x H x D)	482 x 132.6 x 400.5 mm	
Weight	11.8 kg	

2.1.8.7 Wall Mount Remote Microphone Specifications for Interface

- (1) Wall mount remote microphone for emergency and general broadcast.
- (2) Zone selection or all call.
- (3) VX-3000 setting software permits desired functions to be assigned to individual function keys (equipped with 2 LED indicators).
- (4) CPU-switch for emergency broadcast to all zones even in case of a CPU error.
- (5) RM-320F: Key extension unit with 20 additional keys.
- (6) Up to 4 RM-320F Extension unit units can be used with each RM-200SF Remote Microphone.

Specifications	RM-200SF	RM-320F
Power Source	24 V DC (operating range: 15 – 40 V DC), supplied from the audio input unit.	-
Current Consumption	240 mA or less	180 mA max. (in terms of RM-300MF)
Distortion	1 % or less	-
Frequency Response	200 Hz – 15 kHz	-
Signal-to-Noise Ratio	55 dB or more	-
Audio Output	0 dB V, transformer-balanced	-
Microphone	Unidirectional dynamic microphone with talk key, AGC (ON/OFF switchable), microphone element failure detectable by using a built-in small oscillator	-
Volume Control	Microphone volume, Monitor speaker volume	-
Connection Cable	Shielded CPEV cable (each one pair of audio wire, data wire, monitor/control wire, and power supply wire) or Shielded Category 5 twisted pair cable (CAT5-STP) or greater, M3. screw terminal	Connection to RM-200SF by dedicated cable
No. of Connectable RM -320F	Max. 4 units	-
Key Operation	Emergency key, Talk key, 3 Function keys	20 Function keys
Finish	ABS resin, bluish gray (PANTONE 538 or its equivalent)	
Dimensions (W x H x D)	200 x 215 x 95 mm	175 x 215 x 70 mm
Weight	1.48 kg	700 g
Applicable Box	Wall mounting box: YS-11A	-

2.1.8.8 Remote Microphone Specifications for Interface

- (1) Desktop microphone for both general and emergency broadcast.
- (2) Zone selection or all call.
- (3) VX-3000 setting software permits desired functions to be assigned to individual function keys (equipped with 2 LED indicators)
- (4) RM-210F: Key extension unit with 10 additional keys.
- (5) Up to 7 RM-210F Remote Microphone Extension units can be used with each RM-300X Remote Microphone.
- (6) Can be mounted on the wall by using optional wall mounting bracket WB-RM200.

Specifications	RM-300X	RM-210F
Power Source	24 V DC (operating range: 15 - 40 V DC, supplied from the voice evacuation frame) or DC input power supply connector (when the optional AD-246 power supply unit used.)	Supplied from the optional RM-300X
Current Consumption	240 mA or less	80 mA or less
Audio Output	0 dB (*1), 600 Ω, balanced	-
External Microphone Input	-40 dB (*1), 2.2 kΩ, unbalanced, ø3.5 mm phone jack (2P) for electret condenser microphone, (phantom power supply:3 V DC). -20 dB (*1), 4,7 kΩ, unbalanced, ø3.5 mm phone jack (2P) (AUX Input).	-
Frequency Response	100 Hz – 20 kHz	-
Distortion	1 % or less	-
Signal-to-noise Ratio	60 dB or more	-
Microphone	Unidirectional electret condenser microphone with AGC (ON/OFF selectable)	-
Chime	Built inside (PCM sound source), Monitoring possible using built-in speaker	-

Level Control	Microphone sensitivity control, monitor speaker volume control, chime (adjustable using the software)	-
Connection Cables	Main line: Shielded CPEV cable (1 pair of audio wire + 1 pair of data wire + 1 pair of monitor/control wire + 1pair of power supply wire) or Shielded Category 5 twisted pair cable(-CAT5-STP) or greater, Branch line: Shielded Category 5 twisted pair cable (CAT5-STP) or greater, RJ45 connector	
No. of Connectable RM-210F	Max. 7 units	-
Operation	Function switch, covered switch, Broadcast switch	Function key x 10
Finish	ABS resin, black	
Dimensions (W x H x D)	190 x 76.5 x 215 mm (gooseneck microphone excluded)	110 x 76.5 x 215 mm
Weight	880 g	350 g
Option	Remote microphone extension: RM-210F, Wall mounting bracket: WB-RM200 Electret condenser microphone: WH-4000A, YP-M101, YP-M301 etc.	Wall mounting bracket: WB-RM200

2.1.8.9 Terminal Unit Specifications for Interface.

- (1) Convert the RJ45 connector into a screw terminal block.
- (2) Used to connect between a trunk cable (such as CPEV cable) and a feeder cable (such as CAT-5 or CAT-6 cable) in wiring a remote microphone.
- (3) Built-in indicator shows the voltage status of DC power cable when the remote microphone cable for the VX-3000 series system is connected.

2.1.8.10 End of Line Unit Specifications for Interface.

- (1) Speaker line failure can be detected with high accuracy.
- (2) Module for installation between the speaker line end and the emergency input terminal of the VX-3008F and the VX-3016F.

2.1.9 Electrical Requirements - Public Address (PA) System (2nd Phase) power supply and backup power supply scope of work.

Scope of work for the detail design, supply, delivery, installation/erection, construction, factory acceptance testing, site acceptance testing, cold and hot commissioning, and handover of the electrical power supply and backup power supply for the second phase of the PA system project:

- (1) The PA System design to be done by the *Contractor*. The final designs shall be approved by Eskom Electrical Engineering before any equipment, material or construction labour are started, procured, or initiated.
- (2) Eskom Quality Control (QC) shall be applied throughout the project. The *Contractor* shall supply populated Inspection and Test Plans (ITP's) for all the Works, Installations, Tests and Commissioning activities and steps.
- (3) The *Contractor* adheres and applies the Eskom Standard 240-161708025 Generic Public Address Systems Technical Specification Standard, to the designs and execution of the project.
- (4) The *Contractor* shall perform site inspections during identification of main power supply points and the cable installation routes.
- (5) The *Contractor* to supply 230V AC Load Schedules per server rack cabinet. Load schedules shall contain position/area/zone description, make/brand, component description, model, quantity, OEM wattage rating, OEM current/amp rating. The *Contractor* compiles and supply this electrical load list.

- (6) The backup electrical power supply shall be installed in a server rack cabinet or electrical distribution board. Maintenance access shall be ensured to the back and front of the panel or server rack cabinet. Design Proposals shall first be submitted to the Employers before final approval is done.
- (7) The *Contractor* evaluates the power requirements of the PA system per server rack cabinet, including the wattage of amplifiers, speakers, and other components to determine the backup power needs. The *Contractor* compiles and supply this electrical load list.
- (8) The *Contractor* uses the power requirements to design the battery backup system. The battery backup system shall be equipped with EN54 compliant stand-by batteries to cater for a minimum standby period of 24 hours and a continuous broadcast of 30 minutes at full power.
- (9) The technology for the Stand-by batteries shall be Stationary Vented Nickel Cadmium - The Stationary Vented Nickel Cadmium batteries and shall comply with Eskom Standard 240-56360086 or
 - a. The technology for the Stand-by batteries shall be Lithium Iron Phosphate batteries and shall comply with Eskom Standard 240-170000103 or
 - b. The technology for the Stand-by batteries shall be Stationary Vented Lead Acid Batteries Standard batteries and shall comply with Eskom Standard 240-56360034.
 - c. The battery options shall be listed in a technical report that shall list the amount of batteries required to perform according to EN54, their cost and type of battery.
 - d. Lithium Iron Phosphate battery backup system that complies with EN54 shall take preference.
- (10) The *Contractor* shall be responsible for sizing, installing, and commissioning of the Charger as per the Eskom standards. The *Contractor* ensures compatibility between the charger and the back-up batteries as not to shorten the predicted life of the batteries. The charger shall be able to drive the full load while charging the batteries and the rated capacities.
- (11) The minimum lifespan of the batteries shall be 15 years.
- (12) The system must be capable of discharging and re-charging each battery at a predetermined interval for purposes of keeping each battery in optimal condition.
- (13) The backup system shall be powered by 24VDC via power supply modules working off 220VAC and must be capable of a seem-less transition between AC and DC – the charger shall comply with Eskom Standard 240-53114248 – Thyristor and Switch Mode chargers, AC/DC to DC/AC converters and UPS standard.
- (14) Ensure seamless integration of the backup power supply with the PA system, including automatic switchover in case of a power outage or main power supply failure. In case of failure a standing alarm signal shall be sent to the PA system and shall be activated until an operator cancels the alarm.
- (15) The Employer will provide electrical AC power source of connections for the loads to be supplied in according to the electrical load list supplied. Thus, the Employer shall provide points of supply for the AC power supply and the Contractor shall connect electrical cabling, earthing and fit miniature circuit breakers (MCB) at the identified electrical power source of connections for the loads.
- (16) The *Contractor* shall be responsible for sizing and routing of the cables in accordance with their design loads.
- (17) The *Contractor* shall be responsible for supplying, pulling and termination of all interfacing power cables including racking where routing may need to be extended. All the cabling, racking and trenching

Works shall be done in accordance with Eskom standard 240-56227443 Requirements for Control and Power Cables for Power Stations Standard.

- (18) Electrical installation Work shall comply to SANS 10142-1 and Certificates of Compliance (COC) shall be issued for all the electrical installations.
- (19) Assure and verify that the backup power supply does not compromise the sound quality or safety of the PA system.
- (20) Factory Acceptance Testing: Perform thorough testing to verify that the backup power supply can sustain the PA system's operation during 220V AC power supply availability and during 220V AC power interruptions. This includes testing switchover times, battery life, and system performance.
- (21) Provide a maintenance and testing schedule for the backup power supply system to ensure it remains in good working condition. This shall include component testing or replacement, and regular system checks and tests.
- (22) Provide detailed documentation of the backup power supply system, including manuals, maintenance record templates, and emergency procedures. All drawings shall be on Eskom standard drawing template and soft copies of the drawings shall be provided in MicroStation format.
- (23) The following drawings shall be provided:
 - a. Schematics and Circuit Diagrams: Indicates electrical connections and functions of a system or circuit.
 - b. Wiring Diagrams: Indicates how components are connected.
 - c. Block Diagrams: Indicates the system as a series of functional blocks and how they relate to each other.
 - d. One-Line Diagrams: Power distribution, Indicates the electrical components and connections in a simplified, single-line format.
 - e. Panel Layouts and General Arrangement: Indicates the physical arrangement of components within an electrical control panel, server equipment rack, and the layouts.
- (24) Training shall be provided for Eskom personnel on how to operate, maintain and troubleshoot the backup power supply system, highlighting emergency conditions.
- (25) Provide and Emergency Response Plan outlining the steps to take in case of a power outage or emergency condition and how to restore normal operation of the electrical backup system.
- (26) Fit a monitoring system to track the status of the backup power supply locally on the server equipment rack by providing voltage readings of the DC system and remotely on the PA system by alerts and alarms in case of issues.
- (27) All plant labelling shall be done according to Eskom standards. Includes wiring, terminations, equipment, cabling. KKS system shall be applied. Cable schedules shall be supplied.
- (28) Supply quotations for the final detail design for implementation.
- (29) In case there are more than one Contractor involved in the PA System - Phase 2 Project, all the *Contractors* shall be fully responsible for the successful completion of the entire project. Teamwork between the Contractors is of utmost importance.

2.1.10 Electrical cabling and Power supply.

- (1) The *Contractor* provides for the design, supply, installation, and commissioning of UPS in accordance with the Eskom specification 240-53114248_ Thyristor and Switch Mode Chargers, AC/DC To DC/AC Converters and Inverter/Uninterruptible Power Supplies Standard. The *Contractor* ensures schedule A & B are submitted as part of the design *works*.
- (2) The *Contractor* is responsible for the sizing of the UPS based on the UPS load calculation in **Appendix H** for Phase 2. As part of the *works* the *Contractor* is responsible to demonstrate the cheaper design alternative by performing cost-benefit analysis between the use of centralised UPS supplied from 220VAC that will supply all the zone amplifiers via very long cables or dedicated UPS for each zone.
- (3) The *Contractor* is responsible for verification of the load calculations in **Appendix H** for Phase 2.
- (4) The *Contractor* provides for the design, supply, installation, commissioning, and connection of electrical cables as indicated in the LOSS in **Appendix D**.
- (5) The detailed design submitted by the *Contractor*, as part of the *works*, contains the calculations for the actual power consumption and size of control cabling to be used to supply various areas to the *Employer* for verification and acceptance.
- (6) The *Contractor* adheres to 240-56227443 requirements for Control and Power Cables for Power Stations Standard.
- (7) Where available the *Contractor* makes use of existing structures to route power cables.
- (8) Where racking is required, the *Contractor* adheres to 240-56227443 requirements for Control and Power Cables for Power Stations Standard.

2.1.11 Limits of Supply and Services (LOSS)

- (1) Phase1 entails the design for both phase 1 and 2, supply, installation and commissioning of newly installed terminal equipment and distributed power amplifiers including power cabling and associated racking as indicated in Limit of Supply and Services (LOSS) diagram in Appendix D.
- (2) Phase 2 works information entails the supply, installation, and commissioning of EN54 compliant terminal equipment and amplifiers on the entire plant, new ash dam and the coal truck weigh bridge in Camden Power Station.

2.1.12 Training

The *Contractor* provides training for the *Employer's* personnel. The *Employer's* training requirements are as follows:

- (1) The Provision of detailed training manuals incorporating all aspects of the training that will be provided to the Project Manager for acceptance.
- (2) Initial training of *Employer's* personnel in the operation, calibration, and maintenance of the *works*.
- (3) The *Contractor* provides formal theoretical training to the *Employer's* personnel in the operation, maintenance and general running of the *works* and equipment before commencing testing and commissioning of the *works*. The disciplines to be trained are operating (All shifts

= 10 personnel), control and instrumentation (C&I) maintenance (6 x personnel), C&I engineering (2 x personnel) and Quality Control (1x personnel).

- (4) The *Contractor* presents sufficient training interventions to accommodate all above-mentioned personnel.
- (5) The following is considered to be the minimum requirements for such training:
- a. Theory of processes.
 - b. Plant and component description, layout, and design.
 - c. Alarms.
 - d. System operation:
 - i. Normal operating procedures.
 - ii. Routine test and inspection procedures.
 - iii. Normal and emergency shutdown procedures.
 - iv. Emergency and alarm conditions.
 - e. Operational problems:
 - i. Troubleshooting.
 - ii. Loss of supply (e.g., electrical power).
 - f. Dangers and precautions.
 - g. Recommended settings (electrical, control and instrumentation).
 - h. Test and inspection plans (electrical, control and instrumentation).
 - i. Inspection and Maintenance Procedures (electrical, control and instrumentation):
 - i. During plant operation.
 - ii. During shut down periods.
 - j. Special tools and equipment:
 - i. Requirements.
 - ii. Training.
 - k. Fault Finding:
 - i. Items to inspect.
 - ii. Typical observations and/or deviations.
 - iii. Recommended corrective actions.
 - l. Recommended spares (electrical, control and instrumentation):
 - i. Item description.
 - ii. Part number/type.
 - iii. Supplier.
 - iv. Drawing designation.
 - v. Quantity installed on plant.
 - vi. Recommended stock.
 - m. During the testing, commissioning, and handing over of the *works*, it is the *Contractors'* responsibility to provide practical training to the *Employer's* personnel in the operation, maintenance and general running of the *works* and Equipment. For this purpose, the Project Manager reserves the right to allocate certain staff to the *Contractor's* team during erection

and commissioning period. The *Contractor* declares the staff as competent, in writing, to operate and maintain the *Contractor's* plant and equipment prior to hand over or provide supervision for the period.

2.2 Testing and Commissioning

This is defined as bringing into service all items of the *works* as specified, meeting the requirements of the functional Works Information, as well as the PA system performance including all necessary testing and verification of the stated performance. The equipment covered by the Works Information is installed and complete in all respects by the dates stated in the Accepted Programme.

The *Contractor* provides sufficient personnel for the satisfactory and timely commissioning of the equipment. Before equipment is placed in service, the *Contractor* certifies that it is in a suitable and safe condition. Prior to the time when cold commissioning commences, the *Project Manager* nominates a representative to co-ordinate the commissioning of all equipment forming an integral part of the plant being commissioned. The *Contractor* co-operates fully with the *Project Manager's* Representative/s in the work of commissioning the whole of the plant for which the *Employer* supplies the portion of equipment specified. The *Employer* uses the *works*, without taking over the *works*, before Completion for the commissioning, optimisation and capability testing of the *works* and associated plants.

2.2.1 Factory Acceptance Test (FAT)

All equipment is comprehensively factory tested prior to shipment. The *Employer* has the right to appoint a representative or representatives to inspect all parts during manufacture and to be present at any of the tests specified.

- (1) The proposed test procedure, together with test dates, is prepared by the *Contractor* and submitted to the *Project Manager* for acceptance during the detailed design freeze stage.
- (2) Simulated inputs are used for the test. During the test, the system is exercised to determine the integrity and compliance to system requirements.

2.2.2 Site Integration Test (SIT)

SIT is done to ensure the correct performance of the control systems and equipment and ensure compliance with the Works Information before commissioning of plant commences.

- (1) The proposed site integration test procedure, together with test dates, is prepared by the *Contractor* and submitted to the *Project Manager* for review and acceptance during the detailed engineering stage as per Appendix G – Vendor Document Submittal Schedule.
- (2) The final test procedures are prepared by the *Contractor* and submitted to the *Project Manager* for acceptance at least 10 working days prior to the scheduled test date. The *Contractor* shows these dates in the Accepted Program.
- (3) The *Contractor* provides all the test equipment for testing the individual systems. Records are to be kept of each SIT in a logbook defining the test to be undertaken, time and date of the commencement

of the test, duration of the test, criteria that need to be met and results entered of the tests. These records are submitted to the *Project Manager*.

- (4) In the event of an error of any test (hardware/software) the fault is logged and analysed. The *Project Manager* determines if the item is of a minor nature, the *Contractor* is allowed to rectify the fault and the item re-tested for the full duration. Major faults such as power supply failures, system stall, bus failure, etc. terminates the SIT. The *Contractor* rectifies the fault and re-starts the SIT after proving the rectified piece of equipment by carrying out the appropriate diagnostic tests. When the test is successful, the system is classified 'ready for use'. The PA system is then deemed ready for cold commissioning.

2.2.3 Cold Commissioning

2.2.3.1 Functional Tests

- (1) The functional tests form part of the cold commissioning of PA system and include the checking of all measurement loops. These tests are conducted in conjunction with the *Employer's Representative/s*. Special care is taken to safety aspects, special function limits, and position indication.
- (2) As part of the functional test the *Contractor* simulate faults to check measurement loops for:
 - a. Detection of open circuit loudspeaker lines on each connected zone.
 - b. Detection of short circuit loudspeaker lines on each connected zone.
 - c. Detection of earth leakage faults on loudspeakers on each connected zone.
 - d. Detection of microphone capsule failure.
 - e. Power amplifier failure detection.

2.2.4 Hot Commissioning

The *Contractor* notifies the *Project Manager* that cold commissioning is complete and requests the commencement of hot commissioning. Hot commissioning is where the system is placed into operation.

- (3) The commissioning activities are carried out in conjunction with the *Employer's Representative/s*. The *Contractor* is responsible for the hot commissioning of all the equipment forming part of the *works* to satisfy the requirements of the Works Information.
- (4) On completion of the optimization and testing phase the *Contractor* requests the commencement of operational acceptance tests (OAT) from the *Project Manager*.
- (5) The *Contractor* produces a detailed operational acceptance test procedure twenty working days in advance for acceptance by the *Project Manager*. This is shown on the Accepted Program.
- (6) The *contractor* is responsible to take sound level measurement for all the areas using a calibrated decibel meter to verify required sound level per area.

2.2.5 Completion

- (1) On completion of all tests the *Employer* runs the *works* for an unbroken period of 72 hours without hardware or software malfunctions. During this period any or all functions may be exercised. In the event of any hardware or software fault, the *Contractor* remedies the fault, and the 72 hours test shall be restarted.
- (2) A test certificate is provided by the *Contractor* for entire PA System installation for each phase. The format of this certificate must be accepted by the *Project Manager*.

2.3 Procedure for submission and acceptance of *Contractor's* design

2.3.1.1 Design Freeze Milestone

- (1) The *Contractor* cannot commence any of the installation work until the detailed design is complete and accepted by the *Employer*. This shall be indicated as a milestone in the Project Execution Programme.
- (2) Employer must review and accept detail design within the period ranging from the minimum of 14 days (2 weeks) to a maximum of 56 days (8 weeks) or agreed reply period.
- (3) All design documentation must be completed before design freeze as per Appendix G – Vendor Document Submittal Schedule.
- (4) A detailed implementation plan must be completed and accepted by the *Employer* before the design freeze. Should the *Employer* not respond within the reply period (7 working days or agreed reply period as per NEC3 ECC contract guideline) the plan submitted by the *Contractor* shall be deemed as the accepted plan.
- (5) The field work cannot commence without official access from the *Employer*.

2.3.1.2 Commissioning Completion Milestone

- (1) Commissioning is complete when all plant forming part of the *works* is returned to service.

2.3.1.3 Project Completion Milestone

- (1) The *Contractor* updates the design freeze documentation package with any changes made during commissioning.
- (2) The *Contractor* submits as-built documentation to fulfil the project complete milestone as per Appendix G – Vendor Document Submittal Schedule.

2.4 Other requirements of the *Contractor's* design

- (1) The *Contractor* follows the existing Camden PS plant codification and Labelling philosophy as per document 240-64550962_Label Specification and Plant Codification.
- (2) The *Contractor* follows the existing Camden PS modification's philosophy.
- (3) The *Contractor* follows the existing Camden PS documentation control philosophy.

- (4) The *Contractor* provides a list of equipment which needs to be removed during the *works*.

2.5 As-built drawings, operating manuals, and maintenance schedules

All documentation shall be provided as per Appendix G. The *Contractor* provides good quality operating and maintenance manuals prepared by suitably experienced personnel. The maintenance manuals explicitly state the maintenance requirements for each piece of equipment. Four copies of the first draft manuals as well as all “as built” drawings are submitted to the Project Manager for review and acceptance. Manuals are in English, and each manual is complete with the Power Station’s name, contract number and index. The Contractor also provides an electronic copy of these documents on Microsoft Word for Windows.

The manuals should indicate the level of responsibility of the operating personnel for each action in the procedures. Included in these manuals are the following:

- i. EN54 compliance certificates, data sheets for terminal equipment.
- ii. Electrical diagrams.
- iii. General arrangement and installation drawings and instructions in Eskom drawing template found in **Appendix F**.
- iv. Operating procedures and instructions for normal and emergency conditions
- v. Maintenance procedures and instructions for specific plant and equipment.
- vi. All drawings required for component location, dismantling and re-assembly for maintenance.
- vii. Equipment details such as make, model, type, and specifications.
- viii. Detailed parts lists and ordering instructions pertaining to storage of spare parts or to their shelf life.
- ix. Exploded view type drawings clearly detailing the part and uniquely identifying it, technical descriptions of the equipment and component parts.
- x. Troubleshooting and fault-finding guide.
- xi. Safety procedures and instructions.
- xii. All special tools and equipment required for maintaining and operating the works.

The maintenance manuals are separated into electrical and C&I volumes. The manuals are designed such that they can be clearly understood by technical, maintenance and operating personnel. The technical manuals include complete detailed descriptions, as-built drawings, diagrams, illustrations, schedules, and data for use by Employer’s technical staff to evaluate performance, trace faults, adjust, maintain and fully understand the plant and plant equipment and to allow satisfactory training of junior staff in conjunction with the operating manuals.

The operating manuals are set out in simple terms in ordinal, tabular or pictorial form to provide factual and concise descriptions of:

- i. What an alarm condition implies and how it is corrected.
- ii. What problems can occur and how they are overcome.
- iii. A routine visual plants inspection procedure.

The operating manuals are intended for daily use and therefore shall be separated from the technical and maintenance manuals. Bold print, diagrams, illustrations, etc. shall be used. Materials shall be suitable for

heavy duty, preferably covered with protective transparent material, and be in loose leaf form to allow substitution and addition of pages.

The maintenance instruction manuals shall include schedules to cover plant inspection procedures, fully detailed maintenance programmes for plant and plant equipment services at daily, monthly, three monthly, six monthly, yearly and any other necessary intervals, and contain manufacturer's detailed maintenance, supplier's detailed maintenance, diagrams, sectional drawings giving part numbers, descriptions, etc.

4 AUTHORISATION

This document has been seen and accepted by:

Name and Surname	Designation	Accepted
Douglas Mugweni	C&I Engineering	13/04/2024
Lindiwe Makhubo	Camden Safety Manager (Client)	13/04/2024
Selelepoo Ntoampe	Design and specification	13/04/2024
Peski Ntshangase	Project Co-ordinator	13/04/2024
Paul Du Plessis	PEIC-C&I Specialist	13/04/2024
Riaan Grobler	Electrical Engineering	13/04/2024
Siphiwe Shabangu	Quality Control	13/04/2024

5 APPENDIX B: PHASE 2 LOUDSPEAKER ZONE

*The SPL indicated in the tables below is an estimate. The *Contractor* responsible for verification of SPL for each zone for accurate loudspeaker design selection.

Table 4: Zone 5 (unit 1)

Area Description	Speaker Type	Power Ratings	SPL > SPL(Ambient) + 10dBA	Quantity	Total calculated speaker load per zone	Addition of 20% power factor for amp & cable efficiency losses	Amplifier total capacity
0 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
12 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
29 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
36 m Level	Horn Speaker	15W	110dB	4	168 W	201.6 W	240 W
	Wall mount/ box Speakers	6W	94dB	4			
48 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			

Table 5: Zone 6 (Unit 2)

Area Description	Speaker Type	Power Ratings	SPL > SPL(Ambient) + 10dBA	Quantity	Total calculated speaker load per zone	Addition of 20% power factor for amp & cable efficiency losses	Amplifier total capacity
0 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
12 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
29 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
36 m Level	Horn Speaker	15W	110dB	4	168 W	201.6 W	240 W
	Wall mount/ box Speakers	6W	94dB	4			
48 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			

Table 6: Zone 7 (Unit 3)

Area Description	Speaker Type	Power Ratings	SPL > SPL(Ambient) + 10dBA	Quantity	Total calculated speaker load per zone	Addition of 20% power factor for amp & cable efficiency losses	Amplifier total capacity
0 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
12 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
29 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
36 m Level	Horn Speaker	15W	110dB	4	168 W	201.6 W	240 W
	Wall mount/ box Speakers	6W	94dB	4			
48 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			

Table 7: Zone 8 (Unit 4)

Area Description	Speaker Type	Power Ratings	SPL > SPL(Ambient) + 10dBA	Quantity	Total calculated speaker load per zone	Addition of 20% power factor for amp & cable efficiency losses	Amplifier total capacity
0 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
12 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
29 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
36 m Level	Horn Speaker	15W	110dB	4	168 W	201.6 W	240 W
	Wall mount/ box Speakers	6W	94dB	4			
48 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			

Table 8: Zone 9 (Unit 5)

Area Description	Speaker Type	Power Ratings	SPL > SPL(Ambient) + 10dBA	Quantity	Total calculated speaker load per zone	Addition of 20% power factor for amp & cable efficiency losses	Amplifier total capacity
0 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
12 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
29 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
36 m Level	Horn Speaker	15W	110dB	4	168 W	201.6 W	240 W
	Wall mount/ box Speakers	6W	94dB	4			
48 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W

	Horn Speaker	15W	110dB	4			
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Table 9: Zone 10 (Unit 6)

Area Description	Speaker Type	Power Ratings	SPL > SPL(Ambient) + 10dBA	Quantity	Total calculated speaker load per zone	Addition of 20% power factor for amp & cable efficiency losses	Amplifier total capacity
0 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
12 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
29 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
36 m Level	Horn Speaker	15W	110dB	4	168 W	201.6 W	240 W
	Wall mount/ box Speakers	6W	94dB	4			
48 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			

Table 10: Zone 11 (Unit 7)

Area Description	Speaker Type	Power Ratings	SPL > SPL(Ambient) + 10dBA	Quantity	Total calculated speaker load per zone	Addition of 20% power factor for amp & cable efficiency losses	Amplifier total capacity
0 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
12 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
29 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
36 m Level	Horn Speaker	15W	110dB	4	168 W	201.6 W	240 W
	Wall mount/ box Speakers	6W	94dB	4			
48 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			

Table 11: Zone 12 (Unit 8)

Area Description	Speaker Type	Power Ratings	SPL > SPL(Ambient) + 10dBA	Quantity	Total calculated speaker load per zone	Addition of 20% power factor for amp & cable efficiency losses	Amplifier total capacity
0 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
12 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
29 m Level	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			
36 m Level	Horn Speaker	15W	110dB	4	168 W	201.6 W	240 W
	Wall mount/ box Speakers	6W	94dB	4			
48 m Level	Wall Mount Speaker	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			

Table 12: Zone 18 (Coal weigh bridge)

Area Description	Speaker Type	Power Ratings (watts-W)	SPL > SPL(Ambient) + 10dBA	Quantity	Total calculated speaker load per zone	Addition of 20% power factor for amp & cable efficiency losses	Amplifier total capacity
Coal weigh bridge	Wall mount/ box Speakers	6W	94dB	4	168 W	201.6 W	240 W
	Horn Speaker	15W	110dB	4			

Table 13: New Ash dam

Area Description	Speaker Type	Power Ratings (watts-W)	SPL > SPL(Ambient) + 10dBA	Quantity	Total calculated speaker load per zone	Addition of 20% power factor for amp & cable efficiency losses	Amplifier total capacity
Offices	Wall mount/ box Speakers	6W	94dB	2	222W	266.4W	300 W
	Horn Speaker	15W	110dB	2			
Maintenance Yard	Horn Speaker	15W	110dB	3			

6 APPENDIX H: PHASE 2 UPS LOAD CALCULATIONS

Table 14: Phase 2 UPS Load Calculations

RACK NUMBER	KKS	EQUIPMENT DISCRIPTION	QUANTITY	POWER WATTAGE(W)	TOTAL POWER/EQUIP	TOTAL POWER (WATTS)
1	00CYC01PAR001	PABX TO PA	16	18.4	294.4	582.9
		Sirio 25	1	10	10	
		Tuner	1	55	55	
		Mixer Pre-Amplifier				
			Power Supply PS02	1		
			ML42(Mic/Line) Module/card	2	59	
			CA42(Chime/Alert) Module/card	2	59	
			DM46(Digital Message)	1	59	
		Main Signal Controller	1	15	15	
		Speaker Selector with Digital Matrix	1	2.4	2.4	
		Media Receiver	1	3.6	3.6	
		Relay Group	1	11.5	11.5	
		Power Distribution	1	120	120	
		Fault Standby Amp Switcher	1	12	12	

RACK NUMBER	KKS	EQUIPMENT DISCRIPTION	QUANTITY	POWER WATTAGE(W)	TOTAL POWER/EQUIP	TOTAL POWER (WATTS)
2	00CYC01PAR002	Monitor Unit	2	20	40	4464
		Fault Standby Amp Switcher	2	12	24	
		2-Channel P.A. Power Amplifier	6	670	4020	
		Power Amplifier	2	190	380	
3	00CYC01PAR003	Monitor Unit	1	20	20	9222
		Fault Standby Amp Switcher	1	12	12	
		2-Channel P.A. Power Amplifier	1	670	670	
		1-Channel P.A. Power Amplifier	6	1420	8520	
4	00CYC01PAR004	Monitor Unit	1	20	20	8621
		Fault Standby Amp Switcher	1	12	12	
		Speaker line Checker	3	23	69	
		1-Channel P.A. Power Amplifier	6	1420	8520	
5	00CYC01PAR005	Monitor Unit	1	20	20	11392
		Fault Standby Amp Switcher	1	12	12	
		1-Channel P.A. Power Amplifier	8	1420	11360	
6	00CYC01PAR006	Monitor Unit	1	20	20	11392
		Fault Standby Amp Switcher	1	12	12	
		1-Channel P.A. Power Amplifier	8	1420	11360	

RACK NUMBER	KKS	EQUIPMENT DISCRIPTION	QUANTITY	POWER WATTAGE(W)	TOTAL POWER/EQUIP	TOTAL POWER (WATTS)
7	00CYC01PAR007	Monitor Unit	1	20	20	11392
		Fault Standby Amp Switcher	1	12	12	
		1-Channel P.A. Power Amplifier	8	1420	11360	
8	00CYC01PAR008	Monitor Unit	1	20	20	11392
		Fault Standby Amp Switcher	1	12	12	
		1-Channel P.A. Power Amplifier	8	1420	11360	
					Total Power(W)	68457.9
					Total Power(kW)	68.46
					Total Power(pf=0.8) (kVA)	85.57
					Total Power (Future Expansion)(kVA)	106.97