1. PROJECT DETAILS

Project Description	**Physical Security Infrastructure Upgrade Programme (PSIUP)**						
Project No.'s	**ID**	**C.SECURIT**	**WBS**	**C.SECURIT**	**Rev**	**0**	
Operating Unit & Project Office:	**Security**			**Capex Project**			
Project Manager:	**Corrie Ungerer**						
Programme Manager:	**Adv. Karen Pillay**						
Project Sponsor / Client Representative:	**Brig-Gen (ret.) Tebogo Rakau**						
Engineer / Discipline Manager:	**TBD**						
PLCM Phase	**DRA**						

CONTENTS

FIGURES

TABLES

DOCUMENT HISTORY

Rev	Date	Author	Reason for Change
0.1	05/05/2017	Avinesh Teeruth	First draft for internal review
0.2	15/05/2017	Avinesh Teeruth	Updated revision issued for Eskom Review
1	28/08/2017	Avinesh Teeruth	Rev 1 issued to Eskom

2. INTRODUCTION

The Physical Security Infrastructure Upgrade Programme (PSIUP) is a capital project that is sponsored by the Divisional Executive: Security. The programme is aimed at ensuring that security is improved at all Eskom sites with a particular focus on National Key Point (NKP) sites and sites that are critical for electricity supply, nationally.

All reasonable precautions shall be taken to protect Eskom assets against attacks and threats and to protect Eskom against any consequent legal liabilities.

The programme aims to collaborate and align efforts across the communications, logical and physical security domains in an effort to standardise security within Eskom. This project is in response to specific needs for operational improvements, cost reduction, safety and regulatory concerns as raised at EXCO and Board Levels.

A 'technology-centric' approach is preferred for the mitigation of identified and emerging security threats, to improve the security conditions at sites and command and control throughout the organisation.

3. HIGH LEVEL USER REQUIREMENT

3.1 HIGH LEVEL PROJECT DESCRIPTION

The PSIUP aims to collaborate and align efforts across the telecommunications, logical and physical security domains in an effort to standardise security within Eskom. This project is in response to specific needs for risk treatment, operational improvements, cost reduction, safety and regulatory concerns as raised at EXCO and Board Levels. The DRA phase of the programme shall focus on planning, designing and costing the roll out the full spectrum of physical protection systems at Eskom sites over the short term (next 3 years), medium term (next 5-7 years) and long term (next ten years). For the next three years (2017- 2019) priority shall be given to the following initiatives:

a. Roll-out of the Eskom Integrated Access Control (IAC) systems;
b. Roll out of integrated CCTV surveillance and monitoring systems;
c. Development of the IT and Telecommunications network for security functions; and
d. Implementation / establishment of the security command and control centres at site, regional and national levels.

3.2 BACKGROUND AND JUSTIFICATION

A surge in crime related incidents at Eskom sites had prompted Exco in November 2008, to mandate the then Group Risk Management department to initiate a Security Improvement Plan (SIP). The goal of SIP was to cultivate a climate of security awareness and appreciation of the importance of security. SIP was concluded in 2010 with limited success due to financial constraints.

Following the completion of SIP, Exco at a meeting held on the 2 of February 2011 approved the subsequent Security Recovery Programme (SRP) to deal with the changing security environment and capacity requirements for effective security. The SRP aimed to deliver the necessary security capability

and capacity necessary for an improved security function and operating model. The recommendations of the SRP led to the establishment of the Security Division and the centralisation of security in Eskom.

The security and safety of people; the integrity of information and assets and legislative and regulatory compliance are key priorities in Eskom. Security is a key enabler Eskom business sustainability and in ensuring secure and uninterrupted operations.

4. DOCUMENT PURPOSE

This technical specification provides general recommendations, as well as specific product design and specifications for the Design of Security Control Centres. The Control Centre design outlined in this document forms part of the Eskom Physical Security Infrastructure Upgrade Programme (PSIUP).

This document's layout conforms to the IEEE/ANSI 830-1998 Recommended Practice for Software Requirements Specifications Ref [18].

5. ABBREVIATIONS AND DEFINITIONS

5.1 ABBREVIATIONS

All the following abbreviations and definitions may not be currently use this draft version of this document but may be used in further iterations. It will be amended accordingly at a later stage.

Abbreviation	Description
Av	Audio Visual
CCTV	Closed Circuit Television
CBR	Chemical/Biological/Radiological
cfm	Cubic feet per minute
dB *L*	Decibel (Sound Exposure Level)
DLP	Digital light processing
ELB	Electronic Log Book
HEPA	High efficiency particulate air
HFE	Human Factors Engineering
IAC	Integrated Access Control
IEC	International Electrotechnical Commission
IP	Internet Protocol
ISO	International Organisation for Standardisation
IT	Information Technology
IT	Information Technology
JOC	Joint Operation Centre
kg	kilogram
km	kilometre

Abbreviation	Description
LAN	Local Area Network
LCD	Liquid crystal display
LDAP	Lightweight Directory Access Protocol
LED	Light emitting diode
LON	Local Operating Network
L/s	Litres per second
m	meter
mA	milliampere
mm	millimetre
MTBF	Mean Time Between Failures
MWP	Megawatt Park
NSCC	National Security Control Centre
NVR	Network Video Recorder
OMA	Outdoor Morpho Access
OT	Operational Technology
PA	Public Address
PIN	Personal Identification Number
PIR	Passive Infrared Sensor
POE	Power Over Ethernet
ppm	Parts per million
Prox	Proximity
PSIUP	Physical Security Infrastructure Upgrade Program
RSCC	Regional Security Control Centre
SANS	South African National Standard
SAT	Site Acceptance Test
SCC	Security Control Centre
SIP	Security Improvement Plan
SOP	System Operating Procedure
SQL	Structured Query Language
SRP	Security Recovery Programme
SSCC	Site Security Control Centre
SWGIT	Scientific Working Group for Imaging Technology
SXGA+	Super Extended Graphics Array
Tx	Transmission
UPS	Uninterruptable Power Supply
VIP	Very Important Person
VLAN	Virtual Local Area Network

Abbreviation	Description
WAN	Wide Area Network
XGA	Extended Graphics Array

Table 1: Abbreviations

5.2 DEFINITIONS

Definitions	Description
Alarm or Notification event (Response data or related activity)	An alert is a notification of a particular event (or series of events) that has occurred, which is sent to responsible parties for the purpose of action and response. (ITIL Definition: Alarms) e.g. the user swipes his card, and the second part of two-factor authentication fails. The system alarm may be to capture images to alert the operator, and the operators alarm in turn may be a call to the guard at the gate.
Anthropometrics	Physical attributes, such as body size, reach, and visual capabilities, are relatively easy to document
Console/Workstation	Combination of work equipment (operating and administration) for a particular person in the work place
Control Centre	A place from which an organization, activity, mechanism, system, etc., is centrally monitored, regulated, and directed, or in which operational devices and controls are housed
Control Room	Core functional entity, and its associated physical structure, where operators are stationed to carry out centralized control, monitoring and administrative responsibilities
Control Suite	Group of functionally related rooms, co-located with the control room and including it, which houses the supporting functions to the control room, such as related offices, computer equipment rooms, rest areas and training rooms
Controlled Disclosure	Controlled Disclosure to External Parties (either enforced by law, or discretionary)
Equipment Cabinet	An enclosure with fitted, fixed or removable side panels and doors. The cabinet contains a computer rack for mounting computers or other electronic equipment.
Ergonomics	Ergonomics is the science of humans' relationship with the working environment. It considers all aspects of human interaction with systems and machines and its application takes many forms, which include the working environment, the social environment, physical aspects of equipment design, information engineering and psychological aspects of information transfer
Event (Detection data or related activity)	Signifies a correlation of incidents that require an action or response. (Based on Security Information & Event Management (SIEM)) e.g. the user swipes his card, but the second part of two-factor authentication fails. In the case of the sensor, satisfaction of the nuisance filter rules has escalated it to be an event.
Human Factors Engineering (HFE)	Human Factors Engineering applies science-based knowledge concerning a human being's physical and psychological capabilities and limitations to the design of devices and systems for human use.
Human-performance design approach	Approach to interactive system development, focusing specifically on making systems usable, and emphasizing the role of human operators as control agents who maintain authority within a working system

Definitions	Description
Incident (Detection data or related activity)	Refers to the rate of occurrence, leading, or may lead to an unplanned interruption, reduction in quality, creating a (negative) impact on the service or service quality. (ITIL Definition: Incident), e.g. the user swipes his card, but it is not recognised. This results in a delay in the queue, but no system reaction required. This could be a trigger on a sensor, but the rule requires more than one trigger before accepting it as an event.
Nuisance Alarm	arm generated when a detection system responds for something other than an intruder (e.g. a bird sets off an alarm). In principle, a nuisance alarm is declared when the evaluation of supporting evidence shows clear cause for the signal, but it is not of security interest.
Occurrence (Detection data or related activity)	Relates to a normal activity or an instance of a happening with no response criteria, e.g. the user swipes his card
Operational Zone	The assigned areas in which an operator has an assigned function and can exercise authority
Primary user	Person engaged in those job functions normally associated with control centre activities
Secondary user	Person that occasionally uses or maintains the control centre
Situational awareness	Is the perception of environmental elements and events with respect to time or space, the comprehension of their **meaning**, and the projection of their status after some variable has changed, such as time, or some other variable, such as a predetermined event
Use cases	Detailed realistic examples of how users may carry out their tasks in a specified context and with the future platform. These examples are compiled and refined with the co-operation of the users in order to provide a vivid representation of the envisioned use of the system and provide insight as to the exact methods users shall employ to accomplish specific tasks
Veiling Reflections	Veiling Reflection is the reflection of a large luminance area on a task. This results in a loss of contrast between the task and the background.
Work Environment	The physical, organizational, social and cultural factors surrounding a person in his/her work space
Work Space	The volume allocated to one or more persons on the work system to complete a work task
Work System	One or more persons and equipment working together to perform his/her work function
Work Task	Activity required achieving an intended outcome of his/her work function
Workflow	Workflow is the series of activities that are necessary to complete a task. Each step in a workflow has a specific step before it and a specific step after it, with the first step is usually initiated by an outside event. Some activities may be automated, while others require operator interaction. Essentially an automated Standard Operating Procedure.

Table 2: Definitions

6. REFERENCE MATERIAL

The latest revision at the contract award of the hereunder codes, regulation and recommendations

All the following reference material listed here below may not be currently use this draft version of this document but may be used in further iterations. It will be amended and alphabetically arranged accordingly at a later stage.

[1]. Act 49 OF 1995 - National Building Regulations and Building Standards Amendment Act

[2]. BS 1182: Parts 1, 2 and 5 or Reaction to fire tests for products

[3]. BS 1706: Specification for electroplated coatings of cadmium and zinc on iron and steel

[4]. BS 4579-1:1970: Specification for performance of mechanical and compression joints in electric cable and wire connectors. Compression joints in copper conductors

[5]. BS EN 12329: Corrosion protection of metals. Electrodeposited coatings of zinc with supplementary treatment on iron or steel

[6]. BS EN 12330: Corrosion protection of metals. Electrodeposited coatings of cadmium on iron or steel

[7]. BS EN 61238-1:2003: Compression and mechanical connectors for power cables for rated voltages up to 36 kV (Um = 42 kV). Test methods and require

[8]. EEMUA 191 "Alarm Systems- A Guide to Design, Management and Procurement".

[9]. EEMUA 201: Human Computer Interface Guidance Document

[10]. GGR 0992: Plant Safety Regulations

[11]. IEC 1218-1: Requirements for tensile force heat cycling, resistance and temperature measurement

[12]. IEC 60060-1: High voltage test techniques Part 1 General definitions and test requirements.

[13]. IEC 60071: Insulation Co-ordination

[14]. IEC 60269: High voltage test techniques Part 1 General definitions and test requirements.

[15]. IEC 60439-1:1992: Specification for low-voltage switchgear and controlgear assemblies. Specification for type-tested and partially type-tested assemblies

[16]. IEC 60529: Degrees of protection provided by enclosures (IP code

[17]. IEC 61000: Electromagnetic compatibility (EMC)

[18]. IEEE/ANSI 830-1998: IEEE Recommended Practice for Software Requirements Specifications

[19]. ISO 11064: Ergonomic design of control centres standards

[20]. ISO 31000: Risk management

[21]. ISO 7730: Ergonomics of the thermal environment

[22]. ISO 9001: Management Systems

[23]. ISO 9001: Quality Management Systems

[24]. ISO 9001: Quality Management Systems

[25]. ISO 9001: Quality systems. Model for quality assurance in design/development, production, installation and servicing

[26]. SANS 10114-1: Interior lighting Part 1: Artificial lighting of interiors

[27]. SANS 10114-2: Interior lighting Part 2: Emergency lighting

[28]. SANS 10139: Fire detection and alarm systems for buildings

[29]. SANS 10142-1: The wiring of premises Part 1: Low-voltage installations

[30]. SANS 10222-1: Electrical security installations

[31]. SANS 10400 -The Application of the National Building Regulations

[32]. SANS 1091: National colour standards for paint

[33]. SANS 1274: Coatings applied by powder coating process

[34]. SANS 1507: Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)

[35]. SANS 61000-1-2: Electromagnetic compatibility (EMC) Part 1-2: General – Methodology for the achievement of functional safety of electrical and electronic systems including equipment with regard to electromagnetic phenomena

[36]. SANS 9000 to 9004: Quality management systems and standards

[37]. ISO 5457:1999(en): Technical product documentation — Sizes and layout of drawing sheets

ESKOM documents & drawings

[38]. 240-102220945: Specification for Integrated Access Control System (IACS) for Eskom sites

[39]. 240-114441369: Transmission and Distribution Engineering Change Management and Critical Asset Classification.

[40]. 240-44175038: Control of Non-Conforming Product or Service Procedure

[41]. 240-53114002: Engineering Change Management Procedure.

[42]. 240-53114026: Project Engineering Change Management.

[43]. 240-55410927: Cyber security standard for Operational Technology

[44]. 240-55683502: Definition of Operational Technology (OT) and OT / IT Collaboration Accountabilities

[45]. 240-56063805: LV Power and Control Cable with Rated Voltage (Draft Version)

[46]. 240-56355808: Ergonomic Design of Power Station Control Suites Guideline

[47]. 240-56364535 - Architectural Technical Specification for Structures and other Buildings

[48]. 240-64636794: Eskom's Standard for Wiring and Cable marking in Substations

[49]. 240-64636794: Standard for Wiring and Cable Marking in Substations

[50]. 240-70413291: Specification for Electrical Terminal Blocks

[51]. 240-70413291: Standard for Wiring and Cable Marking in Substations

[52]. 240-79537982: Security Threat and Risk Assessments

[53]. 240-86738968: Specification for Integrated Security Alarm System for Protection of Eskom Installations and its Subsidiaries

[54]. 240-86738968: Specification for Integrated Security Alarm System for Protection of Eskom Installations and its Subsidiaries

[55]. 240-9119034: Specification for CCTV Surveillance with Intruder Detection

[56]. 63-34425 Doc type: CCITE Use Cases Specification for Integrated Access Control

[57]. EMN 32-1286: Process Control Manual (PCM) for Manage Item Configuration

[58]. ESK AM AAA I: Corporate ID Manual

[59]. ESK PB AAQ 3: Interior Specification for Eskom

[60]. ESKASAA04 – Eskom Standard for Electronic Protection and Fault Monitoring Equipment for Power Systems.

[61]. Eskom Drawing 0.54/5007: Earthing Standard

[62]. IT00118: Test Plan for Integrated Access Control

[63]. N.PSZ 45-45: KKS Key Part- Fossil Power Station

[64]. NWS 1220: Standard specification for Cable and reduction boxes for power stations

[65]. NWS 1525: Control and instrumentation cables for power stations

[66]. NWS1527: Standard specification for the installation of cables and cable racks at power stations

[67]. SRP/PO/Gen OR/001: Outline Generic Security Physical Design for Coal Fired Power Stations

Ario Documents and Drawings

[68]. EPSIUP Task 606-237 Deployment Model

[69]. EPSIUP Task 606-238 Change Management Plan

[70]. EPSIUP Task 606-252 Generic Specification for Office Blocks Buildings Campuses

[71]. EPSIUP Task 606-257 High level Test Plan EPSIUP

[72]. EPSIUP Task 606-256 PSIM System Functional Specification

[73]. EPSIUP Task 606-265 Specification for Video Surveillance and Intrusion Detection Systems

[74]. EPSIUP Task 606-267 Specification for Integrated Access Control

[75]. EPSIUP Task 606-270 Specification for Integrated Security Alarm System

[76]. EPSIUP Task 606-298 V&V Procedures

[77]. EPSUIP Task 606-261 Power Management User Requirement Specification

[78]. EPSIUP Task 606-73-001 PSIUP Training Plan and Philosophy

Project document rules

[79]. VGB-B 106 B3 E Part B: KKS-Identification Systems for Power Stations

[80]. OPS0014: Eskom KKS Key Part

[81]. N.PSZ 45-45: KKS Key Part- Fossil Power Station

[82]. VGB-B 105 E 5th Edition 10/2003: KKS Identification System for Power Stations

Note: In case of any conflict between the above listed documents and/or with this document the Contractor must point out these conflicts and refer the decision to Eskom, whose decision shall be final and binding.

7. DOCUMENT CONTENT

7.1 EXECUTIVE SUMMARY

The following paragraphs shall outline the design concept for the PSIUP Security Control Centre (SCC).

7.2 SCOPE, CLIENT REQUIREMENTS AND EXPECTATIONS

This specification describes the minimum requirements for the design of Security Control Centres that form part of the Eskom Security Management System.

The Security Control Centre shall provide the situational interface to the protected areas, thereby providing a means to anticipate and react to any security threats.

The scope of work shall cover a Generic Security Control Centre that is scalable across, site, region and national control centres.

Figure 1: Control centre conceptual design

Figure 1 extracted from Ref [46] shows a conceptual layout of a control centre.

7.3 ENVIRONMENTAL CONDITIONS AND DESIGN CRITERIA

All the elements of the system shall be able to function in all climatic conditions prevailing in South Africa with the minimum environmental conditions below, without the performance being impacted or the system life time shortened:

Altitude:

0 – 2000 meters

Ambient temperature:

-10 to + 55 °C

Relative humidity:

Up to 100 % outdoors, 5 to 95% indoors in the specified temperature range.

Resistance to corrosion:

The components of the system shall be inherently corrosion resistant.

7.4 FRAMEWORK FOR AN ERGONOMIC DESIGN PROCESS

The Control Centre design shall follow the ISO 11064 Ref [19] standards for ergonomic design of control centres.

The main components of Human Factor Engineering (HFE) that are detailed here provides guidance for the following aspects:

Part 1 – Principles for the design of control centres

Part 2 – Principles for the arrangement of control suites

Part 3 – Control room layout

Part 4 – Layout and dimensions of workstations

Part 5 – Displays and controls

Part 6 – Environmental requirements for control centres

Part 7 – Principles for the evaluation of control centres

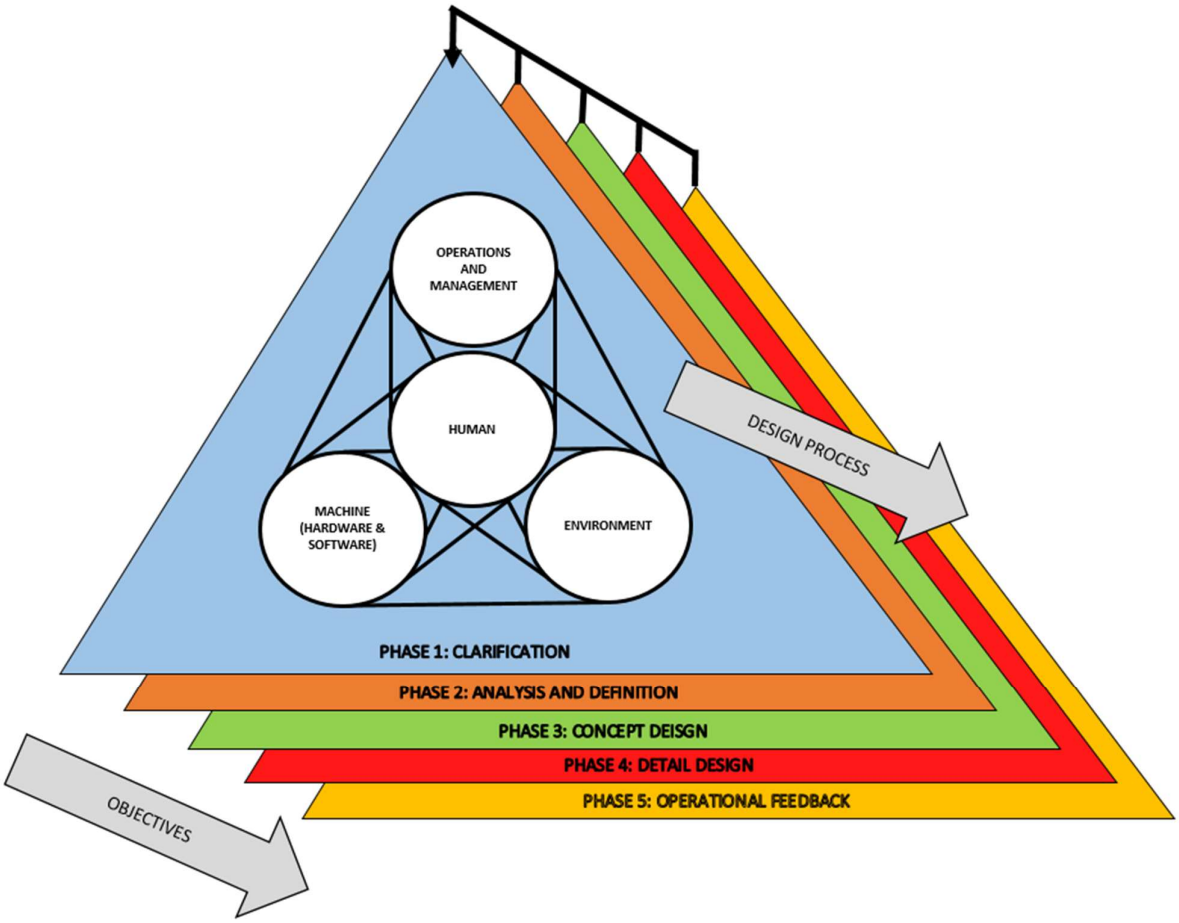


Figure 2: Ergonomic approach to system design

7.4.1 Steps to good design

To generate a Functional Design, ISO identifies a **front-end loading** method but it should also be acknowledged that many of the work design systems required to ensure human safety are not fully identified and addressed by this standard.

The standards do however help the designer understand the use of space, considerations for workstation layout and design, and the use of other systems such as off-workstations. The methodology is a **participatory process** and uses iterative design approach.

Important questions shall be addressed before the design process starts. During the process, the designer often should deal with additional complexity, such as changes to the number console operators; changes in PSIM and technology; a change in software and user interface design capability; or correcting previous design deficiencies or incorporating recent advances in technology, operations and improved management systems.

The standard also includes layout and dimensions of workstations. It's a tome of control room **best practices**, the purpose of which is to enhance human performance and promote safety best practice.

7.5 FUNCTIONALITY REQUIREMENTS (INCL. PERFORMANCE)

7.5.1 General Functional Requirements

All Security Control Centres shall have the following general functional requirements:

Operational:

- Monitor of access control of the control centre and sites under the control centre's responsibility
- Classify incidents, apply the appropriate response, and create the alarms & notifications.
- Manage the response to incidents and escalate the level of response when needed.
- Continuous monitoring of site perimeters.
- Monitor general surveillance and anti-tampering/sabotage observations.
- Control of PTZ cameras to verify an incident as being a nuisance alarm or a real threat.
- Monitor of all detection incidents.
- Use the PA system to deter any threat.
- Remote operation of tactical counter measures such as strobe lights, smoke and pepper spays.
- Investigate user security profiles and behaviours
- Respond to emergency / evacuation notifications
- Maintain the Electronic Incident Logbook (ELB) (continuous with a shift handover), and generate daily/weekly reports
- Support regulatory compliance in all spheres of Eskom business

Maintenance:

- Monitor Security Equipment (hardware) faults and failures (System Status)
- Escalate Hardware and Software faults and failures
- Log entries into electronic preventative maintained schedule

7.5.2 Descriptions of data to be entered into the system:

The PSIM shall be required to handle the following types of data; Security Alarms, Maintenance Alarms, Video Surveillance Footage, Escalated Alarms, SOP's, Employee identification/information, Access levels, Vehicles and people backlisting's. The logging of security events in an electronic logbook format shall also be possible. The logging of maintenance issues into an electronic maintenance logbook or into a preventative maintenance system (part of the PSIM) shall be possible. User log in with associated access rights as stipulated by a primary and secondary user access rights.

7.5.3 Descriptions of operations performed per workstation screen

Security Operator Workstation:

Screen 1: Investigation of video footage.

Screen 2: Alarm Screen

Screen 3: Reviewing and Recording of Incidents

Screen 4: Escalation of Alarms/Incidents/Sops (Touch screen)

Maintenance Operator Workstation:

Screen 1: Maintenance alarms

Screen 2: Maintenance alarms logging

Screen 3: Maintenance and preventative maintenance scheduling and fault escalation.

7.5.4 Descriptions of work-flows performed by the system

The workflow performed by the system is described in detail in, EPSIUP 606-256 PSIM System Functional Specification, please see Ref [72].

The following workflows is described in paragraph 7.16.3.2 of this document, Control Centre Work Flows:

- Data Collection
- Data Processing
- Application Service
- Display platform.

The security and maintenance use cases are described in paragraph 7.16.3.3, Alarm Management. The use cases shall typically describe the Control Centre Work Flows from a user perspective. The following users are identified:

- Security Operator
- Security Supervisor
- Security Manager
- Maintenance Operator
- Maintenance Personnel
- IT Support Personnel

7.5.5 Descriptions of system reports or other outputs

- Daily and weekly incident reports
- System fault reports
- Hardware fault reports
- Preventative maintenance reports

- Maintenance reports
- Employees time and attendance reports
- Vehicles registration lists
- Adhoc reports to assist investigations

7.5.6 Who can enter the data into the system?

Refer to EPSIUP-606-256 PSIM System Functional Specification for more detail.

	Login Access	Change/alter workflows	Capture Incident Report entries	Access to incident Reports	Capture Maintenance Report entries	Access to Maintenance Reports
Security Operator	Yes	No	Yes	Yes	Yes	Yes
Security Supervisor,	Yes	Yes	Yes	Yes	Yes	Yes
Security Manager	Yes	Yes	Yes	Yes	Yes	Yes
Maintenance Operator	Yes	No	No	No	Yes	Yes
Maintenance Supervisor.	Yes	No	No	No	Yes	Yes
IT/Maintenance Support.	Yes	Yes	No	Yes	Yes	Yes

Table 3: Control Centre Access Levels

7.6 KEY DESIGN CONSIDERATIONS FOR THE CONTROL ROOM

In this Section, recommendation, best practices and industry standards Ref [19] shall be detailed. The following areas of Control Centre design shall be considered:

- Architectural Factors
- Interior Finish Selections
- Workstation Arrangements
- Movement of Personnel & Maintenance Access Factors
- Environmental Considerations
- The PSIM System
- Video Wall Technology

7.6.1 Architectural factors

Architectural factors considered in the room design include:

- Overall space provisions and achieving the best fit for the current building
- Exits, Entrances and Walkways
- Windows
- Layout Considerations

7.6.1.1 Overall space provisions

The Control Suite will be accommodated with the following considerations:

- Spatial Criteria
- Future Expansion
- Height Clearances

Overall Spatial Criteria	
Current standards and best practices:	Proposed design:
Avoid obstructions and structural features as they will severely reduce the available space and provide less optimal layouts	The Control Room needs to develop into an area that is free of structural columns; the entire space needs to be unencumbered within the boundaries of the exterior walls.
Allow for a minimum of $4m^2$ of space per working position,	The available footprint shall be considered with the optimization of the available space

Allow for additional space in the control room for operational responses, that is movement between workstations, amenities and operational equipment	The room shall be designed such that there are walkways and links between supervisors and responders to effectively interact when required. All walkways shall be wide enough for wheelchair operation.
Allow for additional space in the control room for extra staff that may be present during abnormal operations, critical scenarios and similar scenarios	The room shall be designed such that there are meeting areas that can accommodate any additional staff that may be present. The room shall be able to accommodate at least 2 times the number of regular required staff per shift. In addition, the layout of the positions needs to allow for sufficient space for other operators/staff to be present at the position itself with sufficient space with limited disruption to the operator. This also addresses the shift change recommendation.
Allow for extra space to accommodate extra staff during shift changes,	As above
Provide square, circular or hexagonal space to allow the maximization of links between functional areas,	The space design for the Control Room is generally a square or rectangular design and, as a result allows for maximum space efficiency and operator positioning
Future Expansion	
Current standards and best practices:	Proposed design:
Future expansion considerations are strongly recommended. Considering the lifespan of a typical control room, future increases in workload, staffing, functions and equipment should be taken into account. In general, the recommended space allocation for future expansion should be around 20% of the overall space.	Best practice shall be adhered to.

Table 4: Overall Spatial Criteria

Height Clearances	
Current standards and best practices:	Proposed design shall adhere to best practices and current standards:

Utilise a single height finished floor to facilitate easier movement within the space (equipment, maintenance, people) and future reconfiguration.	The floor is designed to be at a single level for the entire room. The audio-visual displays need to be visible across the area. The ceiling height needs to be considered, if tiered flooring is a requirement for the overview of the Video Wall by Supervisors or others. The meeting areas are to be designed to be at the same level as the rest of the Control Room since it is utilized by internal users (Operators) only and has no requirement for elevated viewing. This also aids the use of wheelchairs.
Slab to slab heights should be at least 4m and finished height (raised floor to ceiling) should be at least 3m.	Allowance for ample vertical space as well as provide a feeling of more openness in the space for the Operators need to be considered. This will also be dependent on the raised flooring
Ceiling should be relatively uncluttered in order to avoid reflections, acoustical issues or distractions within the space.	Conformance to Current standards and best practices.

Table 5: Height Clearances

7.6.1.2 Exits, entrances & walkways

The following are general recommendations and best practices to be considered when determining exits, entrances & walkways;

Exits, Entrances and Walkways Spatial Criteria	
Current Standards and best practices:	Proposed design:
The number and location of entrances/exits should take in to account the number of operators, support staff or any other persons that may be present in the control room at any given time.	Conformance to Current standards and best practices.
In general, it is recommended that the control room have one main entry point in order to better maintain security and access control. Additional emergency exists should be added to the space, however, these should be alarmed exit points and not used for general access (with the exception of possible larger scale maintenance access).	The Control Room shall have one main entrance. There shall be a dedicated emergency exit. Due to the predicted vast increase in occupation of this space It is also recommended that local fire codes be reviewed for compliance and incorporated in to the design.
The sizes of entrances/exits should accommodate control room operators, visitors with disabilities, movement of equipment and the introduction of	The Control Room Design shall comply to the current Standards as referenced in section 6 of this document and Best Practice.

any other maintenance equipment. Entrances that are sized for equipment passage are usually adequate for persons using wheelchairs.	
Where changes of floor level are introduced in conjunction with entrances or exits, proper physical "aids" should be provided (such as guard rails, handrails, anti-slip surfaces) to minimize potential hazards.	The Control Room Design shall comply to the current Standards as referenced in section 6 of this document and Best Practice.
Floor covers shall be electro-statically dissipative and grounded	The Control Room Design shall comply to the current Standards as referenced in section 6 of this document and Best Practice.

Table 6: Exits, Entrances and Walkways - Spatial Criteria

7.6.1.3 Windows

The following should be taken into account when installing windows to a control room:

- Windows/skylights should be avoided. If they cannot be avoided they should be bullet proof. If they are fitted they should only provide indirect light (e.g. a screen between window and operators)
- Workstations should not be directly facing a window.
- Windows shall not be located directly behind the operator.
- Windows shall have user controlled blinds.

7.6.1.4 Layout Consideration

- Separation of CC in fire zones.
- Equipment room that houses servers, telecoms and UPS etc shall be separate from electrical room.
- Backup generators secured, but far enough not to present risk of fumes & fire.
- EP Room in close proximity to the CR, ideally with a window on the video wall. But not open, so that noise is not transmitted.
- Quiet box shields in radio/telecoms section or supervisor, so verbal commands are less audible to not distract other operators.

7.6.2 Interior finish selections

All interior furnishing and fixtures shall comply with ESK PB AAQ 3, Interior Specification for Eskom Ref [59] and ESK AM AAA I Corporate ID Manual Ref [58].

The following paragraphs shall be considered when determining the interior finishes of a Control Centre. It should be read in conjunction with the specifications mentioned above.

The interior design of the control Centre shall support the operational activities. Colours, textures and materials shall provide a pleasant working environment and calming backdrop to the control activities being

undertaken. Colour and finishes shall be chosen in consideration of wear and tear and 24-hour operation. It should provide for easily cleaned surfaces which can be repaired when light damages are sustained.

Walls shall be pale in colour, selected to avoid psychological effects. Consideration to textured finishes as it helps reduce reflected glare.

The excessive use of either dark or light finishes on building structures or on furniture shall be avoided.

Consideration shall be given to colour selection at desk based screens and overview displays as it can create either and oppressive environment or distract or interfere with visual tasks.

Backdrops to visual display units or control equipment, shall be devoid of heavy strong patterns.

Carpets shall be of heavy contract grade, where used. Small random patterned carpets with subtle colour variation is recommended. Carpets with large and geometric shapes shall be avoided.

Plants, picture frames, or other forms of visual relaxation, shall be provided as a variation in texture and colour to detract from the rigid geometry imposed by workstations, cupboards, overview displays and ceiling grids.

The reflectance gradient shall be consistent with the normal. Ceilings shall be brighter (0.85 to 0.90), than walls and walls shall be lighter than the floor finishes.

All furniture and finishes shall be such that glare is eliminated, whether associated with workstation or not.

Large colour contrast shall be avoided on workstations, general furniture and equipment finishes.

Consideration shall be given to matte or non-reflective surfaces, and low brightness reflector assemblies. Luminaries shall be kept to an acceptable value when designing the control centres.

It is preferable that the control centre is without any windows. This limits the operators being distracted by external events and also reduces glare. Should this be unavoidable, all windows shall be provided with adjustable blinds, tinted or covered with anti- glare or anti-reflective film to reduce glare. Windows shall be bullet proof to UL 752 Level 8, (approximately NIJ III) to defend against 5 shots of NATO 7.62x51 calibre.

The control room finishes shall achieve a specified time-based reverberation based on the need for good verbal communications and transmission of auditory warning. The minimum objective requirements for acoustical environment of a control room are:

- Maximum ambient noise — 45 dB $L_{Aeq,y}$
- Maximum background noise — 35 dB $L_{Aeq,y}$
- Minimum background noise[1] — 30 dB $L_{Aeq,\,y}$
- Maximum ratio of alarm noise to background noise — >15 dB
- Minimum frequency reverberation times[2] — 0.4 sec

[1] A minimum level of background noise is specified to maintain privacy; if it is too quiet individual conversation stand out

[2] Reverberation times are a significant factor in the intelligibility of communications. Lower reverberation times help to improve this situation.

Source: BS/EN/ISO 11064-6:2005

7.6.3 Workstation/Console arrangements

Control room console design is a specific area of human factors engineering (HFE) that optimises the workspace in the immediate vicinity of the operator. A control room console unit consists of computer monitors, keyboard, communications equipment and other equipment essential to the operator's task mounted on a desk or sit/stand workstation. The optimal configuration of these elements has profound implications for the safety, health and performance of the people operating within mission-critical, 24/7 environments.

Control room console design should employ a scientific approach to understanding the operators' tasks so that the configuration of the equipment can be optimized to support the task actions required. Information needs to be in the right place at the right time with easily accessed control. It must take account of other factors such as lighting and how this might affect the information presentation on the screen. Line of sight and arc of reach are taken into account, with established primary, secondary and tertiary zones of placement according to task priorities.

Modern workstations need to encourage postural variation. There is evidence that sedentary behaviour is associated with negative health outcomes. Studies confirm that prolonged occupational sitting:

- Has acute negative effects on metabolism
- Is associated with greater cardiovascular morbidity
- Is associated with chronic back pain
- Promotes weight gain
- Is associated with chronic diseases that result in premature death

The layout of the workstations shall consider the following general factors;

Task Analysis	Task analysis shall be conducted during the preliminary design phase interviews.
Organizational Factors	Understanding the responsibilities of individuals and the requirements for supervision.
Operational Links	Understanding key operational links including visual and verbal communication
Collaboration	Understanding the requirements for social and working interactions within the control room.

Table 7: Factors for Workstation Arrangement

7.6.4 Movement of personnel

The following recommendations should be adhered to in relations with the movement of personnel within the control room:

Sufficient provisions shall be made for the general movement, such that control operations are not interrupted by either visual or auditory distraction.

Care shall be taken to provide sufficient circulation areas where shift changeover is effected and two shifts are present at the same time.

The layout of the control room shall allow for the orderly evacuation of the room. Control room circulation routes should be arranged to avoid cross-circulation. Fixed items should be placed far enough from the swept area of hinged doors in order to avoid pinch points. The possibility of individuals being overcome by fire, smoke or gas should be considered in the design of door swings, such that the likelihood of an unconscious individual obstructing the door is minimised.

For wheelchair users, allowances need to be made for the maximum width of the largest wheelchair and clearances for elbows to propel the chair. The recommended minimum clearances are:

- 1200 mm for length of wheelchair (including foot rest and clearance).
- 900 mm for width of wheelchair and clearance.

Wheelchair users will require additional space for turning and these should be provided at appropriate locations in the control room. The recommended diameter for circular turning is 1525 mm.

7.6.4.1 Maintenance access

Maintenance access within the control room shall adhere to the following where possible:

- Space shall be allowed for maintenance such that inadvertent activation of equipment or systems is avoided. Housed equipment should be mounted at least 700 mm above the finished floor height for reasons of visibility and access for maintenance.
- Rear access to control workstations shall allow maintenance staff to continue their operations without impediment to other control centre operators.
- Sufficient clearance behind the control workstation shall be allowed for a kneeling maintenance engineer to work.
- Provisions for maintenance of Off-workstation panels and displays shall be made. Rear access may be required.
- Sufficient space shall be allowed for the 95th percentile maintenance technician from the user population, and consideration given to the use of ladders and carrying of tool boxes.
- Where heavy or bulky items of equipment need to be removed, the appropriate manual handling guidelines should be consulted. It is sometimes necessary to provide mechanical assistance or hoist points.
- Access to service ducts and serviced equipment should, wherever practical, be from outside the control room, but still fall within the security zone of the security control centre.

7.6.4.1.1 Cleaning

For cleaning of the Control Room space, the following are recommended guidelines:

- Inadvertent activation of any safety-critical controls shall not be possible during cleaning.
- A sufficient number of power outlets should be provided which will enable cleaning appliances to be used, and maintenance to be undertaken, without causing electrical interference or disturbing control room operations.

- Where gaps occur between items of equipment or furniture, sufficient clearances should be allowed for cleaning to be undertaken.
- All necessary cleaning of the Control Room shall be possible without interruption to control room activities.
- Special provision such as kitchen is required where food and other refreshments will be permitted to be consumed in the control room.
- The control room layout should not give rise to unsuitable working postures or working movements for cleaning staff.
- A central vacuum system should be provided to minimize unwanted sounds from cleaning the floor covering. The vacuum canister shall be isolated from the Control Room

7.6.5 Environmental guidelines

7.6.5.1 Thermal environmental considerations

The following are the recommended thermal values (as outlined in ISO 7730) Ref [21];

7.6.5.1.1 For sedentary activity during winter conditions:

- The operative temperature should be between 20 °C and 24 °C (i.e. 22 °C ± 2 °C)
- The vertical air temperature difference between 1,1 m and 0,1 m above floor (head and ankle level) should be less than 3 °C
- The surface temperature of the floor should normally be between 19 °C and 26 °C, but floor heating systems can be designed for 29 °C;
- The mean air velocity should be less than 0,15 m/s
- The radiant temperature asymmetry from windows or other cold vertical surfaces should be less than 10 °C (in relation to a small vertical plane 0,6 m above the floor)
- The relative humidity should be between 30 % and 70 %

7.6.5.1.2 For sedentary activity during summer conditions:

The operative temperature should be between 23 °C and 26 °C (i.e. 24,5 °C ± 1,5 °C). The vertical air temperature difference between 1,1 m and 0,1 m above floor (head and ankle level) should be less than 3 °C. The mean air velocity should be less than 0,15 m/s. The relative humidity should be between 30 % and 70 %.

- As compensation for diurnal rhythms, control room operators shall be able to increase control room temperatures by 1 °C to 2 °C.
- Consideration shall be given to buffer zones which offer an intermediate temperature to limit thermal shock to people moving in and out of the control room.

The thermal and lighting needs for maintenance and other staff working long hours in equipment rooms should be considered by installing stand-alone (independently controlled) HAVC and lighting in these areas. Air supply diffusers shall be located in the raised floor at appropriate locations within the Control Room. Diffusers shall not be placed next to the operator positions so to avoid excessive heat or cold air

blowing on the operators. Air returns should be located in the ceiling in larger control centres. At smaller control centres such as the SSCC the air-conditioning system may be wall mounted split units.

7.6.5.1.3 Air quality considerations

The following are the recommended air quality considerations (as per ISO 11064):

Direct drafts onto personnel shall be controlled by checking the air velocity/ air flow. Short circuits between inlets and outlets shall be avoided by location extractor grilles to encourage even distribution of air. HVAC systems shall be designed to avoid vibration and minimize noise from the system.The rate of air change (i.e. the relation between the capacity of the Mechanical system and the physical volume of the control centre) shall be adjusted in order to maintain good air quality. Fresh air supply per person shall be at a rate of 29 m^3 /hr and maximum CO_2 concentration of 910 ppm.

The ingress of dust and other particles from the ceiling and floor plenum to the Mechanical system should be avoided (physical location of HVAC inlets and outlets, room cleaning, etc.). Installing HEPA/ULPA filters directly in the ceiling of the control room shall minimize, if not eliminate, dust-collecting surfaces, such as the inside of ductwork, between the downstream face of the filter and the room. Remote mounting of HEPA filters is common in less stringent applications since the number of particles that can be contributed by ductwork downstream of the HEPA filters is small as a proportion of the amount that can be tolerated.

A typical office building air should contain from 500,000 to 1,000,000 particles (0.5 microns or larger) per cubic foot of air. HEPA filter particles as small as 0.3 microns with a 99.97% minimum particle-collective efficiency. The location of ducts and filters should take account of cleaning and maintenance requirements. Avoid areas where 24/7/365 operational equipment is located such as consoles and video walls. Rooms such as toilets, canteens and locker rooms should be maintained at a lower pressure from other areas in order to avoid any odour ingress. The air exchange rate should have a minimum of 15 air changes per hour or 35.4 L/s (75 cfm) exhaust per toilet cubicle. Suitable replacement air should be provided for exhaust systems to ensure a slight negative pressure within the toilet. The replacement air may be taken directly from the exterior, or from adjacent spaces that are permanently air-conditioned or naturally ventilated. The replacement air may be drawn through louvers in the doors, walls, door undercuts, or other means. The exhaust system should dispel the air directly outdoors without causing any nuisance to neighbouring premises. The exhaust air should be discharged to the exterior of the building at a position at least 2 meters (6 feet) above the exterior surface level and at least 5 meters (16 feet) from any opening into the building where the discharge air may re-enter the building such as windows, doors or air intakes.

Operators should be protected against air pollution through the air supply. Potential contamination by external sources of solid particles, e.g. sand, construction materials, plant chemicals, should be controlled through the design of the air handling systems. Also, the malicious introduction of materials into air distribution systems should be taken into account for the safety and security of plant and personnel. HVAC systems can become an entry point and distribution system for hazardous contaminants. HVAC air filtration and air-cleaning systems can reduce the effects of a Chemical/Biological/Radiation (CBR) agent by removing the contaminants from the air within a building. There are a variety of ways to protect building occupants from airborne hazards. These protective measures can be as simple as defining a protective action plan or as complex as strict design measures practical only for new construction.

Humidification plant, such as steam humidifiers, should be of a type designed to minimize the proliferation of micro-organisms, including bacteria that cause Legionnaire's disease and fungi.

The following protective measures should be taken into account when designing air provision systems for control room environments:

- The selection of non-toxic construction material (especially in case of fire)
- The separation of operators' areas from equipment which might emit pollutants in the environment (e.g. photocopiers/ozone, battery rooms)
- An appropriate air change rate which will reduce the concentration of the impurities
- The presence of specific safety procedures and personal protective equipment in case of suspected specific risk (chemical pollution for instance)
- The use of airtight control rooms in case of exceptionally dangerous and polluted working areas
- The installation of gas detection systems
- The installation of fire extinguishing systems using non-toxic products.
- Toilets shall have redundant extraction to the building exterior, built in.

7.6.5.1.4 Lighting considerations

The design of lighting considerations (per ISO 11064-6) Ref [19] shall:

- Provide flexibility for different visual tasks from paper-based to electronic and be undertaken by a range of different operators of varying ages, etc.
- Optimize visual performance at the workplace.
- Take into account the demands of normal and emergency work as well as the effects of artificial and natural light.
- Provide individual lighting at an operator’s position where a significant part of an operator’s duty involves completing tasks at the work surface.
- Necessitate the ability to be able to dim the general lighting.
- Operator-controlled task lighting shall not be a source of glare to other occupants in the room.
- Operators should have some control of the local maintained illuminance associated with their workstation.
- Lighting schemes should avoid veiling reflections and reflected glare off screens.
- Lighting systems should take into account future changes in equipment, workstation layouts, operating procedures, and team working. Options for rearrangement of lighting should be examined.
- The location of any windows, skylights and fixed luminaires should minimize the potential for generating reflections and glare.
- Natural references, such as daylight through outside windows and plants, should be used to enable control room staff to maintain linkage with the external world.
- Suitable control over natural light shall be provided to avoid the difficulties of intense natural light.
- Windows have a psychological value.
- Where levels of illumination are specified, these should be maintained levels for the lifetime of the luminary.

- For good visual conditions, a balanced ratio of luminance values in the field of vision should be sought.
- Glare shall be avoided irrespective of its source, for example from luminaries, reflections and excessive differences in luminance in the visual field.
- The location of light fittings, for example, windows or skylights, shall be such they do not result in glare when shared workstation displays are viewed.
- The needs of those with visual disabilities should be taken into account when preparing specifications.
- Wherever possible, lighting systems should make use of different light sources, both natural and artificial.

7.6.6 PSIM (Physical Security Information Management System) requirements

The PSIM functionality is outlined in EPSIUP Task 606-256 PSIM System Functional Specification Ref [72].

7.6.7 Video wall technology

Video Walls provides an overview of the total system – The “Eagle Eye view”. Not all SCC should have video walls. Refer to Table 13 for the Design Scalability.

7.6.7.1 The factors that should be considered are:

a. Front/Rear Access
   - Front or Rear access shall depend on the physical constraints of the control room.
   - Front Access Rear Projection Video Wall shall be preferred.

b. Screen Size/Resolution
   - How big is the screen?
   - What type of info will be displayed
   - What space is available
   - What distance are the viewers

c. Screen Type
   - Screen Viewing Angles
   - Location of viewers
   - Ambient light reflection
   - Anti-Reflection

d. Display Device Brightness
   - Measured in cd/m2 or nits. Recommended between 450 nits to 500 nits.

- Function of screen area and device brightness
- Aim to reduce operator fatigue

e. Ambient Conditions

- What ambient light is there
- Total avoidance of screen glare
- Contrast ratio delivery

7.7 TECHNICAL REQUIREMENTS

In this section, prescriptive technical details and considerations are addressed

7.7.1 Designing display data

7.7.1.1 Text

- The language used shall be easily understood by the operator.
- Active rather than passive language shall be used, where applicable.
- Text shall be left justified.
- Sans serif fonts shall be used. An example of a sans serif font is Arial. It is found to be more legible.

7.7.1.2 Labels

- Labelling shall be used consistently across the control centre.
- Labels shall be used appropriately in a manner that best describes the function/information being displayed
- The relationship between labels and the equipment they refer to should be clear.
- Labels shall be easily read.
- Standard abbreviations should be used where abbreviations are required.

7.7.1.3 Display devices

- Display devices shall be appropriate for the type of information they are presenting. For example, video footage used for the facial identification of people, a resolution display shall be used.
- Display devices shall be grouped logically to improve signal detection. It is recommended that formal task analysis methods be performed to determine the optimum arrangement for displays and their associated controls.
- The relationship between a control and its associated display shall be obvious.
- The operator should be able to easily understand display feedback.
- The response to this feedback should be obvious, wherever possible.
- The control method provided for navigation around displays should be appropriate for the task to be performed.

7.7.2 Steps to Video Wall Design & Installation

The primary purpose of video walls in control rooms is to provide operators with an advanced operating picture for critical real-time situational awareness. This allows the operators to simultaneously monitor information from various sources and provides them with the appropriate tools for intelligent decision-making in response to operational emergency situations. The video wall permits sharing of real-time critical information.

7.7.2.1 Define the Goal

The use:

The video wall shall be used for situational awareness within the Security Control Centre.

The Objective:

The objective is to ascertain a broad overview for all the operators in the Control Centre of the areas of the regions being monitored.

The Content:

Content shall be at least in 4K (3840 pixels × 2160 lines - 8.3 megapixels) and sources shall include satellite TV, internet, video, live stream, presentation etc.

Readability of text:

The readability of text is of high importance and all data shall be readable form anywhere in the control centre.

7.7.2.2 Plan for Content

The video wall intended content should be considered early in the design process. Also, consideration of who and where content shall be updated from. The content shall be updated from the equipment room, within the building, not remotely from outside the building. In other words, the it shall not be possible to change, edit or configure the content remotely.

How the video wall look architecturally within the space shall be also considered during the design process. Consider the size of the space, traffic patterns, ambient light, and the structure needed for support.

7.7.2.3 Consider Ambient Light & Resolution

The type of system is heavily dependent on ambient light. The ability to produce good contrast ratios is vital to the quality of the image. The size of the video wall and the typical viewing distances dictate the desired resolution. Also, the type of content and readability of text at certain sizes dictates the desired resolution.

7.7.2.4 Budget Options & Compromises

When selecting control room technology, the following considerations are important:

- Total cost of ownership with a potential for high return on-investment
- Smallest screen-to-screen gap to provide a visually seamless and high-quality image
- 24/7 operation

- High reliability and minimum downtime
- Life expectancy with cost affective upgrades

The two types of video walls most used in control centres are:

- Ultra-thin-bezel LCD display wall systems
- Rear-projection DLP display wall systems with long-life LED light sources

Liquid crystal display (LCD)

Liquid crystal display (LCD) is a digital display technology that produces images on a surface by shining light through liquid crystals and coloured filters. There are many HD screen sizes that are now available for control room applications. Thin-bezel LCDs have been increasingly used where space and budget are limited although the system is not recommended for 24/7 operations, especially with static data or graphics displayed for extended periods. These displays are not warranted for 24/7 but rather for 20/7 applications.

The justified the use of thin-bezel LCD technology are due to:

- Lower cost of hardware procurement.
- Savings of real estate in the control centre.

Thin-bezel LCDs possess a significant screen-to-screen gap (as much as 5,7 mm).

Rear-projection DLP cubes

Rear projection technology produces images by means of a projector. Screen sizes range from 127 mm to 203 cm (diagonally). There are also a wide variety of resolutions and aspect ratios available. LEDs are now used as the new light source for DLP cubes. DLP cubes has a life expectancy of 60,000 to 100,000hr.

Rear projection is the preferred technology used in control centres due to its high reliability, no image retention, long life, and seamless design. Rear-projection LED is the technology of choice for mission-critical 24/7 applications.

A direct comparison: LCD video walls vs. DLP video walls

Burn-in or image retention:

LCDs are prone to image retention or burn-in. Most LCD manufacturers do not warrant their panels against image retention when used in a 24/7 environment therefore rated for no more than 20/7 operations.

Non-upgradable technology versus upgradable technology:

LCD technology cannot be upgraded, and once image retention occurs, it cannot be repaired. If a faulty unit needs to be replaced and the identical replacement may not be available when required. LED Rear-projection DLP cubes are repairable and technologically upgradable. Therefore, cubes can be simply upgraded to a higher resolution engine or to the latest light source technology without replacing the cabinet and screen structure with no or very little downtime.

Repairs

LCD display wall panels cannot be repaired on site. DLP cubes can be repaired easily and quickly with on-site spare parts, without disturbing the display area.

Screen-to-screen gap:

LCD display wall panel for control room applications have a screen-to-screen gap of 3,5 mm to 5,7 mm. DLP cubes have no bezels and screen-to-screen gaps from 0.2 mm – 1.5 mm depending on whether the

cubes are rear or front serviceable. It has approximately 60 percent smaller than the screen-to-screen gap of LCD display video wall systems.

Brightness and colour balance:

Although some of the newer LCD displays offer an “optional” colour calibration solution to ensure colour uniformity across individual and multiple screens, this system is typically employed during installation on a one-time basis. The system makes no provision for the colour or brightness uniformity over extended periods of operation. Credible manufacturers offer DLP Display Wall Engines which employ unique built-in circuits to ensure brightness and colour uniformity across the entire display wall image.

Resolution:

Currently, the resolution of the LCD display wall panel is fixed on high definition. This is standard and cannot be upgraded without replacing the entire array of displays when newer resolutions become available. LED DLP display wall cubes can be upgraded from XGA to SXGA+ within the same cabinet and screen structure by simply replacing the engine. The same applies to the upgrading of the DLP light sources.

Duty cycle/ anticipated life:

LCD displays are rated with up to 60,000 hours backlight life. However, no system Mean Time Between Failures (MTBF) is normally published by manufacturers for the device, which is a better indication of how long the unit is likely to last. DLP manufacturers, for example clearly list anticipated life of all major components, viz:

- Fans are designed with an anticipated life of 100,000 hours (eleven+ years)
- LED modules are designed with an anticipated life of minimum 80,000 hours (nine+ years) in normal operations

Response time:

Response time or latency indicates how fast the monitor can display moving images. Should it be too slow, the display’s pixels won’t keep up with the information sent from the computer’s graphics card, resulting in digital noise and/or ghosting. The response time of LCD displays is rated at 8 milliseconds. DLP technology has a response time of approximately 8 microseconds. That is 1000 times faster.

Power consumption:

DLP cubes have a lower power consumption and lower heat dissipation when compared to LCD displays resulting into reduced electricity usage.

7.7.2.5

7.7.2.6 Select a physical location for the Audio Visual (AV) Equipment Rack(s)

Plan for 2-4 equipment racks depending on the size of the video wall. Ideally, these should be located within 60 m of the video wall, in a dust-free environment with access to the front and back of the racks for maintenance.

7.7.2.7 Plan for Power

Video walls can require AC power at the displays and/or just at the equipment rack area. The conduit pathways between the equipment racks and the displays are crucial for installation and long term serviceability and upgradability.

7.7.2.8 Plan for Ventilation

Displays are designed to take in fresh air and exhaust hot air to keep the electronics from overheating. If it is to be flush mounted within an enclosure then provision shall be made for adequate ventilation.

7.7.2.9 Measurements

It is important to measure the mounting surface which the video wall will be attached by using laser tools to determine if it is level and flat is necessary. Most walls are not and shall require evaluation of each mounting point, shimming, and adjustment to ensure the multiple displays create a perfectly smooth surface.

7.7.2.10 Consider Control

Two control panels shall be installed. A version for users with on/off and basic capabilities and an operator version for technical users to monitor and control much more.

7.7.2.10.1 Video Wall Requirements

The Video Wall shall comply to the following requirements:

a. Push / Pull data

   Requirement to control multiple display areas from multiple control points

b. Ability to handle various input types

   Direct Digital (DVI/HDMI), IP Based / RTSP H.264 Cameras/IP Video, Network capture (VNC/RDP), Audio

c. Utilise existing network infrastructure

   No additional AV cabling

d. 4K and beyond

   H.264 running at 4K, what about greater than 4K

e. Same information

   Connected data should be available across all control points

f. Same time

   Information should flow across control points and be available at the same time

g. Multiple locations

   Data not limited to single display areas, have the ability to display in multiple locations

7.7.3 Video Wall Content

The Video Wall should be planed for, during the design process. It shall support the functional requirements of the SCC. The design should incorporate all ergonomic design principles to ensure ease of use for all end users. Figure 2, below illustrates a suggested layout of the required content. The figure is just a suggestion of what the final Video Wall layout design should look like and by no means is meant to be exhaustive of what may be required. During final design, care must be taken into identifying the information required for efficient operation. The content needs to aligned to the SOPs that still needs to be developed.

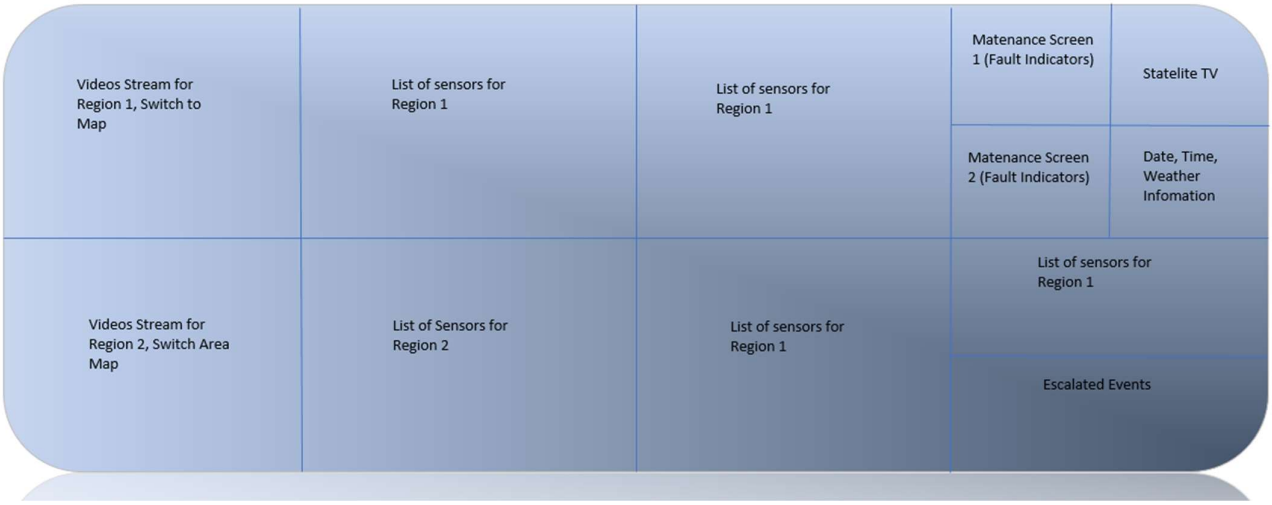


Figure 3: Suggested Video Wall Content

The content shall be flexible in terms of layout. It should be possible to rearrange, add and delete layout as the need arises. Access to change the layout shall be restricted to certain end users. Data from the Video Wall to the Operator Workstations should be easily interchangeable ("push and pull data").

7.7.4 Work Flow Management (WFM)

The Work Flow Management system shall be part of the PSIM software and should support the following functionalities hereunder. For more detail see Ref **Error! Reference source not found.**.

7.7.4.1 The system should have the following capabilities:

- **Workflow Modelling**

Workflow modelling language shall to be able to model both control and data flows. Workflows shall have an automated component and man-in-the-loop components.

- **Workflow Enactment**

A workflow enactment service provides the runtime environment that takes care of the control and execution of the case based workflows. With a workflow enactment service and the defined workflows, highly automated business processes can be deployed with a minimum of human interaction involved

- **Invoke applications**

Some tasks defined in workflows need to invoke external applications to accomplish business processes. According to the Workflow Reference Model, a workflow engine should provide sufficient logic to understand how to invoke potential external applications which might exist in a heterogeneous environment.

- **XQuery support**

Capable of manipulating XML data

- **XML Database support**

Data handled in the WFM framework is mainly wrapped in XML format, the database should to allow data to be stored in XML format.

7.7.4.2 Workflow Management Concept

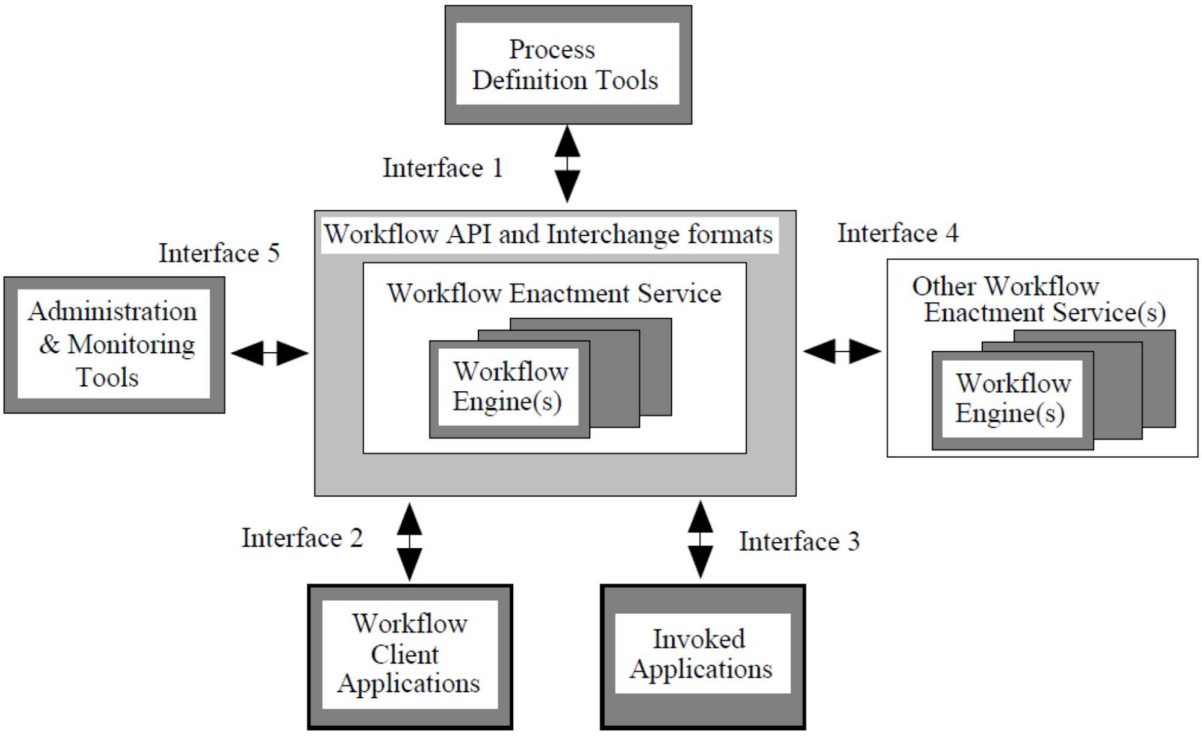


Figure 4: Workflow Reference Model

Workflow Engine is a software service that provides the runtime execution environment for a workflow instance.

Workflow Enactment Service consists of one or more workflow engines and is responsible for creating, managing and executing workflow instances. The workflow engines that belong to a workflow enactment service may be deployed in a centralized or distributed manner.

Process Definition Tools are able to analyse, model, describe and document a business process. These tools may support various workflow modelling languages. The final output of the process definition tools is a process definition which can be interpreted at runtime by the workflow engine(s) within the enactment service.

Workflow Client Applications (also referred as worklist handlers) are software entities which interact with the end-user in those activities which require involve human resources.

Invoked Applications are any applications, programs or services which should be called and invoked in the workflows. The invoked application may be local to the workflow engine, co-resident on the same platform or located on a separate, network accessible platform. For instance, the web services that are involved in the process are invoked applications. Another such interaction shall be the fit-for-duty database.

Administration & Monitoring tools are created for management and control beyond the workflow engines. These tools are used to register the progress of workflow cases and to detect bottlenecks.

Interface 1 is responsible for the exchange of workflow definitions between process definition tools and workflow engines. A universal interchange format for the process definition is required.

Interface 2 was developed to facilitate Workflow Client Application integration with different workflow engines.

Interface 3 copes with the interaction between invoked applications and workflow engines. It is implemented according to the access mechanisms of the invoked applications.

Interface 4 supports workflow interoperability models and the corresponding standards for interworking between multiple workflow enactment services.

7.7.4.3 Control Centre Workflows

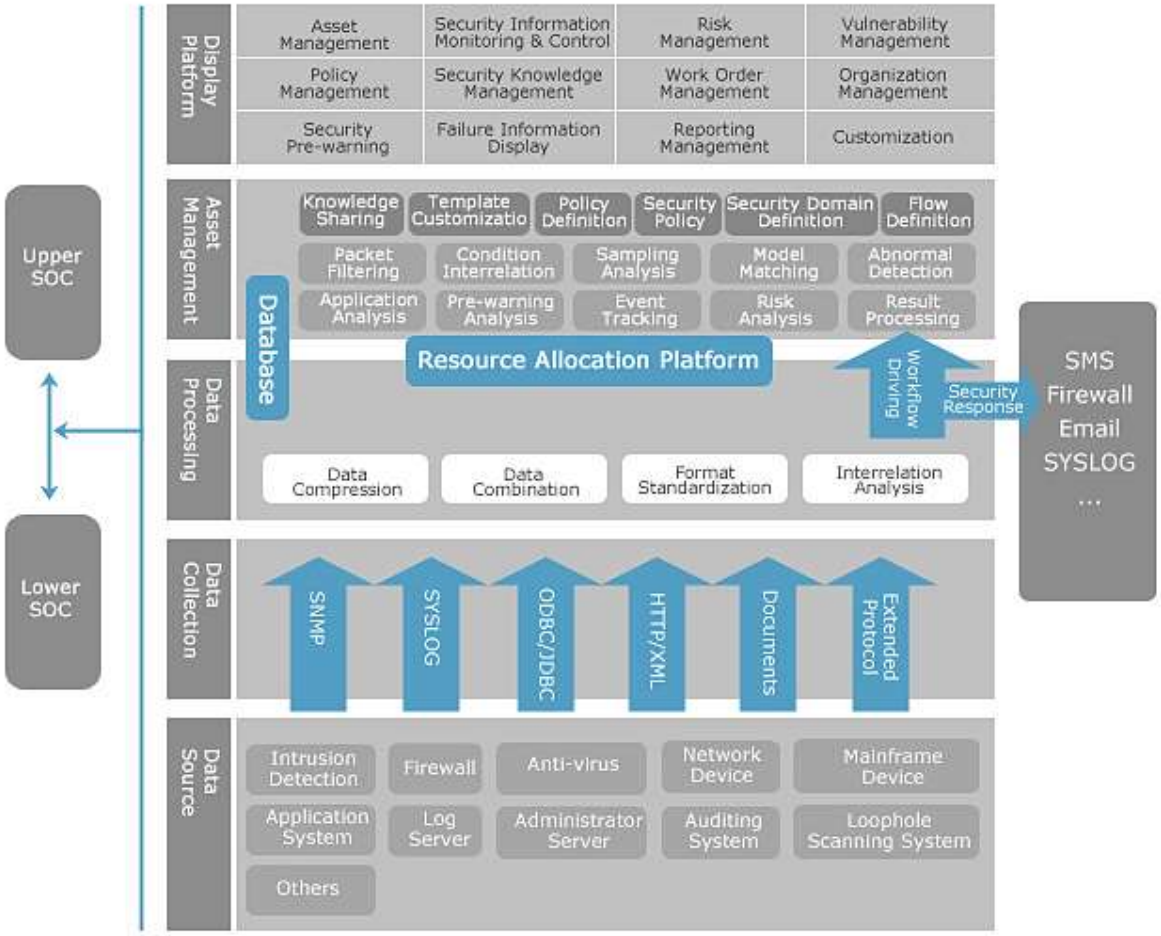


Figure 5: Control Centre Workflow

In general, security control centres data architecture shall be composed of four layers inclusive of data collection, data processing, application service, and display platform.

Data collection: Security information shall be collected from different data sources including network devices, security equipment and host systems according to specific requirements.

Data processing: This function shall be designed to carry out analysis of the collected security information, perform standardized formatting, and to store it into the database after data combination and compression according to the individual policies.

Application service: This layer shall be able to collect information from the database to carry out a data filtering and condition analysis according to established policies, providing data support for the display platform; moreover, it shall also serve as an interface for resource configuration of the display platform.

Display platform: This layer realises all functions of security monitoring, maintenance, management and display through a uniform Graphic User Interface (GUI).

7.7.4.4 Local or regional security operator interfaces (SSCC/ RSCC)

The functional interaction between the operator and the security system is described hereunder. In essence, the security operator and the security system shall interact in the following ways –

- The operators in the security control centre shall have full control over the PTZ camera units, as well as have access to a public address (PA) system and outdoor lights installed at the site. This will enable the operator to obtain visuals of an intruder, as well as provide the operator a means of responding to an incident with the PA system and lighting.
- A 'maintenance' overview of the security system's health shall show which detectors/cameras are believed to be functional. This would highlight system weaknesses that may require temporary interventions. (This in addition to the engineering and maintenance interfaces)
- Dynamic lists (logs) of detection incidents and occurrences shall be available as they unfold, even if they do not satisfy alarm criteria, which can become a daily report on sensors that must be checked for interference or maintenance.
- A 'black-screen' philosophy shall apply to monitoring systems, which makes it very evident when the system creates an alarm. On detecting an incident all available images of the incident shall be displayed with a current/historic perspective. It is expected that the operator must then classify the incident as an event-type from a drop-down list, which creates a SOP workflow. A feature shall be provided whereby subsequent events can be associated to a primary event to accumulate an event time-line as a single case evidence library.
- Upon classification of an event, or as a simple list lookup, the operator shall be able to select SOPs for event types, or contact numbers of emergency responders, managers on duty or secondary responders.
- The system shall allow for the operator to add operator comments linked to real events to add to the incident information.
- The operator shall be able to select any camera to display and control the PTZ cameras. The system shall be configured to a mode which selects whether the operator has preference, or the system has preference in order to target new 'incidents'.
- The operator may select a map-view of the facility. The map (GUI) shall indicate the status of detectors/cameras in available, unavailable, trigger & alarm status. The map shall be able to zoom and pan, and detector type selected or unselected for display. On high enough zoom, or on selection, a sensor's tag shall be displayed. On further selection the data associated with the sensor shall be displayed, e.g. in the case of a camera its current image. This map-view shall enable the operator to rapidly assess the status of a sector, or the real threat in a multi-point diverting attack, to manage the response.
- The operator shall be able to configure what must be displayed on the screens assigned to him.
- The operator shall be able to manually escalate events, or request help in managing events. The screen design shall allow for coordination between multiple operators to manage the unfolding events, and handing over elements of the event. The coordination shall be through information on the GUI and internet-phone (PA system), supplemented by text messages and radio and conventional phones.
- The operator shall be able to provide remote access to unmanned sites, using identification procedures prescribed in a procedure. The user may have to scan at a biometric reader and present an ID to a camera to support the process.
- The operator shall be able to control remote emergency gate/door override functions as well as lockdown functions.

Other functions performed by the Security Reception–
- Visitor and contractor registration, as well as access card anomalies at manned sites.
- Guard-gate procedure interaction for vehicle entry.
- Key system, ceremony, and other.
- Security room functions; front desk, interview room, meeting rooms, mail and delivery rooms,
- Containers: SSEC containers, safes, vaults.

Guard Patrol Interfaces –
If the security manager wishes to deploy the feature, guard patrol routes and rules can be defined. The system can order a patrol along one of the pre-selected routes based on the rules. The system will then track the patrol's progress as the guard completes the route, 'reporting' in at access control or with a GPS tracker. The system could create an operator alert if the patrol is overdue at a control point, thereby ensuring that the route is completed as specified and that the guard is being protected by automated oversight.

Guard interfaces (No local SSCC) -
The security guard interacts with the security system using readers and buttons, and will receive instructions from the remote RSCC using the VOIP intercom or the other means of communication provided. He will not have the benefit of a system GUI interface, but the RSCC will be able to monitor the guard using the site cameras. The security guard interacts with the security system in the following ways –
- The guard shall interact with arriving visitors using the VOIP intercom. Using his access card, the guard can activate the buttons that open the sally port for vehicle or pedestrian entry of exit.
- The guard will complete patrols, and confirm progress by reporting at patrol readers. If the guard requires entry to patrol inside buildings, his card will be authorised for these buildings (with or without time restrictions) and this authorisation will deactivate certain sensors on entry.
- The guard shall control temporary visitor cards which are remotely activated and deactivated.

7.7.4.5 Site operations interfaces (Site Technical Operations Manager)

A video display of the security alarm log and alarm map shall be transmitted to the local Technical Operations Control Room. (Note – not the Security Control Centre or switching room) Only the NKP transmission stations would typically have this local operations control facility. The objective of this shared view is to allow the Eskom site operations manager insight into the security status. The security GUI would make the location and status of ongoing events clear. This will allow the manager to assess whether or not to redirect operational staff away from the event location, or to instruct the pro-active steps deemed necessary in his sphere of command (e.g. control room lock-down). This is an informational display with no command and control functionality. Communication would be by phone.

7.7.4.6 Regional security operator interfaces (Additional RSCC functions)

The Regional Security Control Centre will perform command and control functions for all sites in the region, but it will also have operators dedicated to overseeing unmanned sites. All the features described in 7.6.5.1 will be available to the operator at the Regional Control Centre for the substation is assigned to him. The command strategy is that all events are normally classified and responded to at the Control Centre assigned the facility. Events will typically only be escalated to the RSCC if a SSCC is overwhelmed with activity and requests or is assigned support, or when the scenario becomes serious enough for a remote commander to assume direct control.

The following section describes the interaction that exists for the command and control function:

The RSCC shall receive an escalation notification from a manned site control centre if a) the site operator requests support or escalation, or b) the site operator does not respond to an alarm in a predetermined period and the incident is automatically escalated by PSIM. If the SSCC operator requests support, a geographical sector or an event can be handed over to the RSCC operator to monitor, or to track an ongoing incidents and event(s). The operators at the SSCC and RSCC will coordinate their efforts to prioritise responses, and to manage converging events. Despite two operators now tracking the event, the recorded video and decisions will be assigned by the event tag, and will be collated in one evidence folder and logged correctly in the appropriate electronic Incident Log. The ability to call in support increases the capacity of the site to respond to multiple and complex events.

If the security system automatically escalates an incident, it infers that the site operator was incapacitated, overwhelmed or left his post. The RSCC operator then ensures that the incident receives the appropriate attention, even if it is simply classifying the incident as a nuisance occurrence. It ensures that real threats do not go without response. Humans do need to go to the bathroom or get distracted, sometimes at inconvenient times, and this backup mechanism creates another level of defence. A special case of this is where the SSCC is vacated due to the intense threat level. In this case the RSCC takes full control with a hand-over procedure and the system operates as if there is no SSCC.

The recording of the event data shall always be done at the Substation security equipment room, and will store the high-definition evidence that can be uploaded after the fact. Real-time data must be transmitted for situational assessment, and if the available bandwidth becomes a constraint, the data load of multi-video displays shall be reduced by changing the compression, the resolution and the refresh rate. Only the data associated with incidents and events shall be replicated to the RSCC storage to ensure that a remote backup copy exists. If more information is needed data-mining can be done by NSCC business intelligence by directly addressing the source database at each site, as a low or standard priority request.

7.7.5 Alarm Management

The EEMUA 191 standard Ref [8] shall be used when designing the alarm management system. The standard has become the globally accepted and leading guide to good practice for alarm management. It gives comprehensive guidance on designing, managing and procuring an effective alarm system. Following the guidance in EEMUA 191 should result in better alarm systems that are more usable and that result in safer and more cost-efficient industrial operations. EEMUA 191 covers the aspects of alarm system life cycle and above standards deal with environment and human computer interaction issues.

Incidents notification shall be identified and classified into two categories:

- Nuisance Incident/Alarm
- Event

Nuisance incident shall be automatically logged but no response by an Operator other that classifying it as such is required, with the option of a note that is then entered as part of the ELB.

An Incident that is an Event shall be classified into an Event-type from a drop-down list. A feature shall be provided whereby subsequent Events can be linked to the current Event in a drag-&-drop type feature to accumulate in one Event time-line.

The Operator shall then access the applicable SOP for the Event type, which shall contain action steps and contact numbers of emergency responders, managers on duty or secondary responders, etc.

The Operator shall be able to add comments linked to Events for information purposes, which become part of the event record and the ELB record.

The Operator shall be able to select any camera to view. The Operator shall also select and drive any PTZ camera associated with sites allocated to his workstation.

The Operator shall be able to select a map of the facility. The map shall indicate the status of detectors/cameras in available, unavailable, trigger & alarm status. The map shall be able to zoom and pan, and detector type selected or unselected. On high enough zoom, or on selection, a sensor's tag must be displayed. The associated sensors' data/image or video shall be displayed when the device is selected.

The Operator shall be able to configure by dragging and dropping what must be displayed across multiple screens.

The Operator shall be able to escalate Events, or request help in managing simultaneous Events.

The supervisor shall monitor workload, and be able to re-assign events and sites between workstations. The SCC shall have event-routing in an automated mode, or based on supervisor assigned sites/sectors to workstations.

As a first response, the operator must acknowledge the incident notification. The urgency class of the incident determines the time permitted for the incident to be acknowledged before escalation. If a new incident is grouped with an ongoing event, it is considered acknowledged by association. If it is not acknowledged in the time allowed, it is automatically escalated to the Regional Security Control Centre for further processing.

After acknowledging the incident notification, the operator can view the evidence that the system presents, and display the different videos or data on the screens available to him. When he draws a conclusion, he assigns it an incident classification from the dropdown menu. If it is a 'real' event, the appropriate SOP defining the required actions shall be displayed. From this point forward, if the operator moves between events, the appropriate SOP and responder information relating to the selected event shall be displayed. He can continue to tick off the SOP steps completed to ensure he has effective place-keeping for each event. If the event is handed over, the new operator will be able to see what steps have been completed. Once the operator believes the event is over, he can add final comments and close out the event. The notes relating to events and incidents shall become part of the event record, as well as the site electronic incident logbook. These documents may be revisited[3] to add additional information, such as offsite outcomes, police report references, etc.

The alarm management system shall be an integral part of the Work Flow Management software. The Management of Alarms within the Control Centre should follow the tables below: The following tables are not finalised and will be revised in further iterations.

[3] To support the evidentiary process, entries are tagged with an identifier linked to a person. No entries can be deleted. A subsequent entry can strike out an earlier entry, but a record of every entry shall be kept.

Security Use Cases	Primary Data Source	Alert Criteria	Action
Intruder at perimeter	PSIM, Video detection.	Video + sensor detection	Alarm displayed in appropriate workstation. Follow SOP.
Intruder at access controlled entrance	PSIM, IAC, Video detection	Sensor tection	Alarm at Security Operator Workstation. Verification via CCTV
Intruder at remote site perimeter	PSIM, Video surveillance and IAC	Video + sensor detection	Alarm displayed in appropriate workstation. Follow SOP.
Intruder at access controlled entrance at remote site	PSIM, IAC	Sensor detection	Alarm at Security Operator Workstation. Verification via CCTV
Unauthorised vehicle entrance at site access gate	PSIM, IAC, Escalated communication/alarm from site security	Video, Site security triggered alarm	Alarm displayed in appropriate workstation. Follow SOP.
Unauthorised remote access	VPN, Applications	Successful VPN authentication from a non-domain member	Display in analyst active channel/Page network team
Fire at Control Centre	Fire detection system	Audible Alarm + Indication	Alarm at Security Operator Workstation. Verification via CCTV, if possible. Follow SOP for evacuation.
Protentional sabotage	Wide area surveillance cameras	Video stream of event + operators' conclusion based on site security rules	Notfifcation of local security personnel, escalate to RSSCC if required/applicable.

Table 8: Security Use Cases

Maintenance Use Cases	Primary Data Source	Alert Criteria	Action
Camera Fault	Camera, PSIM	Unclear or no Visual	Alarm displayed at the maintenance operator's workstation. Follow procedure for repairs
Sensor Fault	Sensor, PSIM	Sensor malfunction	Alarm displayed at the maintenance operator's

			workstation. Follow procedure for repairs
Software Fault	PSIM	Software malfunction	Alarm displayed at the maintenance operator's workstation. Follow procedure for repairs
Fault due to sabotage taking place	PSIM, Sensor, Camera	Sensor and/ Camera malfunction. Security operator's confirmation	No action immediately until the event has passed. Then only the necessary procedure for repairs shall follow. For example, logging of fault onto the maintenance register.

Table 9: Maintenance Use Cases

Admin Use Cases	Primary Data Source	Alert Criteria	Action
New Employee Access	PSIM	New Employee needs Access/HR	Manager add employee to system. Follow SOP
Remove Employee Access	PSIM	Employee does not need Access/HR	Manager delete employee from system. Follow SOP
Contractor Needs Limited Access	PSIM	Maintenance Schedule	Manager add contractor to system. Follow SOP
Time and attendance	PSIM	Human resources or Line manager	Time and attendance register for the employee is filtered and saved or printed.

Table 10: Administrative Use Cases

7.7.5.1 Audible Alarms

The design of the alarm system should prevent masking and flooding of alarms. Masking is where one alarm noise masks a similar sounding alarm preventing the operator from detecting the signal. Flooding happens when a system alarms which has a 'knock on' effect on other related systems, the result of which is the triggering of myriad other alarms - flooding the control room with sound. The design shall comply to EEMUA 191, Ref [8]

- All employees on site should know what each alarm means and what the required response is, if the cause of the alarm has the potential to affect them. For example, all employees should be able to distinguish between a Local Site alarm and a PSIM alarm.
- All notifications should be classed and graded, and if common-cause, grouped. Different acknowledgement periods are allowed for each class of notification before escalation.

- An alarm should reset automatically if the fault that generated it is rectified and logged.
- Alarm messages shall be presented in a standard format, based upon defined conventions.
- Alarm messages shall clearly inform the operator of the reason for the alarm.
- Following an alarm, the response required by the operator shall be clear by means of an automated SOP.
- The coding of alarms shall not be based purely on colour Alarm signals shall be at least 10 dB(A) over the background noise of the control room.
- Alarms shall not prevent effective communication within the control room.
- An alarm log should be provided to for diagnostic purposes. It shall be included in the site ELB.

7.7.6 Security & access

Access control for the Control Centre shall comply to the IAC Specification, Ref [74] and the Generic Specification for Office Blocks Buildings and Campuses Ref [70].

Security and controlled access to the Control Room shall be considered as part of the overall design. The security should encompass aspects such as: Closed circuit television for monitoring and recording security around access and movement within and around the building. Access control and the rolling out of access permissions. Building hardening and the use of service portals to compromise the SCCs function.

- The following are the access points relevant to the Control Centre:
- Main reception area
- Main door (access to the control room)
- Equipment room
- HVAC room
- Emergency exits
- Maintenance room
- Emergency Preparedness (EP) room
- Staff entrance

It is recommended that the different functional areas and individuals receive variations of specific access permissions within the SCC.

This will prevent unauthorized personnel from access and disruption of the control room environment, or getting access to auxiliary rooms in which they perform no function.

7.7.7 Power and Emergency power supply

Power requirements shall comply to document EPSUIP Task 606 Power Distribution and backup power

There is a requirement for an emergency power supply to support the SCC. An Uninterrupted Power Supply (UPS) shall be mandatory for computerized alarm systems. A UPS shall be provided as part of building services, with space provided as part of the building's mechanical/electrical room. Alternatively, a UPS could be provided as part of the alarm system, with space being provided in the equipment room.

7.7.8 Electrical and data cabling and routing

All Cabling shall comply to the following:

- SANS 1507: Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V), Ref [34]
- 240-56063805: LV Power and Control Cable with Rated Voltage, Ref [45] NWS 1525: Control and instrumentation cables for power stations, [65]

The raised floor design in the Control Room enables the use of the plenum under raised floor for cable routing. Operator consoles will be designed to operate equipment remotely from the control room. Consideration needs to be given to the appropriate cable routing to the various operational areas.

The following are the cable routing recommendations:

All cables shall be run under the raised floor following specific easy to access routes under the raised floor, directly to the console positions. The cables shall enter the consoles directly through core-drills or other openings in the raised floor panels, located directly under the console structures (not visible). An alternative is to use overhead ducts if raised flooring is not an option (Note that this is not the preferred method). This shall not be acceptable for RSCC or NSCC.

- Cable routing shall maintain a separation between power and data of at least 150mm.
- All cable routing shall be in dedicated cable trays elevated above the concrete slab.
- Where possible, dedicated cable raceways shall be provided to each operator position and will be appropriately identified.
- A modular power distribution system within the operator consoles is recommended. It shall be capable of distributing up to 3 dedicated 20A circuits with separate circuit control at the console position. The power distribution system shall be certified and shall utilise a quick connect system. These plug points shall be fed from one circuit to ensure that any faults on the workstation does not result in a trip at other non-affected workstations.

Installation of cables and cable racks shall conform to the Installation of Cables and Cable Racks at Power Stations, NWS 1527, Ref [66].

7.7.9 Lighting design

Control Room Lighting shall comply to Statutory regulations, SANS 10114-1, Interior Lighting, Part 1: Artificial Lighting, Ref [26]

All emergency lighting requirements shall comply to SANS 10114-2 - Interior Lighting Part 2: Emergency lighting, Ref [27].

7.7.9.1 The following are the general lighting recommendations in terms of standards and best practices:

- According to best practice; luminance levels on work surfaces where paperwork is undertaken should be “maintained” at a level of 200 lux to 750 lux (20-foot candles to 75-foot candles), with an upper limit of 500 lux (50-foot candles), where various wattage units are used; this can be a combination of ambient and task lighting.
- In the modern control room environments, it is recommended that light intensity at the operator control console is designed to meet the minimum of 630 lux as stipulated in SANS 10114-1.

- Dimming should be provided with a lower limit of “maintained” 200 lux (20-foot candles), on the work surface at all times.
- Electric lighting should achieve a glare index (UGR) (Unified Glare rating) of 19 or less for all work positions.
- Lamps with a general colour-rendering index of 85 to 90 should be used.
- High-frequency control gear should be used to avoid flicker with use of LED fixtures.

7.7.9.2 The following are some general recommendations:

- The overall room lighting shall be achieved using indirect ceiling mounted fixtures.
- The room lighting shall be dimmable, thus allowing the optimum adjustment depending on desired conditions.
- The overall room lighting shall be supplemented by individual task lighting located on the operator positions.
- The location of the ceiling lighting fixtures shall be based on the reflected ceiling.
- indirect fixtures shall be used to reduce glare and provide consistent ambient light.
- A proposed lighting plan will only be done after as part of the final detailed design after the layout has been approved.

7.7.10 HVAC System

HVAC Systems shall comply to 240-56355808 Ergonomic Design of Power Station Control Suites Guideline, Ref [46] paragraph 3.3.5.2. The HVAC System shall be designed for 50 % redundancy.

7.7.11 Fire Protection

The Control Suite shall comply to SANS 10139 Fire detection and alarms for buildings, Ref [28]. Consideration shall be given to equipment that can be damaged by water.

Any fire alarms shall be locally monitored within the Control Centre.

7.7.12 Emergency Preparedness Room (EP Room)

All Control Centres shall have an EP Room for escalated emergency events. The EP room shall be equipped with conferencing facilities and have access to satellite TV. Clear view of the Video wall from the EP Room is necessary. The EP Room may be on a raised floor level to allow for clear visibility of the video wall or the content of the video wall can be projected in the EP room with a video projector/display.

The EP Room shall have the following capabilities:

1. A link for Laptop presentations (with Audio) via video display/projector
2. DSTV Viewing via video display/projector
3. Video Conferencing
4. Audio Conferencing

5. Sending of Video conferences to the main video wall from this venue
6. Audio and Video Switching
7. Control of the electric frosted glass between the EP room and the main control.
8. Control of motorised curtains, as an alternative to the electric frosted glass interface.
9. End user control via an integrated control system to include, source, switching, volume control, channel selection on DSTV, frosted glass and curtain control, sending of video conferencing content to the video wall and digital signage system.

7.7.12.1 EP Room Display

The display shall be at least 4K display that is large enough for the room based on ergonomic design principles. The Screen shall be wall mounted at the front of the room and shall provide high quality image in the high lighting levels required for video conferencing.

7.7.12.1.1 Communiction

The EP room shall have access to the IPBX communication network. Radio as well any satellite communication may also be used as back-up.

7.7.13 Access Control

Access control for the EP room shall be adhered to as per the IAC Specification, Ref

Access to all critical cable ways, air ventilation systems and all communication systems shall be access controlled. Access control for the Control Centre shall be locally monitored.

7.7.14 Control Centre Communication Room

A equipment room or closet shall be provided for the building's private branch exchange (IP PBX) (usually one per building) and for distribution panels/frames. The distribution panel/frame accommodation provides space for the termination points of all communications cabling on each floor of the building. This includes both interior alarm zone wiring and remote site wiring. Termination points on each floor facilitate cabling changes and maintenance. No accommodation for a IP PBX is required in smaller buildings. Instead, accommodation for a main distribution point is required. These rooms may also be a convenient place to accommodate the data gathering panels for automated or multiplexed alarm systems.

7.7.15 Control Centre Design

7.7.15.1 Designing for all end users

A functional control room should be designed so that it is "fit for purpose". That is; it should meet the requirements for all end users. A functional analysis for all end users should be at the beginning of the design stage. The functional analysis shall include all the anticipated modes for all expected end users:

Steady state operation

Normal transient operation (start-up, shut down)

Emergency/abnormal operation

Maintenance (Scheduled or unscheduled)

List of end users:

Security Manager

Shift Supervisor(s)

Administrator (LAN/PSIM

Control room operator(s)

Support Technician/Engineer, etc

Support staff (Cleaning Services, etc.)

After identifying the end users, then the next step is to determine the potential operational links or interface relationships between the physical functional areas of the facility and the end users. This should be done so that these links are accommodated for, in the development of the conceptual layouts for areas where an end user will reside, for example, the control room. Table 8 below provides an example of the main functions of the spaces inside a control room and their interrelationship (high (H), medium (M), low (L) or none) as rated by the end users

	Area (sq.m)	Function	Control Room	Shift Manager Office	Operator 1 Desk	Operator Desk 2	Tea Room	Pause Room	Store Room	Meeting room
1		Control Room								
2		Shift Manager Office	H							
3		Operator 1 Desk	H	H						
4		Operator Desk 2	H	M	H					
5		Tea Room	M	M	M	M				
6		Pause Room	M	L	M	M	M			
7		Store Room	L	L	L	L	L	L		
8		Meeting room	M	H	M	M	L	L	L	

Table 11: Interface Relationship Matrix for Control Room Building

- H High
- M Medium
- L Low

7.7.15.1.1 Control Room Links

Once links and interfaces are defined and prioritised, a link analyses to begin the process of determining potential locations and layouts should be carried out. A Link Analysis is typically performed to optimise

the layout based on the interface relationship determined for the various end users. An example of the result of such a Link Analysis is depicted in Figure 4. The layout in the figure below is just an illustration of a control centre layout and by no means implies that it is the most efficient layout. There shall be instances where the layout cannot be altered much due to existing building infrastructure at sites. The diagram indicates the method necessary for the determining final layout of a control whether a new build or not.

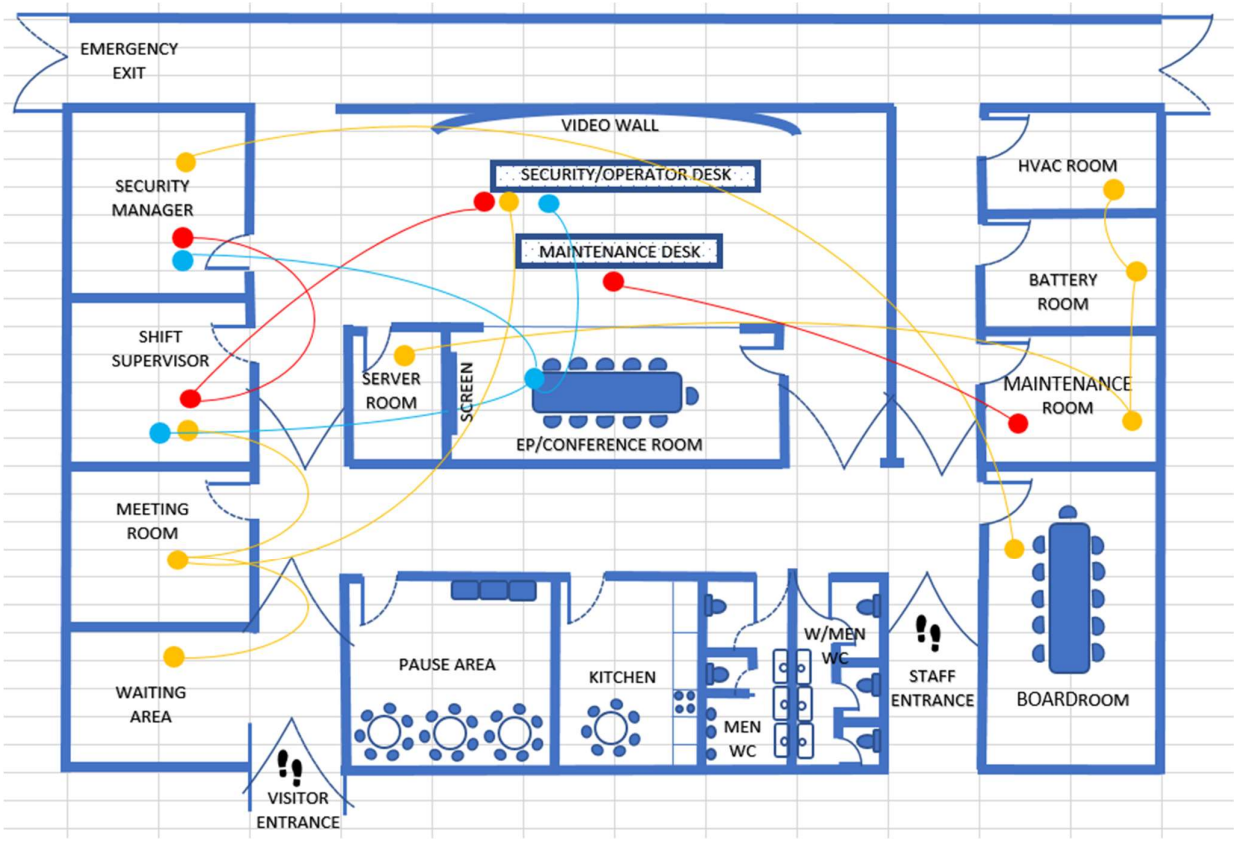


Figure 6: Link Analysis for Control Room Building

High Traffic
Medium Traffic
Low Traffic

7.7.15.1.2 Physical Workspace

7.7.15.1.3 Workstations/Consoles

The Control Centre shall consist of both security operator and maintenance desks. Figure 6 and 7 below show the typical arrangements that can be adopted. The workstation video screens shall operate on a blank screen principle. In other words, these screens shall only display videos only when a fault is alarmed. Work station screens shall be 4K.

a. Security Operator Workstation

Figure 7: Security Operator Workstation

The use of fourth screen in the form of a touch screen tablet shall be provided at each operator desk. Touch screens are to reduce operator error, especially when performing tasks under duress. The content of the touch screen should be to also access SOP's and to perform further action as required.

b. Maintenance Operator Workstation

Figure 8: Maintenance Operator Workstation

If a Video Wall is present, depending on the control room size, it is considered best practice that the video of the alarmed incident be pulled by the operator into the dedicated workstation screen, for further investigation. There shall be a fourth security workstation screen for monitoring of escalated faults from

RSCC's (for example). The recording of escalated faults shall remain on the 3rd screen as for local incident recording.

7.8 CRITICAL SUCCESS FACTORS

7.8.1 Integrated multi-faceted system

It is important that the control room specification is read in conjunction with the associated PSIM [72], IAC [74], Video Surveillance [73] and Power Supply [77] Specification. All interface requirements must be noted and adhered to, to ensure smooth integration of the system.

7.8.2 Existing Buildings

Retrofitting into an old or existing building may pose some difficulties due physical, environmental or legal restraints. It may be necessary to obtain formal authorisation first. This may necessitate a deviation from the ideal design layout This could be time consuming and should be investigated as early as possible prior to project inception.

7.8.3 Scaling

Is should be noted that this document outlines a generic control room design. It is important that the site-specific designs are scaled based on the sites' functional requirements. It also depends on whether the site in question is an old or existing building.

Table 11 should be used when determining the scale of the control centre based on its functions as well other restraints as outlined in the table.

7.9 KEY ASSUMPTIONS

All sites are flexible in terms of remodelling existing buildings and old control centres.

7.10 SYSTEM CONFIGURATION AND MANAGEMENT

System configuration and management shall comply to the following documents:

- Process Control Manual (PCM) for Manage Item Configuration, EMN 32-1286, Ref [57].
- Engineering Change Management Procedure, 240-53114002, Ref [41].
- Transmission and Distribution Engineering Change Management and Critical Asset Classification, 240-114441369, Ref [39].
- Project Engineering Change Management, 240-53114026, Ref [42]

7.11 DRAWINGS AND RELATED DOCUMENTATION

7.11.1 Language

All the documents drawings and labels shall be written in English language.

7.11.2 Units

The International Metric System (SI) shall be used for all physical and electrical units.

7.11.3 Presentation of documents

- The standard sizes of documents will be A0, A1, A2, A3, A4 according to international standard ISO 5457, Ref [37].

7.11.4 Number of copies

7.11.4.1 For documents submitted for approval:

Electronic encrypted files sent by e-mail.

7.11.4.2 For final documents:

7.11.4.2.1 Drawings

- . paper print **2** copies
- . CD rom **2** sets

7.11.4.2.2 Other documents:

- . paper print **2** copies
- . CD rom **2** sets

7.11.4.3 Computer file

. All document shall be provided under Acrobat Recorder (pdf format) File and MicroStation V8 (Dgn format) file

7.11.5 List of final documents

The manufacturer shall provide for review, information the following drawings and documents as a minimum guide. The final requirement shall be set by the contractual requirements.

Description	Review (R) Information (I)	Time schedule (month after order)	Last issue (month after order
- Document list	I	*1*	*3*
- Design and manufacturing schedule	R*	*At order*	
- Technical data schedule	R*	*At order*	
- Material list	I	*1*	
- KKS Labelling Schedule - Structural drawings - Civil drawings - Definitive drawing for civil works			

- Electrical single line drawings - Electrical Schematic diagram - Cable Schedules - Cable Blocks - Plumbing drawings - HVAC drawing and layout - Instrumentation and IT data sheets - Fire protection drawings - Interior architectural drawings - General arrangement drawing (floor space) - External Architectural Drawings - Furniture, console manufacture and installation document - Shop fitting activities document			
- 3d Drawing of the Control Suite - Lighting Schematics - 3d Lighting Model -	R R*	*2*	*3*
Calculations - Lighting Calculations doc - HVAC Calculations doc - UPS Calculations - Battery Design Calculations - Video Wall Sizing calculations doc - Video Wall Layout - Video Wall Wiring Diagram			
- All Equipment Data Sheets			
- Linkage Analysis			
- All Ergonomic drawings and dimensions	R*	*3*	

	R*	*2*	
- Transportation and storage instructions	R*	*2*	*2*
- Packing list	I	*2*	*2*
- Terminals drawings and location	R*	*3*	*3*
- Technical literature on all fitting and accessories with circuit diagrams and connecting diagrams	I	*1*	*3*
- Factory test reports and test certificates of all equipment	R*	…	*At delivery*
- Site erection procedure	I	*2*	*At delivery*
- Operating and maintenance manual	R*	*2*	*At delivery*
- Erection and commissioning manuals	R*	*2*	*At delivery*
- Quality control program (inspection and test procedure and time schedule)	R*	*At order*	

Table 12: List of Final Documents

* Documents subject for penalties (refer to commercial specification)

7.12 DESIGN AND DATA CALCULATION SHEETS

All design, data sheets and calculations and drawing shall be subject to the Eskom's approval process.

No hardware should be ordered or purchased prior to design approval.

1. HVAC

Heat Load and air flow calculations of the HVAC System shall be provided for each HVAC system eg, the control room, equipment room etc. The layout of ducts with supporting calculations required for duct type selected, etc.

2. Lighting

All lighting calculations, load distribution and 3d simulation shall be provided This shall include all emergency lighting. Cable routing drawings shall be provided.

3. Control room linkage analysis
4. UPS design Calculations
5. Size and shape of video wall calculations
6. Battery capacity calculations

7.13 DESIGN CHANGES

- All design changes after approval the Eskom approval process shall comply to the Eskom ECN process as outlined by Process Control Manual (PCM) for Manage Item Configuration, EMN 32-1286 Ref [57].

7.14 VERIFICATION AND VALIDATION

The equipment shall be verified and validated as outlined in the EPSIUP Task 606-298 V&V Procedures Ref [76]

7.14.1 General

The contractor shall be responsible for all quality control including inspection, examination and testing of the equipment.

The contractor shall use as a guide the ISO 9001 and submit to the purchaser its quality plan.

The purchaser shall have the right to conduct surveillance review of quality plans and of the contractor's quality control including witnessing of quality related manufacturing activities at any stage of manufacture.

7.14.2 Inspection

According quality control program handed over by the seller and after purchaser's agreement.

Visual inspection includes checks for satisfactory workmanship, materials, freedom for surface defects, wire checks, painting, dimension accordance and compliance with general specification.

Examination of conformity certificate of materials.

7.14.3 Factory tests

The FAT shall be performed at least one month before delivery to site. As a minimum, the FAT covers the tests recommended in Ref [71]. The FAT program and procedure shall be submitted to Eskom for approval. The Contractor shall provide all test equipment during the FAT.

7.14.4 Site commissioning tests

7.14.4.1 The contractor will give a detailed list of the site test comprising:

- The necessary test equipment list
- The schedule of site commissioning test
- The interpretation of site commissioning test results

7.15 MANUALS

All engineering and training manuals shall be provided to Eskom. All training manuals shall be provided to Eskom for approval 2 months prior to the scheduled training dates.

7.16 TRAINING

Training of personal shall comply with document EPSIUP-606-73-001 PSIUP Training Plan and Philosophy Ref [78].

Practical hands-on training for each individual trainee shall form an integral part of each of the following courses:

7.16.1 Training of technical personnel (3 participants, 5 days minimum)

Training shall be provided for in South Africa before FAT commences. This training shall cover all technical aspects of the individual components of the system as well as the overall system configuration. All study material for the course (e.g. manuals, notes) shall be provided by the Contractor. Details of the course modules and course presenter(s) shall be made available to Eskom one month before the commencement of the course.

7.16.2 Training of security personnel (4 participants, 3 days minimum)

Training of security personnel in the operation of the system. Training shall include operation in the different modes. This training shall cover all operational aspects of the individual components of the system. All study material for the course (e.g. manuals, notes) shall be provided by the Contractor. Details of the course modules and course presenter(s) shall be made available to Eskom one month before the commencement of the course.

7.17 IMPLEMENTATION STRATEGY

Control Centre's should be rolled out in a phased manner as this shall make it possible to filter down lessons learned to the designs to follow. The roll out strategy is outlined in the Deployment Model Ref [68].

7.17.1 Design Scalability

It shall be necessary to scale the design based on physical limitation factors of the site existing infrastructure, site function, data flow, criticality, back up requirements etc.

Table 13 and Table 14 should be considered when determining the scale of design for the National Security Control Centre (NSCC), Back-Up National Security Control Centre (NSCCB) and a Regional Control Centre (RSCC) and Site Security Control Centre (SSCC), with associated EP rooms. Factors to consider are elements such as the layout, video wall, workstations, EP room, HVAC room etc. The assumption made in determining the scale is that all sites are a new build. However, the same may apply to existing sites. Further analysis is required during detail design with more consideration of existing sites and their characteristics.

The table below is currently non-exhaustive and more detail will follow with further iterations

Design Elements	Design Suggestions for Control Centre					Technical Considerations
Components (Hardware/Software)	**NCSSA**	**NCSSB**	**RSCC**	**SSCC**	**SSCC at NKP**	**Comments**
Physical Size (Layout)	Medium	Small or Medium	Large	Small	Small to medium	The size of the control centre shall be determined by its function, the data flow and the number of personnel required

Design Elements	Design Suggestions for Control Centre					Technical Considerations
Components (Hardware/Software)	**NCSSA**	**NCSSB**	**RSCC**	**SSCC**	**SSCC at NKP**	**Comments**
Video Wall	Required	Required	Required	Not Required	Required	The decision of installing a video wall shall be made based on various criteria such as size of the control room, the amount of data and video streams it needs to handle versus the number of personnel.
Video Wall Size	Large	Large	Medium	N/A	Small to Medium	Video wall sizing shall be determined as per paragraph 7.16.2.4. Factors that affect video wall sizing are the size of wall available if it is in an existing building, the number of personal and the ergonomic requirements for viewing distances, angles etc
Workstations for Security Operator	4 screens	4 screens	3 or 4 screens	3 or 4 screens	3 or 4 screens	The number of screens required shall be based on the function of the site. A site that can receive escalated events a should have a fourth screen dedicated for this. A site may also be a required to operate as a back-up site should another fail. A fourth

Design Elements	Design Suggestions for Control Centre					Technical Considerations
Components (Hardware/Software)	**NCSSA**	**NCSSB**	**RSCC**	**SSCC**	**SSCC at NKP**	**Comments**
						screen may be dedicated for this functionality.
Workstations for Maintenance operator	2-3 Screens	2-3 Screens	2-3 Screens	2-3 Screens	2-3 Screens	Screens for Maintenance operators shall be as per paragraph 7.16.8.1.6
EP Room	Required	Required	Required	Required	Required	The EP Room shall be required at all Control Centres.E
HVAC Room	Required	Required	Required	Wall mounted	Required	HVAC Room shall be required at all Control Centres as the Air quality requirements for the Control Centres are specific to the Design and is critical to the functioning of the equipment.
Maintenance Room	Required	Required	As required	Required	Required	Maintenance Room shall only be required at sites that are identified as being the central maintenance provider for a specific area.
Sever Room	Required	Required	Required	In SCC	Required	The server room shall be required at all Control Centres.
Equipment Room	Required	Required	Required	In SCC	Required	
Integrated Access Control (IAC)	Required	Required	Required	Required	Required	IAC shall be installed at all Control Centres and shall be monitored from

Design Elements	Design Suggestions for Control Centre					Technical Considerations
Components (Hardware/Software)	**NCSSA**	**NCSSB**	**RSCC**	**SSCC**	**SSCC at NKP**	**Comments**
						within the Control Room

Table 13: Scalability of Design of a Control Centre

Table 14 should be considered when determining the scale of design for the EP rooms:

Design Elements	Design Suggestions for EP Room					Technical Considerations
Components (Hardware/Software)	**NCSSA**	**NCSSB**	**RSCC**	**SSCC**	**SSCC at NKP**	**Comments**
Physical Size (Layout)	Medium	Small or Medium	Large	Small	Small to medium	The size of the control centre shall be determined by its function, the data flow and the number of personnel required
Video Wall	Required	Required	Required	Not Required	Required	The decision of installing a video wall shall be made based on various criteria such as size of the control room, the amount of data and video streams it needs to handle versus the number of personnel.
Video Wall Size	Large	Large	Medium	N/A	Small to Medium	Video wall sizing shall be determined as per paragraph 7.16.2.4. Factors that affect video wall sizing are the size of wall available if it is in an existing building, the number of personal and the

Design Elements	Design Suggestions for EP Room					Technical Considerations
Components (Hardware/Software)	**NCSSA**	**NCSSB**	**RSCC**	**SSCC**	**SSCC at NKP**	**Comments**
						ergonomic requirements for viewing distances, angles etc
Integrated Access Control (IAC)	Required	Required	Required	Required	Required	IAC shall be installed at all Control Centres and shall be monitored from within the Control Room

Table 14: Scalability of EP Room

7.18 ENGINEERING DESIGN REQUIREMENTS

In this Section, Technological Requirements are outlined.

7.18.1 System general requirements

7.18.1.1 Labelling and Configuration

All, equipment, wiring, cables, panels, etc shall conform to the KKS coding and labelling standards for all hardware and process related equipment.

The following specifications shall be adhered to:

VGB-B 106 B3 E Part B	KKS-Identification Systems for Power Stations, Ref [79]
VGB-B 105 E 5th Edition 10/2003	KKS Identification System for Power Stations, Ref [82]
OPS0014	Eskom KKS Key Part, Ref [80]
N.PSZ 45-45	KKS Key Part- Fossil Power Station, Ref [63].

7.18.1.2 DC and AC supplies to the panels

There are two Power options for the Security equipment; 110V DC and 220V AC.

Power requirements shall comply to EPSIUP Task 606-261 Power Management User Requirement Specification, Ref [77].

The required arrangement for DC supplies is shown in Ref [77] to the Panel Suite. For the purpose DC surge suppression, DC line filters shall be installed in the security panels for the protection of the equipment against spikes. Isolating switches and suitable fuses shall be provided.

A 220V AC, 15A switched socket and 15W, 220V AC compact fluorescent interior light shall be provided for each panel. The socket shall be connected to an earth leakage protection device within the panel. This earth leakage protection unit shall be rated at 30 A with 30 mA earth fault sensitivity. The light shall be controlled by a door operated switch. The earth leakage protection unit and the door-operated switch shall be wired to the panel supply terminals.

A 110V DC supply shall be provided for the security system from a redundant external battery/battery charger system.

The equipment shall be able to withstand 12% ripple on the DC supply voltage with redundant internal auxiliary DC supplies to the electronic units. Should the one or both of the internal auxiliary supplies fail the relay shall not lose the saved data or set files.

DC fail relays shall be provided to monitor the 110V DC supply of the Main 1 and 2 (only if redundancy is required) security panels.

7.18.1.3 Time synchronisation

The Contractor shall provide a means for time synchronising to the security cabinet. With GPS based master station provided by Eskom. The Contractor's interface requirements to the GPS based master station shall be provided to Eskom.

Best practices for the use of video surveillance published by The Scientific Working Group for Imaging Technology (SWGIT) as Recommendations and Guidelines for the Use of CCTV in Security Systems for Commercial Institutions. For security system data to hold up in a court of law, it must demonstrate the ability to accurately re-create the events surrounding a particular action. Accurate time stamping is essential for event reconstruction. The SWGIT recommendations specify the use of Network Time Protocol (NTP) for IP-based systems and GPS-based timing equipment as an industry-standard time synchronization method.

7.18.1.4 Panels (swing frame units) and accessories:

The Main 1 and Main 2 (If redundancy is required) security cabinets/panels shall be designed to accommodate flush mounted equipment housed in 19-inch type racks (where possible) on the front swing frame.

A back-swing frame shall be provided to allow access from the back of the panel to the plant interface terminals.

Epoxy resin powder coating system applied by electrostatic process in accordance with the coating manufacturer's proprietary procedure to a nominal thickness of 80 micrometres.

The Contractor shall determine the method used for cleaning the substrate and the need to prime the substrate prior to the application of the powder coating. The Contractor specifies the method and materials to be used for repair procedures. Refer Paragraph 3.7.8 of Specification for CCTV Surveillance with Intruder Detection, Doc ID 240-9119034, Ref [55].

7.18.1.5 Minimum Wiring requirements and wiring identification

All current and voltage transformer circuits shall be wired with colour coded multi-strand 2,5mm² PVC wire. The voltage drop for control and voltage transformer circuits shall not exceed 1.5% under any condition.

The AC circuits shall be wired with multi-strand 2.5mm² black PVC wire and DC panel wiring and bus wiring shall be wired with 1.5mm² grey multi-strand PVC wire.

For easy wiring code identification wire colours shall be as follows:

• Black for AC circuits

• Grey for DC circuits

• Power circuit wiring shall be coloured as per the phase - red, white, blue and black (neutral).

Bus wiring is terminated on one side of the terminals only. This leaves one side of the terminals free for individual panel use only. Where more than two wires are required to be connected on the bus wiring side of the terminal, an extra set of terminals shall be placed next to the first two, with bridge pieces to provide connection points.

Alphanumeric codes shall ensure that all cable cores and wires shall be unambiguously identified. Wiring ferrules shall be suitable for affixing to the cable cores and wires.

Ferrules with wire identification numbers shall read from left to right (the right way up) on vertical terminal strips and from top to bottom.

Stripping of insulation shall be carried out in such a way that conductors are not damaged. The stripping tool shall be of the type that permits the length of the strip to be pre-set.

The crimping tool does not release the termination during normal operating until the crimp is correctly formed. The crimping tool shall be regularly inspected for correctly forming the crimp and the pressure of the release mechanism. The crimping tool must not damage the wiring and lug insulation.

All wire ends shall be terminated using crimp type lugs. Not more than two conductors shall be connected to any single side of a terminal excluding any purpose made interconnections.

For control wiring each wire tail shall be of sufficient length to reach the allocated equipment plus an additional length of 50mm to facilitate changes in wiring. The slack appears as close as possible to the component in the form of a loop.

Wiring shall be neat in appearance and shall be braced and placed in PVC trunking to prevent vibration and the possibility of forces being exerted on termination arrangements. Where only a few wires have to be braced (excluding panel doors) “wash line” supports shall be used, no stick on plastic bracing supports shall be allowed.

Wires to Plant on swing doors shall be so arranged as to give a twisting motion and not a bending motion to wires. Wires passing through holes in compartments shall be protected by means of neoprene grommets. Bevelling of sheet steel shall not be acceptable as a substitute.

No panel wiring shall be joined other than via a terminal.

Dielectric (insulation withstand) test of all wiring shall be conducted using 1kV to earth for 60 seconds with all electronic equipment disconnected.

7.18.1.6 Panel materials

Moulding materials shall be self-extinguishing, or resistant to flame propagation, substantially non-hygroscopic, and do not carbonise when tested for tracking. The mouldings shall be dimensionally stable and have high impact strength. The materials used shall be to be of the flexible type to avoid cracking of terminals.

Mouldings shall be mechanically robust, of flexible material and withstand the maximum possible torque that may be applied to the terminal screws. Terminals where pressure is applied to the moulding when tightening the terminal screw or nut shall not be acceptable.

Steel parts, other than stainless steel, shall be plated and passivated. Current carrying parts shall be non-ferrous and plated. All plating shall be compatible with other parts of terminations and lugs. Screws into steel shall be steel, stainless steel or phosphor bronze. Steel screws shall be plated and passivated. All plating complies with the standards BS 1706 Ref [3] and BS 1182 parts 1, 2 and 5 Ref [2] or BS EN 12329 Ref [5] and Ref [6] BS EN 12330.

Tapped holes shall have not less than 2 full threads. Terminal blocks shall have separate terminals on each unit for incoming and outgoing connections and their contact pressure shall be independent of each other.

Terminal covers or shrouds and barriers, shall be of insulating material, self-extinguishing or resistant to flame propagation, mechanically robust and clipped into the moulding.

7.18.1.7 Power terminals

Terminals for external power cables up to and including 16 mm² shall be of the screw clamp insertion type or stud type complete with bolts, nuts, washers and locking devices.

Terminals for external power cables above 16 mm² shall be of the stud type complete with bolts, nuts, washers and locking devices. Links between power terminals shall not be acceptable and shall be carried out with bridge piece wiring.

7.18.1.8 Power lugs

Crimping on power lugs shall be in accordance with BS 4579 Part 1 Ref [4] or BS EN 61238-1 Ref [7]. Crimping tools shall be re-calibrated according to their manufacturer's recommendations. The crimped area shall be equivalent to the conductor cross sectional area.

Documented proof of conformance to IEC 1218-1 requirements for tensile force heat cycling, resistance and temperature measurement Ref [11] may be requested by Eskom.

7.18.1.9 Control terminals

The terminals shall be of the rail mounted screw clamp spring-loaded insertion type where terminations or lugs are compressed between two plates by means of terminal screws. Terminals shall be spring loaded such that the action of the springs is independent of the action of the terminal screws.

Terminal screws shall be captive within the mouldings and their heads do not project above the mouldings when fully released. Each terminal accepts up to two hooked blade type lugs.

Terminal entries shall be shrouded such that no current carrying metal is exposed when hooked blade lugs are fitted.

Springs shall be aged and withstand corrosion that might affect performance during their working life. Springs do not carry current.

Cross connection facilities shall be provided for connecting two or more adjacent terminal ways without interfering with the terminal openings.

The terminals shall be sized to provide for pre-insulated lugs to fit after being crimped with the 'flat' crimp lying parallel with the rail. The insulation impulse level and isolation requirements between individual terminals shall be guaranteed.

7.18.1.10 Stud type

Two terminal studs shall be provided for each "way", and be of sufficient length to accommodate two ring tongue terminations in addition to a full nut and a locking device.

Loose links, where provided, shall be secured by a nut and washers, and shall be of tin-plated copper or brass.

Barriers shall be provided between terminal "ways". These barriers project at least 1 mm above the studs.

7.18.1.11 Screw clamp insertion type

The terminals shall be rail mounted and comply with the requirements as laid down for the control terminals with the exception that they shall not be spring-loaded.

7.18.1.12 Component terminals

All types of commonly used terminals shall be permitted. However, terminals that employ a pinch screw shall not be acceptable.

7.18.1.13 Unit DCS interface terminals

Screw type corrosion protected disconnect test terminals (blade type) shall be used for the security panel and control interface to the Unit DCS/BMS system. The terminals shall be suitable to accommodate 0.5 mm² UVG type cables. The terminals shall be separately mounted in the panels based on the voltage level.

7.18.1.14 Mounting

The terminals shall be spring retained on the assembly rail complying with DIN EN 50045 and when mounted and wired in service shall be close fitting to avoid the accumulation of foreign matter between adjacent terminals. End barriers or shields shall be provided for open sided patterns.

It shall be possible to replace any terminal in an assembly without dismantling adjacent units; it shall be permissible, however, to loosen any clamping device. Screw retention of any component from the rear of the mounting rail shall not be acceptable.

All terminal blocks shall be readily accessible.

7.18.1.15 Control lugs

All control lugs shall be of the compression type. Cable lugs and ferrules shall be in compliance with NRS 028:1991.

7.18.1.16 Hardware

The equipment shall not mal-operate if the DC auxiliary supplies are switched on or off permanently or repeatedly at a random rate for periods of 5, 10, 50, 100, 200 and 500 ms. Refer to the standard ESKASAA04 Ref [60] for the required equipment performance under electrical disturbances.

7.18.1.17 Auxiliary relays and timers

Auxiliary relays, logic functions and timers that form part of the security scheme shall be an integral part of the Controller.

7.18.1.18 Contacts

All security trip channel relays shall be fitted with self-resetting contacts or latching outputs where required.

Each security function operates at least two (alarm type) potential free contacts, wired out to terminals for distribution of information to external data acquisition equipment.

7.18.1.19 Operation indicators

Operation indicators e.g. alarm and trip annunciation, shall operate immediately when the security functions operate.

7.18.1.20 Name plate

- A name plate made of plastic sandwich type material black letters and white back will be solidly fixed on upper part of cubicle front face and will bear the functional mark indicated by Eskom.
- A firm plate with indications according to IEC 60439 Ref [15] will be solidly fixed on the equipment.
- All labels mounted externally and pertaining to operating instructions shall be in English language.
- All labels mounted internally and pertaining to maintenance instructions shall be in English language.

7.18.1.21 Steel work

- The cubicle will be made of sheet steel with a minimum thickness of 20/10 of mm and equipped with handling hook.
- The degree of protection of the cubicle and apparatus will be at least IP 31 on all the faces of equipment according to IEC 60529 Ref [16].
- Door accessories will be made of dust proof materials. Door shall be lockable by key
- The cabinets will be provided with doors and removing covers for allowing easy inspection and maintenance.

7.18.1.22 Protection against corrosion and painting

- The painting shall be compatible with the end use of the equipment and must durably protect the metallic parts of the equipment against corrosion by an appropriate treatment according to the ambient conditions defined in paragraph 2.
- Reference of colour: Ral 7032.
- The nuts and bolts will be coated with electrolyte zinc and bichromate. Total thickness of the coating: about 10 microns
- The Contractor shall describe Method of protection against corrosion and painting.

7.18.1.23 Connection and cabling

7.18.1.23.1 Connection and cabling

Cable penetration is through the lower part of the cubicle, adequate space will be provided for cables and connection. Bottom plate will be provided with the cubicle.

The connecting terminals must permit the connection of:

- Direct auxiliary power
- External logic signals
- Internal analogue signals from unit

All internal wiring of the racks (if any) and of the whole equipment will be performed in factory up to terminal blocks.

The control connecting terminals must permit the connection of cables of 0.5 to 1.5 mm2 by screw attachment.

7.18.1.24 Earthing

Earthing requirements shall adhere to Ref [77], Power Requirement Specification.

- The ground circuit in the security cubicles will be made with copper bars; all metallic parts will be connected to this bar.
- An earthing terminal adequate for copper conductor will be provided.

7.18.1.25 Interchangeability

- Equipment components parts may be replaced by any part of the same type taken from spare parts or from identical equipment.

7.19 ROLES AND RESPONSIBILITIES

Roles and responsibilities are indicated in the Limits of Supply and Services (LOSS) Diagrams in the Appendices.

7.19.1 The following interfaces are foreseen:

Appendix A: Control Room Power Cabling

Appendix B: HVAC 1 Power Cabling

Appendix C: HVAC 2 Power Cabling

Appendix D: ICT Interface

Appendix E: Control Room Integrated Access Control (IAC)

Note: The LOSS Diagrams can be revised by the during the project as deemed necessary. All affected parties shall be notified.

7.20 COMMUNICATION AND CHANGE MANAGEMENT STRATEGY

The Change Management Strategy is outlined in EPSIUP Task 606-238 Change Management Plan, Ref [69]

8. PROJECT ADDITIONAL INFORMATION (IF REQUIRED)

N/A

9. DOCUMENT ACKNOWLEDGEMENT

By signing this document, the people listed record their agreement on the contents of this document.

Client Representative:

: **Name** : George Jordaan

: **Signature** :

: **Date** : .....

10. DOCUMENT APPROVAL

Accepted by: : **Name** : Corrie Ungerer

(Senior Project Manager) : **Signature** :

: **Date** : .....

Approved by: : **Name** : Karen Pillay

(Programme Manager) : **Signature** :

: **Date** : .....

Authorised by: : **Name** : Brig- Gen (ret.) Tebogo Rakau

(Sponsor/Client Representative) : **Signature** :

: **Date** : .....

11. APPENDICES

11.1 APPENDIX A

Supplier Technical Data: Schedule A. Example. To be updated and filled in by Supplier

Item	Description	Manufacturer Proposal
	GENERAL	
	Delivery Required	
	Delivery to:	
	Erection	
	Commissioning	
	Manufacturer of Equipment	
	Switched Socket Outlet	
	Interior Light	
	Battery Supply Voltages	
	Drawings	
	.	
	Technical, Maintenance and Operating	
	Manuals	

	Software/firmware requirements	

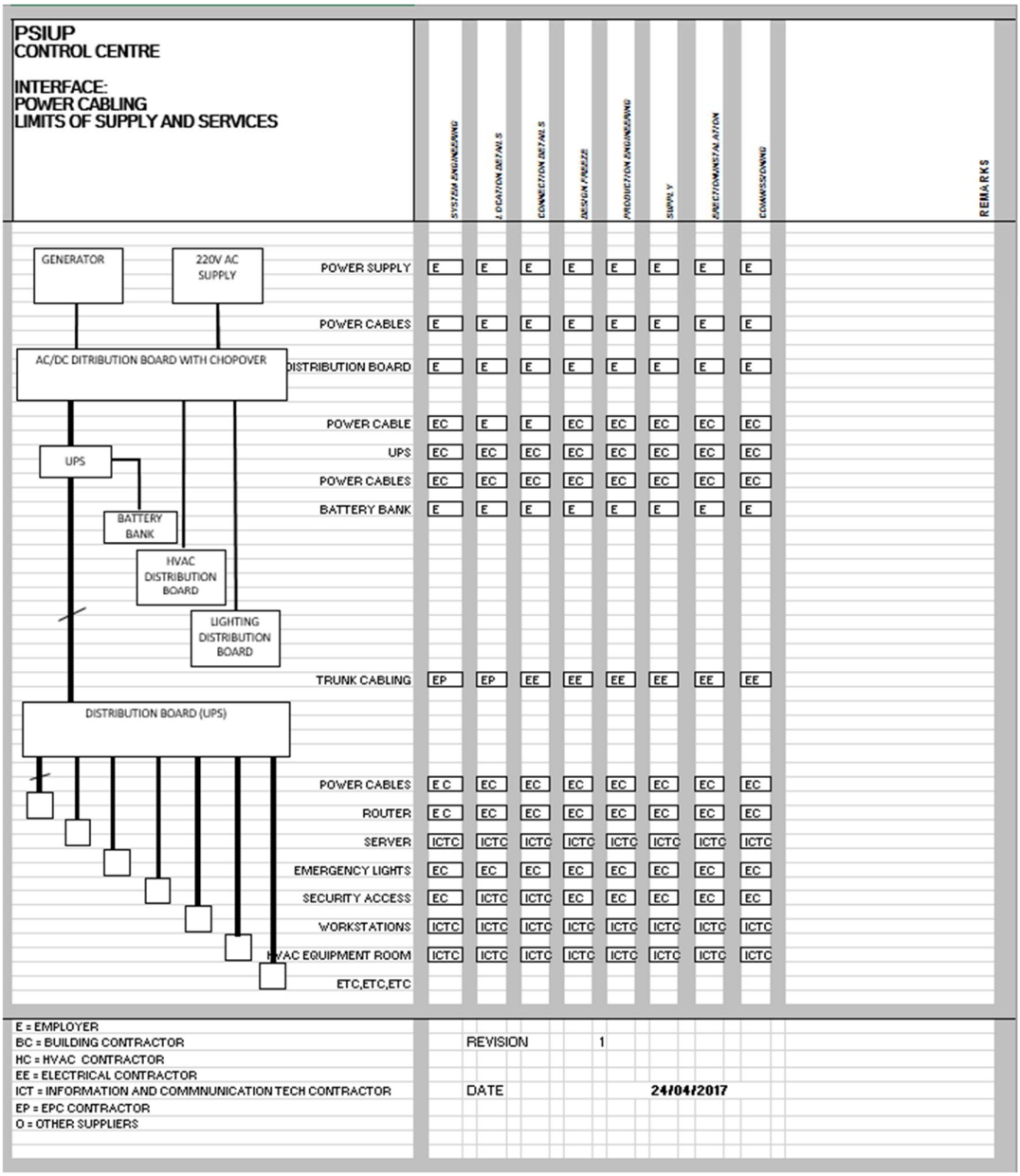
11.2 APPENDIX B

Recommended Spare List:

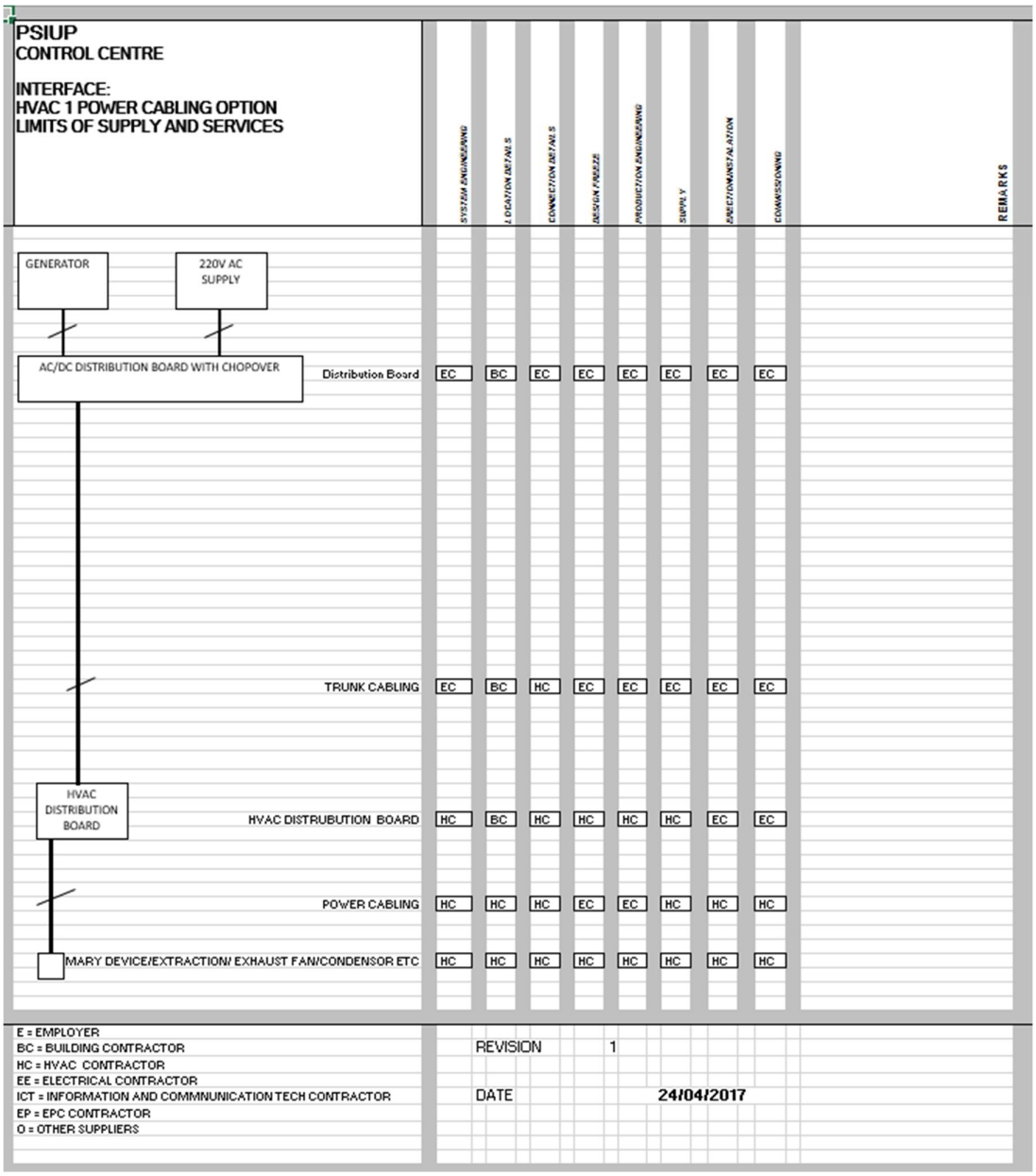
The supplier is responsible to identify a spares parts list for a 10-year operation. The following are just recommendations and not meant to be exhaustive.

ITEM	DESCRIPTION	PRICE [ZAR]
Server	1x server spare	
Controllers	10% spare of the installed capacity	
PTZ camera	20 % of installed capacity at the control centre	
Surveillance cameras	20% of installed capacity at the control centre	
Detection cameras	20% of installed capacity at the control centre	
Workstation screens	10 % of installed screens at the control centre	
Touch screen tablets	10 % of the installed screens at the control centre	
Hard drive	1 one spare hard drive	
DLP Screen cube	1x cube spare	
DLP light bulb	1 x spare	
DLP XGA/SXGA engine	1 x spare	

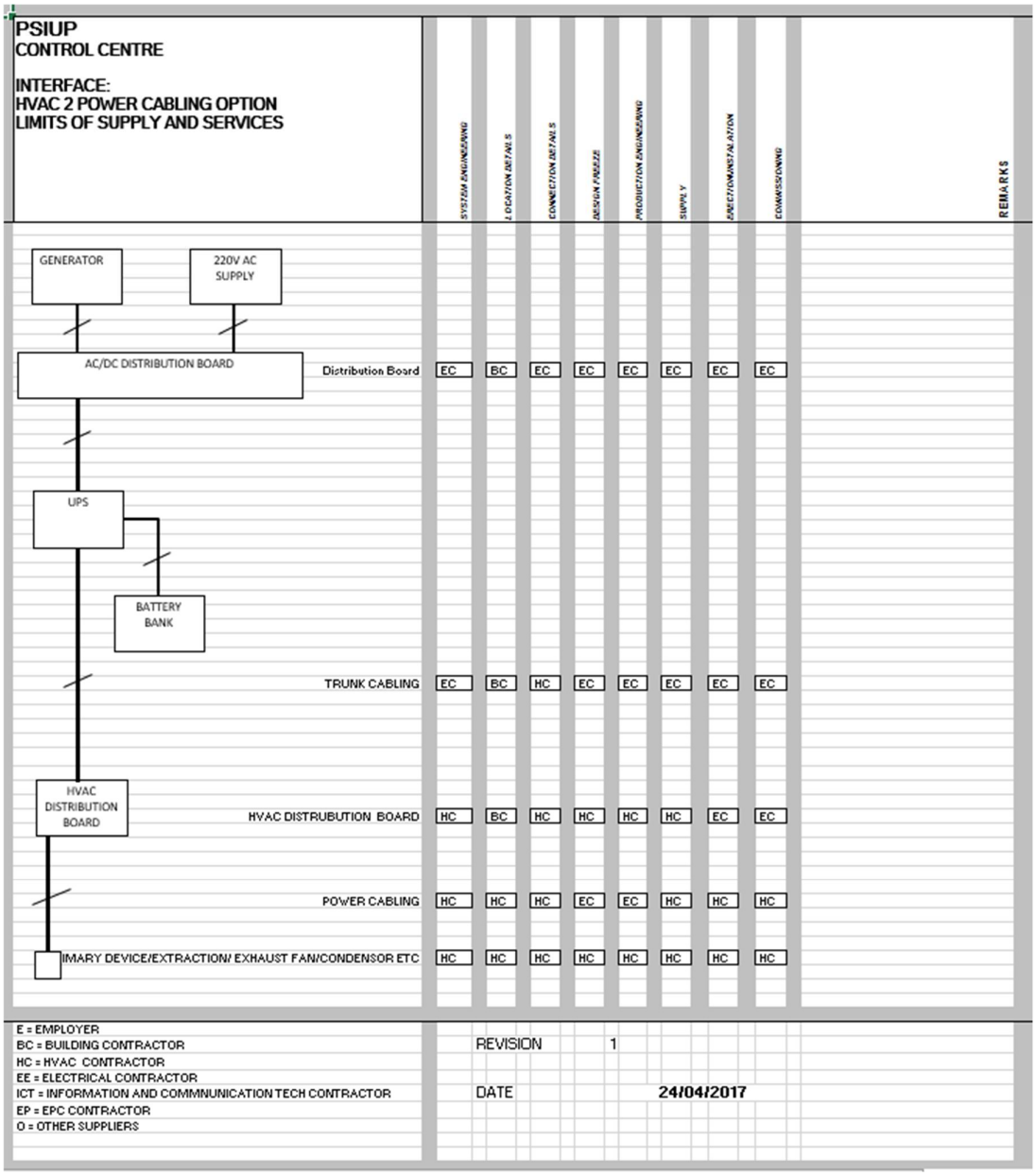
11.3 APPENDIX C



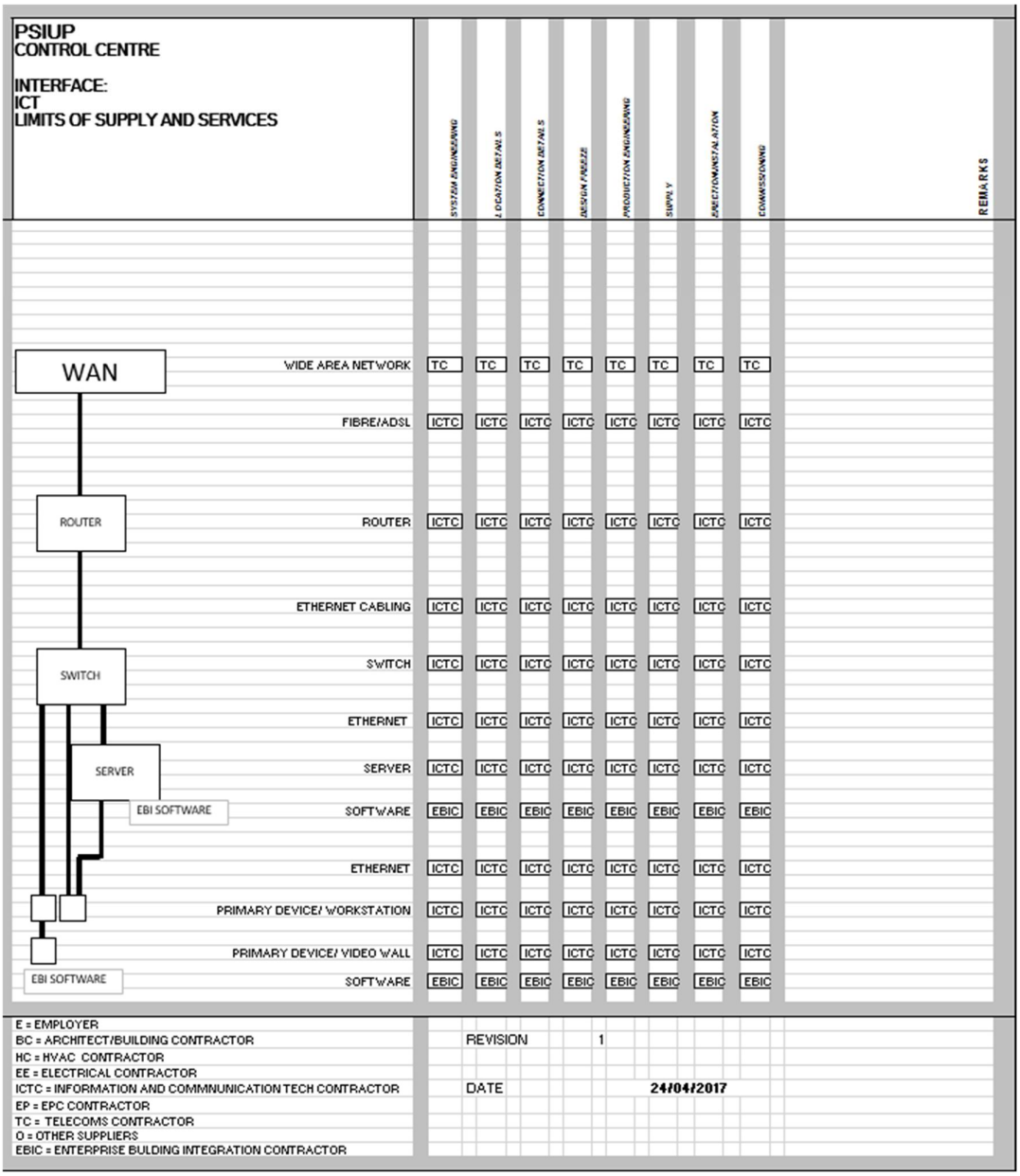
11.4 APPENDIX D



11.5 APPENDIX E



11.6 APPENDIX F



11.7 APPENDIX G