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Department :
Economic Development, Tourism and
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PROVINCE OF KWAZULU-NATAL



Vuthela
ILEMBE LED PROGRAMME

Vuthela SCADA Project

Functional Design Specification
Report

Vuthela iLembe LED Programme

Reference: 503986

Revision: C

2019-05-20



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Document control record

Document prepared by:
Aurecon South Africa (Pty) Ltd

Reg No 1977/003711/07

First Floor
 West Building
 Milkwood Office Park
 Cnr Umhlanga Rocks &
 Douglas Saunders Drive
 La Lucia Ridge 4019
 Durban
 PO Box 335
 Umhlanga Rocks 4320
 South Africa

T +27 31 575 5500

F +27 86 244 9177

E ethekwini@aurecongroup.com

W aurecongroup.com

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Document control						aurecon
Report title		Functional Design Specification Report				
Document code		Project number		503986		
File path		P:\Projects\503986 Vuthela SCADA Project\5 DEL DES\501 Engineering\Specifications				
Client		Vuthela iLembe LED Programme				
Client contact		Client reference				
Rev	Date	Revision details/status	Author	Reviewer	Verifier (if required)	Approver
A	18 February 2019	Draft Report	D. Naicker	M. Piper	R. Ahlschlager	
B1	29 April 2019	Issued for Comments	D. Naicker	M. Piper	R. Ahlschlager	
C	20 May 2019	Final Report	D. Naicker	M. Piper	R. Ahlschlager	
Current revision		C				

Approval			
Author signature		Approver signature	
Name		Name	
Title		Title	
Electrical Technologist			

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1 SCOPE

This document provides the functional design specification for the implementation of a Supervisory Control and Data Acquisition (SCADA) system at the distribution substations which will be linked to a control centre within KwaDukuza Municipality (KDM). In addition, the main feeder breaker that supplies the Mandeni Local Municipality will also be linked to the KDM control centre. The primary purpose of this specification is to ensure that the SCADA system is suitably designed to ensure safe, reliable operation and is simple to maintain.

The SCADA system configuration and the related equipment necessary for the complete installation, is detailed in this design specification and technical data sheets.

2 NORMATIVE REFERENCES

This document shall be applied using the most recent edition and applicable amendments of the documents listed. Where any of the listed documents are out-dated or superseded, the replacement document of the original document shall take precedence.

Any items not specifically detailed in this Specification, which are necessary to provide a safe and fully operational working system, shall be deemed to be included.

Note: In case of a conflicting requirement listed in this and another specification, then the requirements contained in this specification will overrule the requirements in the other specification. In case of doubt, clarification should be sought from Aurecon AME.

The design, construction, inspection and testing of the SCADA system shall comply with all relevant Statutory Regulations and Directives including:

- a) Occupational Health and Safety Act (Act 85 of 1993);
- b) Construction Regulations 2014 issued in terms of Section 43 of the Act;
- c) Local Fire Regulations; and
- d) Regulations of the Local Supply Authority.

and the latest editions of all relevant SANS, British Standards and International Standards, including:

Table 1: Standards and their description

Standard Number	Description
SANS 10142-1	Wiring of Premises Part 1: Low Voltage Installations
SANS 60529	Degrees of protection provided by enclosures (IP Code)
SANS 61643	Low-Voltage Surge Protection Devices
NRS 042	Guide for the protection of electronic equipment against damaging transients
IEC60255	Electrical Relays (all parts)
IEC60870 - 4	Performance Requirements
IEC61000 - 6 - 5	Electromagnetic compatibility (EMC) – part 6-5 Generic standards – immunity for power station and substation environments.
IEC61131 - 3	Programmable Controllers – Part 3: Programming Languages
IEC61850 - 1	Introduction and overview
IEC61850 - 2	Glossary
IEC61850 - 3	General Requirements
IEC61850 - 4	System and project management
IEC61850 - 5	Communication requirements for functions and device models
IEC61850 - 6	Configuration description language for communication in electrical substations related to IED's
IEC61850 - 7 - 1	Basic communication structure – principles and models
IEC61850 - 7 - 2	Basic information and communication structure – Abstract communication service interface (ASCI)
IEC61850 - 7 - 3	Basic communication structure – Common data classes
IEC61850 - 7 - 4	Basic communication structure – Compatible logical node classes and data object classes

Standard Number	Description
IEC61850 - 7 - 420	Basic communication structure – Distributed energy resources logical nodes
IEC61850 - 8 - 1	Specific communication service mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and ISO/IEC 8820-3
IEC61850 - 9 - 1	Specific communication service mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link
IEC61850 - 9 - 2	Specific communication service mapping (SCSM) – Sampled values over ISO/ IEC 8802-3
IEC61850 - 10	Conformance testing
IEC61850 - 80 - 1	Guideline to exchanging information from a CDC-based data model using IEC60870-5-101 or IEC60870-5-104
IEC61850 - 90 - 1	Use of IEC61850 for the communication between substations
IEC61850 - 90 - 2	Using IEC61850 for communication between substations and control centres
IEC61850 - 90 - 4	Network engineering guidelines.
IEC61850 - 90 - 5	Use of IEC61850 to transmit synchrophasor information according to IEEE C37.118
IEC61850 - 90 - 7	Object models for power converters in distributed energy resources (DER) systems
IEC62271 - 3	High Voltage switchgear and control gear – Part 3: Digital interfaces based on IEC61850
IEEE 1613 - 2009	IEEE Standard Environmental and Testing Requirements for Communications Networking Devices installed in Electric Power Substations
IEEE 1815 - 2012	IEEE Standard for Electric Power Systems Communications-Distributed Network Protocol (DNP3)
ISO 9001	Quality Management Systems
ISO9002	Quality Systems Model for Quality for Quality Assurance in Production, Installation and Servicing
Grid Code	South African Distribution Code Glossary and Definitions Version 6
Grid Code	South African Network Code Version 6

3 TERMS AND DEFINITIONS

In the absence of any specific information to the contrary, the following definitions shall apply where used in this standard:

Approval, approved, agreed	Approved or agreed in writing by KDM. Approval may include qualifications and limitations. Approval does not apply to items used outside these constraints.
Equipment	Assemblies of components, sub-units or sub-assemblies usually contained in a suitable enclosure, and capable of performing an overall specified function.
Protection scheme	All switches, IEDs, controls, indications, wiring, terminals and the module housing. These items that provide the required protection functionality for the specific application.
SCADA	This defines the system from the Central Control Room in KwaDukuza to the substations located within its within its area of supply.

3.1 Definitions

<u>Terminology</u>	<u>Definition</u>
Access Point	Communication access point to an IED. This may be a serial port, an Ethernet connection, or a client or server address depending on the stack being used. Each access point of an IED to a communication bus is uniquely identified. Each server has only one, logical, access point.
Attribute	Named element of data and of a specific type
Bay	<p>Substations consist of closely connected sub parts with some common functionality. These may include switchgear between an incoming or outgoing line, the busbar, bus coupler with its circuit breaker and related isolators and earthing switches, etc.</p> <p>The bay comprises a power system subset to be protected, e.g. a transformer or line end, and the control of its switchgear that has some common restrictions such as mutual interlocking, or well defined operating sequences.</p> <p>The subparts are called 'bays' and may be managed by devices with the generic name 'bay controller' and have protection systems called 'bay protection.'</p>
Bay Level	<p>A bay is a part of a substation containing switchgear and control devices designed for an electrical supply line, transformer, etc. connected to busbar of the substation.</p> <p>These parts of a substation may be managed by devices with the generic name 'bay controller' and have protection systems called 'bay protection'.</p> <p>The bay level represents an additional control level below the overall station level.</p>
Gateway	A network interconnection device that supports the full stack of the relevant protocol which it can convert to a non-7 layer protocol for asynchronous transmission over wide area networks.
GOOSE	<p>Generic object orientated substation event (GOOSE) is an occurrence of any change of state, that an IED will multicast in a high speed, binary object, GOOSE report by exception, typically containing the double command state of each of its status inputs, starters, output elements and relays, actual and virtual.</p> <p>The GOOSE report is re-issued sequentially, typically after the first report, again at intervals of 2, 4, 8...60000ms. (The first repetition delay value is an open value, it may be either shorter or longer.)</p>
HMI	Human Machine Interface (HMI) – display screen, either part of an IED or as a stand-alone device, presenting relevant data in a logical format, with which the user interacts. An HMI will typically present windows, icons, menus, pointers, and may include a keypad to enable user access and interaction.
IED	Intelligent Electronic device is any device incorporating one or more processors, with the capability to receive or send, data/ control from, or to, and external source, e.g. electronic multifunction meters, digital relays, and controllers.
Interchangeability	The ability to replace a device supplied by one manufacturer with a device supplied by another manufacturer, without making changes to the other elements in the system.
Interoperability	The ability for two or more IED's from the same vendor, or different vendors, to exchange information and use that information for correct execution of specified functions.

Network Topology	The arrangement of systems on a computer network that defines how the computers, or nodes, within the network are arranged and connected to each other. Some common network topologies include star, ring, line, bus and tree configurations.
Protocol	A set of rules that determines the behaviour of functional units in achieving communication.
Redundancy	Existence of more than one means for performing a required function in an item. Also refers to spare or duplicate functionality that allows a system to continue to operate without degradation of performance in the event of a single failure.
Scalability	The criterion for a cost-effective SAS taking into account the various functionalities, various IED's, substation sizes and substation voltage ranges.
Server	A server on a communications network, is a functional node that provides data to, or that allows access to its resources by, other functional nodes. A server may be a logical sub division, which has independent control of its operation, with the software algorithm (and/ or possibly hardware) structure.
Site acceptance test (SAT)	SAT is the verification of each data and control point and the correct functionality inside the SAS and between SAS and its operating environment on the whole installed plant using the final parameter set. The SAT is the precondition for the SAS being accepted and put into service.
Station Level	The arrangement of systems on a computer network that defines how the computers, or nodes, within the network are arranged and connected to each other. Some common network topologies include star, ring, line, bus and tree configurations.
Substation Automation	A system for providing automation within a substation and includes the IED's and communication network infrastructure.
Switch (Network)	<p>An active network component that connects two or more sub networks, which themselves could be built of several segments connected by repeaters. Switches establish the borders for so called collision domains. Collisions cannot take place between networks divided by switches, data packets destined to a specific sub network does not appear on the other sub networks.</p> <p>To achieve this, switches must have knowledge of the hardware addresses of the connected stations. In cases where only one active network component is connected to a switch port, collisions on the network can be avoided.</p>
TCP/IP	TCP/IP standard internet protocol defines the datagram that provides the basis of connectionless packet delivery. It includes control and error message protocol providing the equivalent functions to network services, layer 3, of the OSI reference model for Open Systems interconnection.
Telecommunications Interface	This is the interface point to the telecommunications network link to the remote power system network control centre.

4 ABBREVIATIONS

APN	Access Point Network
BCU	Bay Control Unit or Bay controller
BTU	Battery Tripping Unit
CAIDI	Customer Average Interruption Duration Index
CAIFI	Customer Average Interruption Frequency Index
CB	Circuit Breaker
CT	Current Transformer/ Transducer
ECT	Electronic Current Transformer/ Transducer
EF	Earth Fault
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
FAT	Factory Acceptance Test
GOOSE	Generic Object Oriented Substation Event
GPS	Global Positioning System (time source)
HDPE	High Density Polyethylene
HMI	Human Machine Interface
HSR	High-availability Seamless Redundancy
I/O	Status Input/ Output Contacts, or channels
ICD	IED Configuration Description
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronic Engineers
IP	Internet Protocol
ISO	International Standards Organisation
KDM	KwaDukuza Municipality
LAN	Local Area Network
MTTF	Mean Time To Failure
MTTR	Mean Time To Repair
OEM	Original Equipment Manufacturer
OS	Operating System
PDU	Protocol Data Unit
PRP	Parallel Redundancy Protocol
RoHS	Restriction of Hazardous Substances
RTU	Remote Terminal Unit
RTAC	Real Time Automation Controller
SA	Substation Automation
SADC	Southern African Development Community
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAS	Substation Automation System
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition
SHMI	Substation Human Machine Interface
SMS	Short Message Service
SNTP	Simple Network Time Protocol
SoE	Sequence of events
SV	Sampled Value (functional constraint – SV substitution)
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/ Internet Protocol
UPS	Uninterruptable Power Supply
V AC	Alternating Current Voltage
V DC	Direct Current Voltage

5 GENERAL

5.1 System Overview

The SCADA system forms an integral part of the substation automation system. It shall provide the Human Machine Interface (HMI) between the operator and the substations equipment, for the overall supervision, control, operations monitoring and recording.

The SCADA system is categorised into two parts namely (1) the local SCADA system and (2) the central or master SCADA system. The local SCADA system is responsible for the automation within a substation and shall be connected to and collect data from the substation equipment (e.g. protection relays and battery chargers) and field devices (e.g. auto-reclosers and sectionalisers). The collected data will then be recorded in a relational database. The central SCADA system is responsible for the supervision and control of the complete electrical system. The local and central SCADA system shall communicate (via appropriate protocol drivers) with the substation equipment and field devices using secure data transmission methods.

The data obtained and recorded at a substation by the SCADA system shall be available at the local and central system for visualisation, trending and analysis.

5.2 Functional Requirements

The central SCADA system shall communicate cyclically with all substation local SCADA systems and remote field devices and shall perform, but not be limited to, all functionality in this specification. The main functions of the SCADA system shall be:

- a) Logging of data to a database
- b) Process data acquisition
- c) Visualisation of equipment status
- d) Real time and historical data trending
- e) Operator command interfaces for controlling and engineering
- f) Alarm management
- g) Report generation
- h) Operator access security system to grant different levels of authorisation.

The SCADA system shall be capable of operating in a Client-Server and/or stand-alone configuration with the capability of having multiple users and multiple workstations working simultaneously on a common SCADA system.

6 SCADA SYSTEM

6.1 Network Topology

KwaDukuza Municipality have distribution substations at various locations within their area of supply. The level of redundancy and the requirements for PRP and HSR networks within a distribution substation is not as critical when compared to a transmission substation. Therefore, only the station level network [i.e. the RTAC, the ethernet switch and the substation workstation] will provide a parallel redundant backbone that will be implemented to offer strong resilience and low failover time.

The IED's installed at the bay level only have a single serial (ethernet) communication port, therefore provision of a redundant backbone to the station level becomes limited. The devices installed at the bay level will employ the star network topology. Majority of the IED's installed at the bay level do not have the IEC 61850 or the DNP3 communication protocol enabled. **It is imperative that the successful Contractor has the IEC 61850 protocol enabled by the OEM as the SCADA design specification is based on it.** The relays that require the IEC61850 protocol upgrade can be referred to in Appendix D while the SCADA Architecture and SLD drawings can be referred to in Appendix F and G respectively.

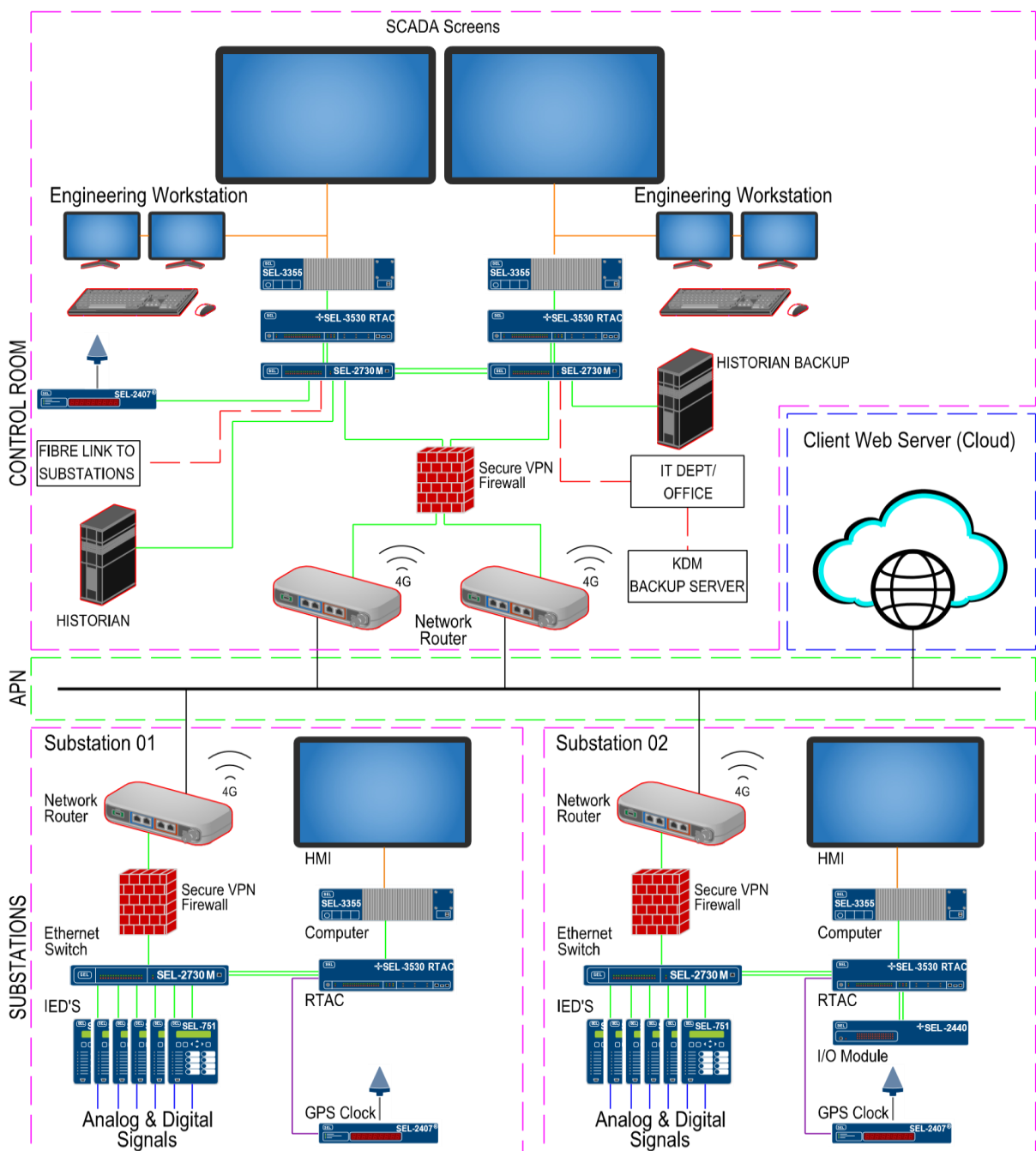


Figure 1: SCADA System Overview

Due to the age of the substations, the majority of primary equipment (e.g. isolators and earth switch) statuses have not been wired to the relevant IED's. This limits the amount of data required on the process level for a fully functional SCADA system. **It is imperative that all primary equipment is wired to the relevant IED's or SCADA equipment, as it forms an essential part of the SCADA system.**

6.2 Substation Automation System (SAS)

The exchange of data between devices and the SAS relies on the IEC61850 ethernet network. The IEC61850 ethernet network forms the connection between the devices in the network, HMI's (for remote control) and SCADA interfaces. SCADA functionality shall be provided on the SHMI installed on the workstation within the substation control room.

The system shall feature secure communications, suitable redundancy protocols, interoperability as defined by the IEC61850 standard, and to allow for future expansions and integration. The engineering setup and operation of the system shall be user friendly and allow for easy expansion when the need arises.

To achieve a cohesive system design, the system components shall be compatible with the highest requirements of the IEC61850 standards. System reliability and availability will have to comply with the requirements mentioned in IEC61850 - 3 and IEC60870 - 4.

Events and alarms shall be time tagged at source (in the local BCUs and substation IED's) and shall be transferred to the remote and supervisory control systems with this time tag. All time tagged events and alarms should have a resolution of at least 10ms on the Station Bus level.

Time synchronisation of the BCUs shall be handled primarily by the local GPS time server. If the time server fails, the RTAC shall provide the path for time synchronisation from upstream communications.

New equipment shall be compatible with the requirements for Ethernet communications based on the IEC61850 standard.

6.3 Control Philosophy

The control of primary plant equipment takes place at various levels. The main control interface between the operator and the primary plant equipment is via the IED's. The four levels of control and monitoring includes:

6.3.1 SCADA from the Centralised Control Centre

- i) Control: It shall be possible to control all circuit breakers within a substation.
- ii) Monitoring: It shall be possible to monitor all circuit breaker, isolator and earth switch positions, electrical measurements, alarms, events and energy values.
- iii) Blocking: The Centralised Control Centre shall be blocked from performing any supervisory control. This shall be achieved by utilising the local/remote switch located on the SHMI panel in the substation control room or from the control panel BCUs. In the event of blocking being left activated, alarming is required at the substation and Control Room.

6.3.2 Remote control from the Local Substation HMI

- i) Control: It shall be possible to control all circuit breakers within a substation.
- ii) Monitoring: It shall be possible to monitor all circuit breaker, isolator and earth switch positions, electrical measurements, alarms, events and energy values.
- iii) Blocking: It shall be possible to block remote control from the control panel BCUs.

6.3.3 Remote control at the control panels in substation relay room

- i) Remote control is possible from the control panels and will typically only be used in emergency situations
- ii) Control: It shall be possible to control all circuit breakers within a substation.
- iii) Monitoring: It shall be possible to monitor all circuit breaker, isolator and earth switch positions, electrical measurements, alarms, events and energy values.
- iv) Blocking: It shall be possible to block remote control from the primary equipment.

6.3.4 Local control from the primary equipment (SCADA Master Block)

- i) This shall only be possible for maintenance on primary components and/or in the case of emergencies.
- ii) Direct control is performed directly on the primary equipment. It shall be possible to control all circuit breakers, isolators and earth switches from marshalling cabinets or directly on the equipment.

6.4 SCADA Safety Philosophy

All commands from the central or local SCADA shall follow a logical sequence. The software shall be designed in such a way that the user is guided step by step through each sequence by identifying visually the remaining valid entries.

For a command to be executed successfully, the command shall be sent to the BCU. Once the BCU has received the control message for the object to be operated, the interlocking criteria shall be fulfilled before the control unit for the particular object is ready to operate. The interlocking criteria shall keep in mind best practices for power utilities and ensure that the selection and interlock criteria be continuously monitored. **Once the interlocking criteria has been specified by the Contractor, it shall be submitted to KDM for approval.**

The system should be made failsafe. If a failure on the central or local SCADA system arises, no mal-operation of the power system should be possible. No fault in the workstations, the RTAC's, the SCADA system or the interfaces between the systems shall interrupt or affect the running of the substation.

As far as is reasonably practicable, no fault in the BCUs or in the communication equipment shall interfere with the other control units or interrupt or otherwise block the remote and supervisory operation of the substation. Backup storage and program maintenance shall be possible without interfering with the actual operation of the control system.

If the central or local SCADA system fails or needs to be restarted, the field devices continue operating and remain unaffected. All measured values and status data from the field devices shall be buffered on the RTAC or the workstation during a SCADA system outage. Once the supply has been restored, all measured values and status data shall be retrieved and the central SCADA system updated.

The central SCADA system shall record the down time and, in the event, that data acquisition has failed and/ or failed to update missing data, shall flag the event and log the "downtime".

7 SCADA HARDWARE

7.1 General

The hardware specified in this Design Specification and Technical Data Sheets shall include all the necessary components for a fully functional SCADA installation, whether specifically listed or not. All hardware shall be rated for continuous operation under the environmental conditions stipulated in the Technical Data Sheets.

Where SCADA hardware is specified, **it remains the Contractors' responsibility** to ensure that the actual hardware offered and installed is adequate to support the offered SCADA software and the specified SCADA functionality, including future expandability.

Computing devices shall be certified to comply with the applicable regulations for Electromagnetic compatibility of electronic and digital equipment in order to limit harmful interference (such as radio equipment). The Contractor shall ensure that SCADA equipment are purchased with the correct power supply ratings. **All substation equipment shall be powered from the substation BTU [110V DC, except Gledhow Substation which is 32V DC]. The control room equipment shall be powered by the UPS [240V AC]. The Contractor shall verify the capacity of the BTU at each substation, providing its expansion if it is necessary.** Reference can be made to Appendix E for the existing KDM Substation BTU Analysis.

7.2 SCADA Equipment

7.2.1 Network Components and Equipment

The Ethernet network will be configured in a manner to incorporate all IED's and related HMI interfaces such that there is seamless communications between devices as well as HMI's. Suitable networking redundancies will be incorporated into the design such that there is no loss of information. The network components will include the following:

a) Fibre optic connections

Fibre optic connections shall be utilised at (1) Lavoipierre substation to the control room and (2) at substations that require signals to be brought to the control room from the HV yard. The termination of fibre optic cables shall give preference to LC connectors. Only under special circumstances [if it exists within a substation] and by approval of the Engineer shall ST connectors be utilised. Fibre optic leads shall be ruggedised and shall be installed within its own ducts/trenches.

b) Copper network connections

These shall be used for connection to computers, printers, IED's etc. The copper network cables shall be of the shielded twist pair (STP) in construction having shielded RJ45 cable boot connectors.

c) Ethernet switches

The ethernet switches perform a critical role in interconnecting IED's and the control infrastructure. The network switches shall meet the following minimum requirements for use within a SAS.

- i) The control room/substation shall have at least one dedicated ethernet switch of rugged construction for use within the harsh electrical environment applications and shall comply with the IEC61850 and IEEE1613.
- ii) Ethernet switches shall comprise a combination of copper and fibre optic ports. Fibre ports shall support the short and long-haul fibre applications.
- iii) Ethernet switches will be supplied with management software to configure and update switches as required

Each substation has a unique SCADA architecture therefore the ethernet switch shall be configured as per the substation requirements. The ethernet switch technical data sheet can be referred to in Appendix A1.

d) Modem

A modem shall be connected to the control room network to provide internet connectivity for the SCADA operations. The modem will have firewall capabilities of industrial standards and will create a Virtual Private Network (VPN) for the entire substation. It shall be equipped with a dual sim to support the communication redundancy required to the control room using different Telecommunication Providers. The modem shall be fully compatible with the communication solution infrastructure of the Telecommunication Providers. Due to the differing power supply voltage of the modem, the modem shall be supplied with a Converter (32V DC –12V DC or 110V DC – 12V DC) to power up the modem. The modem technical data sheet can be referred to in Appendix A2.

7.2.2 Real Time Automation Controller (RTAC)

The real time automation controller shall meet the criteria in the technical data sheet referred to in Appendix A3. The controller is responsible for the communication monitoring, transfer of information and the processing of commands between IED's within the substation and to the control room.

The controller shall be of rugged construction for use within the harsh electrical environment applications. The controller shall also be equipped with HMI software capabilities that presents the substation information onto a display. This prevent the need for third party SCADA software to be installed.

7.2.3 Workstation Equipment

The workstation will provide the interface for the operator/ engineer to visualise the operational condition of the substation, and to view any alarms and event logs that may have taken place. The workstation will also provide access to protection IED's and network switches to carry out configuration changes as required.

The configuration of the workstation will provide secure hierarchical access to KDM employees based on their roles and responsibilities. This provides layers of security such that access is restricted to the network, and external attacks are reduced. Access levels will be provided as per the guidelines present in IEC61850-3 Annexure A.

The workstation shall meet the criteria in the technical data sheet referred to in Appendix A4. The workstation housings shall be robust, cabinet rack mount and capable of operating in either controlled environments or industrial environments and shall carry a 10-year warranty. The workstation shall come equipped with ancillary components such as a keyboard and mouse.

The Contractor shall be responsible for the installation and setup of the SCADA software on each workstation inclusive of all the necessary software requirements for the logging, storing and backing up of data. The workstation shall include but not be limited to the following software:

- i) Windows 10 Enterprise OS, which is the OS approved by KDM
- ii) OEM specific SCADA software
- iii) IED configuration software

7.2.4 Protection IED's (For Shakaskraal and Sheffield Substations)

The Protection IED's shall be installed at the bay level and shall meet the criteria in the technical data sheet referred to in Appendix A5 & A6. It remains the Contractors responsibility to ensure that each relay is ordered according to the CT's utilised on site. The IED's installed shall have the following minimum requirements:

- a) IED's shall utilise microprocessor technology and be equipped with the IEC61850 protocols.
- b) IED's shall support ethernet communication.

- c) IED's shall have sufficient I/O for gathering information and executing control functions as required. It is imperative that during the installation, all circuit breaker status signals shall be wired to the relevant IED.
- d) Protection devices shall have fault recording and load profile data capability that must be enabled during commissioning.
- e) All protection devices shall be required to have full type test certificates. Full details, including ordering schedules / part numbers for each IED offered shall be supplied.

7.2.5 I/O Module

The I/O module shall be utilised at substations where signals from the HV yard have not been wired back to the control room. The I/O module shall be easy to maintain and support, include the DNP3 and IEC61850 communication protocol, meet stringent protective relay standards and be rugged in construction for use within the harsh electrical environment applications. The I/O module communication between the HV yard and the control room shall be done via a fibre optic cable that is housed in an appropriately sized HDPE conduit which is buried in the ground.

The Contractor shall ensure that the I/O module is housed in a 3CR12, epoxy powder coated marshalling kiosk that is robust, can support rack mount equipment, has a tapered roof to prevent water from standing and be ordered with a precast concrete plinth that is equipped with all the fittings required to install the kiosk on the plinth. The I/O module shall meet the criteria in the technical data sheet referred to in Appendix A7.

7.2.6 Serial Port Server

The serial port server shall be utilised at substations where the RS232 communication port is predominantly available. The serial port server shall form the central hub for the IED's with RS232 ports to be connected after which it will provide secure communication through the ethernet networks to the automation controller. The serial port server shall meet the criteria in the technical data sheet referred to in Appendix A8.

7.2.7 Satellite-Synchronised Clock

The satellite-synchronised clock shall be used within the substation to synchronize all IED's using a GPS time source and IRIG-B output. The average time accuracy for the clock should be +/- 100ns. The clock shall have a built in LED time display for convenience in the substation and be of rugged construction for use within the harsh electrical environment applications. The clock shall be equipped with all accessories required for the full functioning of the unit and shall include the antenna, mounting bracket, surge protector and cable. The clock shall meet the criteria in the technical data sheet referred to in Appendix A9.

7.2.8 Substation Human Machine Interface (SHMI)

Each Substation shall be equipped with its own HMI. The SHMI shall be of an industrial grade capable of mounting within a 19" rack mount cabinet. The SHMI shall be equipped with all accessories required for the full functioning of the unit. The SHMI shall meet the criteria in the technical data sheet referred to in Appendix A10.

7.2.9 Workstation Monitor (Control Room Only)

Each workstation in the control room shall have the size and number of displays to be optimised to allow the operator(s) to have a detailed overview of a substation. The display shall be of the backlit LED LCD type and at least 23inch, 16:9 wide aspect ratio, minimum 8ms response time, a minimum of 1920 x 1080 resolution and has a design capability for continuous operation, 24 hours per day. The monitors

shall be mounted on a single desk mount stand capable of supporting two monitors. The workstation monitor shall meet the criteria in the technical data sheet referred to in Appendix 11.

7.2.10 SCADA Monitor (Control Room Only)

The control room shall be equipped with two large SCADA displays that shall be optimised to allow the operator(s) to have a detailed overview of the North and South electrical networks. The display shall be of the backlit LED LCD type and at least 65 inches, 16:9 wide aspect ratio, minimum 10msec response time, a minimum of 1920 x 1080 resolution and has a design capability for continuous operation, 24 hours per day. The SCADA monitor shall meet the criteria in the technical data sheet referred to in Appendix A12.

7.2.11 Printer (Control Room Only)

The control centre shall be equipped with at least one printer. The printer shall as a minimum be a colour laser type printer [Inkjet printer will not be accepted]. The printer shall be connected to the SCADA System's local area network and accessible from all SCADA computers (server and operator workstation). The printer will be used for alarm and event message, measured value trend printing, report printing and engineering change records printing.

7.2.12 Uninterruptible Power Supply (Control Room Only)

SCADA computers and peripherals shall be supplied from a double conversion online type, single phase 230V AC, 50 Hz uninterruptible power supply (UPS). The UPS shall be from a reputable supplier and shall be a standard catalogue item that is RoHS compliant.

The UPS shall be adequately sized to cater for future loads and shall be able to accommodate the inrush currents of all connected equipment. The UPS shall be capable of maintaining the connected load fully operational for a minimum period of 120minutes. Longer back-up times shall be accommodated using additional battery sets.

The UPS shall be microprocessor controlled and be able to supervise critical functions and monitor circuit performance (such as temperature, battery status, mains fail, etc.). These shall be communicated to the SCADA system via a serial, galvanically isolated communications port to ensure correct management of the UPS and equipment connected to it under power fail conditions.

The UPS shall include visual indication of normal and abnormal operation as well as visual and audible indication of battery status. It shall be packaged with rack mounting brackets, rack mounting hardware and support rails, temperature probe and the relevant installation and warranty documentation. The UPS shall meet the criteria in the technical data sheet referred to in Appendix A13.

7.2.13 Generator (Control Room Only)

The control centre shall be equipped with a 22kVA, 230V, single phase generator to provide automatic backup AC supply in the event of a power failure however the final size of the generator is to be determined from the load requirements of the detail design which shall be done by the Contractor. The generator shall comply with the detailed specification referred to in Appendix B.

7.2.14 Earthing and Surge Protection

All computer hardware and peripheral power supplies including all data communications links shall be protected against the harmful effects of lightning and power line surges. The entire installation shall be properly earthed, all equipment enclosures and surge arrestor ground terminals shall be bonded to a common earth bar. The Contractor shall ensure that this is done adequately at all the Substations and the Control Room.

8 SCADA APPLICATION SOFTWARE

8.1 General

The SCADA software package shall be a fully tested, supported and field-proven package suitable for the municipal automation purposes with a wide and well-established user base. The software shall be supplied as a complete package for a fully functioning SCADA system.

No additional software, licenses or modules shall be necessary for the Client to purchase in order to configure or use all the features of the system. The SCADA software shall consist of scalable, complementary, open architecture software objects that are user configurable to implement a functional SCADA system in a modular fashion.

The SCADA software shall support and utilize the features of the operating system that it is deployed on (such as multi-tasking, multi-threading and security). The package shall provide an extensive selection of communication protocol drivers to support various remote connected devices.

The protocol drivers shall be robust and shall detect any communication failures to and from connected devices. Detected faults shall produce event/alarm failure signals for reporting. The package shall be capable of a single user or multi-user (client / server) installation operating in a LAN configuration with the capability of having multiple workstations working simultaneously off a common database.

8.2 Data access method and processing

The SCADA system shall support both polling and event-oriented protocols for accessing data from connected substation devices (Protection Relays, BTU's and RTAC).

The SCADA system shall provide for signal priority processing, i.e. to exclude any signal from being logged or processed unnecessarily while maintenance is being performed to the system or a higher priority condition exists (e.g. inhibit AC failure alarms on every BTU when in reality a power failure has occurred at the main intake point). **The Contractor shall ensure that the signals received at the control room shall include but not be limited to the signal list provided for each substation in Appendix C of the document.**

In terms of process executions, the priorities of activities shall be as shown (in order of highest priority to lowest):

- iv) Control commands
- v) Status indications
- vi) Measurements

Analogue/measured values shall be monitored and registered in the SCADA systems real-time memory, represented by it is a unique tag-name and its instantaneous reading. This information shall be available and continuously updated for further processing, logging and report generation.

The SCADA system shall allow for analogue value manipulation by means of the basic arithmetical functions e.g. product of the voltage and currents to provide the apparent power values. The system shall allow for data to be organised in chronological order.

8.3 Data Logging to Database

The SCADA system shall have historical data logging capabilities that allows the user to define the points that are to be sampled, the sample frequency and how long to retain the sample data. The system shall be capable of (1) sampling data at intervals as low as 1 second and (2) storage of analogue and digital signal data with a minimum capacity of six months. It shall be possible to retrieve data for storage on an external storage medium for future reference and analysis.

The SCADA system shall allow the user to specify recording of statistics in the sample records. The statistics shall include time averages, summations, maximums and minimums, and times of maximums and minimums and shall be based on user-definable observation intervals.

The SCADA system shall be setup with auto-backup procedures of the data which shall be done during the off-peak times in a 24hr period. All historical data (measured values, events and alarms) shall be dynamically replicated to an SQL Server platform for long-term archiving purposes.

The comparison of real time data and historical data trends shall be possible on the display without affecting the on-line data logging. No data shall be automatically aged and/ or deleted from the SCADA database.

A minimum high-resolution dataset shall be kept for 3 months after which data shall be aggregated and stored in a lower resolution data for 3 years after which the oldest resolution data should be overwritten by the new data. The SCADA software Vendor shall specify the amount of storage capacity required for a period of 3 years.

Advanced users shall be able to easily retrieve and use archived data in any form (plain text, comma separated variables, binary or extensible mark-up language) using standard Microsoft products or any other third-party data analysis software.

A separate operator message log shall be provided in the SCADA system via which the manager and operators can capture, record and report on operational events, actions, problems and any other related messages.

8.4 Time and Date Stamping

The SCADA system shall be able to accommodate and record externally time and date stamped data (data that is time-stamped at the source device) as well as data that may require time and date stamping by the SCADA system itself (such as operator actions and engineering changes). All time tagged events and alarms should have a resolution of at least 10ms.

The SCADA database shall support data representation in any of the standard time formats (as selected via the operating system date and time format settings) and use this for viewing, sorting and reporting of logged data. All logic events, status changes and alarms shall be time and date stamped at the substation devices (e.g. Protection Relays) and all SCADA commands (including alarm acknowledgement) shall be time and date stamped in the Central SCADA system.

Time synchronisation shall be handled primarily by the local GPS time server. If the time server fails, the local controller must receive time synchronisation from upstream communications.

8.5 Reliability

The SCADA system shall be designed for high reliability. All hardware and standard existing software used within the SCADA system shall have been proven in user service.

The basic equipment life shall be at least ten years provided that normal routine maintenance is carried out. The equipment shall be designed to operate safely, reliably and efficiently over this period. The replacement parts necessary to achieve this reliability shall be defined by the Contractor.

The system shall minimise the possibility for loss of data. If the system loses data, then the system shall report the state to the user. Such loss of network status data shall be recoverable by suitable means of interrogation of the substation equipment via the SCADA system.

8.6 Availability

The Contractor shall describe all the offered components contributing to the SCADA system. The offer shall include calculations for the Mean Time between Failure (MTBF) and Mean Time to Repair (MTTR) for the following systems

- All IEDs
- Workstation
- HMIs
- SCADA interface (RTAC's or Gateways)

The Contractor shall propose necessary equipment such as programming tools, software, software licenses and training for engineers to acquire the required skills in order to reduce the MTTR and effectively handle the future modifications of the system.

8.7 Redundancy

The Contractor shall explain in detail all system redundancy functions included in the SCADA system offer. Redundancy functions which are not part of the offered configurations, but that will increase the operational reliability and safety shall be offered as options.

8.8 Self-Supervision

The SCADA system should be designed as a self-monitoring system with self-diagnosis that continuously supervise vital functions on the main processors and control units. All faults should be displayed centrally on the HMI and Workstation monitors as well as locally on the faulty equipment.

8.9 Web Client

The SCADA system shall have Web Client capabilities that allow the system to be accessed using a web browser. It shall provide the same monitoring and control functionality as the software installed at the control centre. The SCADA system shall be provided with a minimum of three Web Client user access.

9 SCADA VISUALISATION AND OPERATION

9.1 General

The SCADA package shall provide scalable vector graphics support for the visual representation of the electrical network. The electrical network drawing shall be based on the single line diagrams.

9.2 SCADA Page Layout

The SCADA system shall allow for a hierarchy of mimics, beginning with an overview of the electrical network that progresses down to individual substation overview and finally individual equipment detail. It shall be possible to navigate to the detail of an individual item of equipment by selecting it from any of the substation overview displays using either the mouse, keyboard or a touch sensitive screen / monitor.

All mimic displays shall be fully re-entrant meaning that the operator shall be able to go to any display without first having to backtrack via a previous higher-level display mimic. More detailed information shall be provided when hovering the cursor over equipment symbols e.g. the description of equipment.

The SCADA system shall have the capability to display graphs or tables that can be customised by the Client for the easy viewing of data such as the electricity demands at the various Eskom Intake Points.

9.2.1 Navigation section

A navigation section shall be provided to be used for easy navigation through the detail displays. The navigation section shall have a 'back' button that allow the users to return to the previous page.

9.2.2 Alarm and Message Lines

A message line section shall be provided consisting of the three most recent operator messages. Messages shall typically consist of alarms and operator alerts.

9.2.3 Detail interface requirements

Left clicking on an equipment symbol or control element shall open its faceplate. The faceplate shall show the following detail:

- i) the description and tag number of the unit
- ii) the equipment status of the unit (e.g. open, closed, earthed, tripped)
- iii) open and close push buttons
- iv) equipment measured values (e.g. current, kilowatts, etc.)
- v) a button to navigate to the trend for the equipment
- vi) safety interlocks applicable to the equipment
- vii) equipment down time hours
- viii) fault counter

After selection of the operating mode, the equipment symbol shall change colour (e.g. border or equipment colours to represent modes) and the status text shall change accordingly. Final acceptance of any instruction, data entry or selection shall always require a positive confirmation dialog.

9.3 Alarm and Event Message Handling

All faults and abnormal conditions which may occur in any substation equipment shall generate an alarm and be transferred to the local and central SCADA system.

Events will include, but not be limited to:

- Circuit breaker operation
- Isolator operation
- Earth switch position changes
- Selector switch for remote/ supervisory control on/ off position change
- Intrusion
- AC Fail
- Communication failure

It shall be possible to retrieve and sort selected parts of the alarm and event listings. It shall also be possible to sort the alarms in chronological order and by grouping alarms on a per bay basis or on the basis of the alarm type e.g. protection, overload.

The archive, in the mass storage medium, status indications and fault indications (from protection relays) are to be logged separately in different files.

All local alarms for each bay will be recorded in the BCUs and transferred to remote and supervisory control systems. In addition, the alarms must be displayed on the front of the control and/or protections units.

The SCADA alarm handling feature shall be configured to provide comprehensive fault and error annunciation, including acknowledgement and fault clearing procedures. As soon as a fault or error occurs during normal operation, the respective area display shall start flashing, raise an audible alarm, and indicate a group alarm.

The operator shall be guided by the flashing area to the detailed mimic to which the fault has been localised, from where the operator shall be able to view and acknowledge the alarm and associated alarm text. It shall be possible to configure alarms to trigger an audible alarm with variable tones. Acknowledged alarm text messages that have not yet been cleared in the field, shall be displayed by means of a steady-state font colour. Only after the fault/error has been cleared/reset, shall the alarm text be removed from the list of current alarms.

In addition, potential free contacts in the substation equipment should be available for an audible alarm system in the substation. It should be possible to block the alarm in case the substation is unmanned, in case of maintenance work, or if there is a faulty alarm that is frequently playing up.

The operator shall be able to fully navigate and sort the alarm list, including acknowledged and unacknowledged alarm messages, and shall be able to filter items by type of fault or equipment type. Acknowledged and unacknowledged alarms are to be given different colours.

The system shall be able to accommodate a minimum of 8 000 alarm messages at any one time. Once the limit has been reached, all acknowledged and cleared alarms shall be archived to make space for new alarms. Archiving shall also take place automatically once per day. Error messages shall not take the form of the IED's error abbreviations but shall consist of complete sentences or words.

9.4 Trending

The SCADA system configuration shall provide the ability to store and view any data value from the database and allow for trending of both real time and historical measured values. It shall be possible to display up to 8 values (in any combination e.g. digital, analogue, etc.) per trend page. The system shall bring up pixel-resolution trend curves that shall be displayed in a graphical format i.e. "a bar graph or line graph format". Tools shall be provided that allow the user to configure and customize trend graphs in terms of the line type, colour, axis scales, measurement units and numbering. Trend graphs shall be displayed in separate windows that can be moved, re-sized and minimized to an icon.

The operator shall be able to freely select the beginning of the trend curve and shall be able to spread the ordinate, i.e. “zooming” into or out of the trend. Trends shall show the actual values (which support sample rates as low as 1 second) with the time axis full scale being selectable. The last one tenth of the display shall be updated and once it is full, the total curve shall be moved back one tenth, and so on.

Trend curves shall display the current values, minimum, maximum and average values over the trend range at the cursor position. At least two upper and lower set point limits shall be provided for all analogue measurements. Continuous monitoring of these limits shall be possible. Each set point shall be independently adjustable. Blocking and unblocking of associated alarms shall be possible.

The historical trending curves shall provide for range selection in the following standard configurations of the time axis.

- i) ¼ hour demand - for daily historical trend curve
- ii) 2hour demand - for weekly historical trend curve
- iii) Daily demand - for monthly historical trend curve
- iv) Monthly demand - for annual historical trend curve

9.5 Reports

The SCADA system shall provide for an extensive reporting system, with output options to screen, file or printer. Two broad categories of reports shall be provided, being (1) standard reports and (2) on demand query type reports.

9.5.1 Standard Reports

It shall be able to schedule reports for predefined periods such as daily, weekly, monthly, yearly that includes:

- i) Equipment data (down time, faults, max/min/demand current)
- ii) Electrical consumption
- iii) Operator Alerts and Messages

9.5.2 On Demand Query Reports

The SCADA system shall allow the user to configure custom reports for any period. The user shall be able to select any of the following values over a period (the output shall be Microsoft Excel compatible).

- i) Analogue values, minimum, maximum and demand values (e.g. current measurements, electrical consumption)
- ii) Equipment status
- iii) SAIDI, SAIFI, CAIDI and CAIFI values

9.6 Alert Messages

The SCADA system shall have Email and SMS functionality that allows the manager or operational personnel to receive certain alarms or events that have been triggered. Email and SMS messages shall be configured for up to 10 different recipients and message content as well as recipient contact details shall be freely configurable by the SCADA administrator.

10 SYSTEM SOFTWARE

10.1 General

SCADA Software shall include computer operating system software, hardware and peripheral drivers, SCADA specific applications (data acquisition, data storage, visualization and reporting) as well as general computer operations and maintenance software (e.g. anti-virus software, back-up software etc.). Pricing shall include all software to operate, maintain and program the SCADA system.

Software updates that occur within one year of the contract award date shall be furnished to the Client at no additional cost. All software supplied under this contract shall be registered and licensed to the Client and the Contractor shall include proof of such licences in the Operations and Maintenance Manuals to be submitted on completion.

10.2 Computer Viruses

Unless the Client has his own enterprise wide licence for Computer Anti-virus software, the anti-virus software shall be supplied and installed together with the OEM's operating system.

The anti-virus software package shall be of reputable manufacture with continuous update support to protect the system with the latest anti-virus technology. The anti-virus software shall be provided preferably with an unlimited license linked to the Operating System License (e.g. Windows Defender).

10.3 Computer Operating System

All SCADA computers shall be supplied with latest Microsoft Windows operating system. The operating system shall provide secure, integrated networking (LAN) features, protocols and services without the need for additional 3rd party networking software.

The SCADA logging database shall be accessible (read-only access) via the LAN interface for use in management information services. Offers shall include all database client access licences required for the offered SCADA system. The operating system shall incorporate both a local and domain (work group) based security system with configurable users, groups and access permissions.

10.4 Special requirements

Under no circumstances shall it be possible to cause a system lockup, failure, or database contamination by operators entering spurious data or pressing the wrong sequence of keys or by accidentally leaning on the keyboard of the computer or any of its peripherals.

A "warm boot" (e.g. pressing the Ctrl, Alt and Del keys) shall be protected by means of a password. Inputs by operators shall be vetted for spurious or incorrect data. Appropriate error messages shall be displayed in such cases. In the case of a power failure (and subsequent run-down of the UPS) the system shall automatically shut-down saving all current status and data. The system shall reboot automatically when power is restored and load the last stored status and data in order to continue normal operation. An alarm log entry shall be made stating the time and duration of the power failure.

11 SCADA COMMUNICATION

11.1 General

The SCADA system shall be equipped to communicate with the various substations located within the KwaDukuza Municipality and the Mandeni Local Municipality Main Intake point auto-recloser. **It is the Contractors responsibility to ensure that the cellular communication design has been analysed by experts and that the tailored solution has been approved by KDM before it is implemented.** The communication solution shall take into considerations protection against cyber-attacks and network failure redundancy.

An access point network (APN) shall be established to provide added protection on the cellular network. Modems shall be equipped with open VPN software to create a private network within the substation thereby reducing the risk of unauthorised personnel accessing the system.

11.2 SCADA Equipment Addressing

Every device installed in the SCADA system requires a unique identifier. This shall be done using the Internet Protocol Address version four (IPv4). IP addresses always consists of four numbers (or four octets). It is divided into two parts namely (1) Network ID and (2) Host ID. Figure 2 below represents the IP Address format.

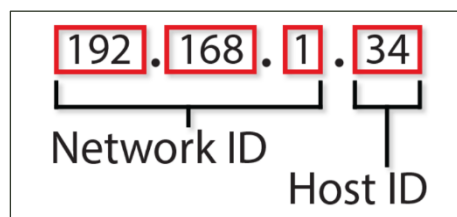


Figure 2: IP Address Format

It is the Contractors responsibility to ensure that each device is configured with an IP Address. The IP address shall be engraved on a label and fixed below each device. The Contractor shall ensure that the host ID (fourth number of the IP Address) is consistent with the type of equipment installed at various locations, for example all workstations shall have a Host ID within the range 20 – 29 as shown in Table 2. This allows for easy identification of the installed equipment during the engineering and commissioning stage of the project.

IP ADDRESS – UNIQUE HOST ID's		
No.	Equipment Type	Reserved Range
1	RTAC	10 – 19
2	Workstation	20 – 29
3	Synchronised Satellite Clock	30 – 39
4	Modem	40 – 49
5	I/O Module	50 – 69
6	Serial Port Server	70 – 89
7	Managed Switch	90 – 109
8	Protection Relays	110 - 254

Table 2: IP Address - Unique Host ID's

12 SCADA ACCESS SECURITY

The Operating System shall provide access security to prevent unauthorised access to the SCADA system. Securing the system through usernames and passwords shall prevent accidental reconfiguring and provide a traceable log of all SCADA activity.

It shall be possible to integrate the security models of server and client computers (e.g. domain / workgroup type security). Any invalid password entry shall be logged by the system with an explanatory message appearing on the SCADA display. Details regarding the use and implementation of passwords shall be finalised with the Client. The passwords shall be per user with individual expiry periods and shall comply with validity rules before being accepted by the system. These rules shall include, as a minimum, a combination of characters and minimum length. Suitable encryption methods shall be applied.

The Operating System security model shall provide for a hierarchy of user access by means of various user account levels. At least four levels of security shall be provided as follows.

- **Field Operators**

Field Operators shall be required to logon to be able to perform their functions as follows:

- i) View and monitor the network statuses and measurements only
- ii) View, acknowledge and reset alarms

- **Controllers**

Controllers shall be required to logon to be able to perform their functions as follows:

- i) View, monitor and control the network
- ii) View, acknowledge and reset alarms
- iii) Select, display and reconfigure trend periods
- iv) Print trends and reports

- **Managers**

In addition to the permissions of Controllers, the managers must be able to perform the following functions:

- i) View the events list
- ii) Reconfigure the events list
- iii) Print the events list

- **Administrators/Engineering**

Shall have access to all SCADA system configuration menu items and functionality including:

- i) Operating System Task Manager
- ii) Operating System Explorer
- iii) Operating System User Manager
- iv) SCADA Software Setup
- v) SCADA Communications Protocol Management.
- vi) Change parameters
- vii) Authorise access to other users

13 CONTROL ROOM FURNITURE

Purpose made SCADA control desk furniture to accommodate the hardware and peripherals shall be provided. The control desk shall include a dust proof compartment in which the Operator workstation computer case and printer shall be housed.

Operator monitors shall be mounted on a single desk mount bracket that supports dual monitor mounts. The bracket shall support vertical and tilt adjustments for the monitors. All cabling shall be done neatly in the desk recesses and no cables other than the keyboard and mouse cables shall be routed outside of the desk.

The control desk shall further contain a section where the Employer's telephone equipment and radio equipment can be housed. Due to the insufficient space at the control desk, a dedicated cupboard shall be provided for the operations and maintenance manuals, operator log books, report files, printer paper, printer cartridges and any other general stationary. The cupboard shall be fitted with roll to side doors and not the hinge type.

A separate desk and chair shall be provided for the planner, dispatcher and the manager. The contractor shall provide a whiteboard with stationery (i.e. set of markers, duster and a tray to house the stationery) for the control room and the manager's office. Figure 3 & 4 below shows the proposed layout options for the control room. The Client shall decide on the final layout of the Control Room.

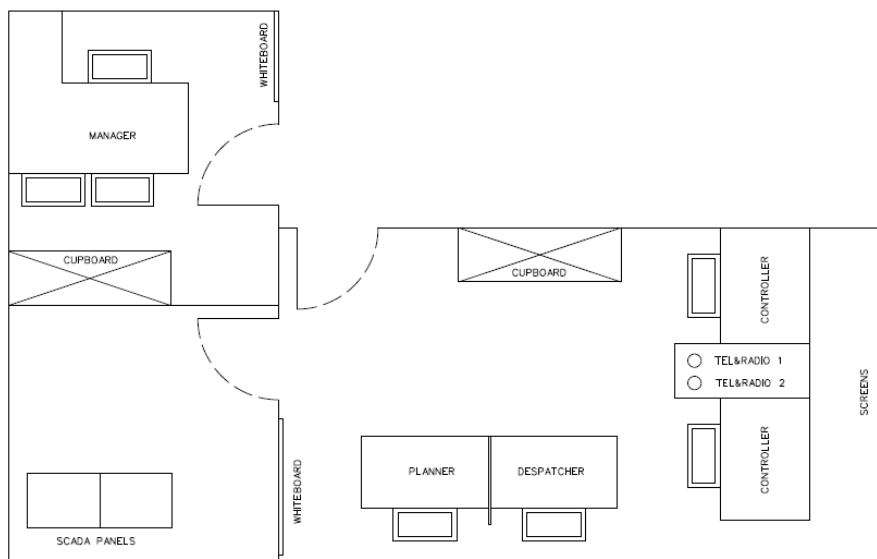


Figure 3: Proposed Layout of the Control Room – Option 1

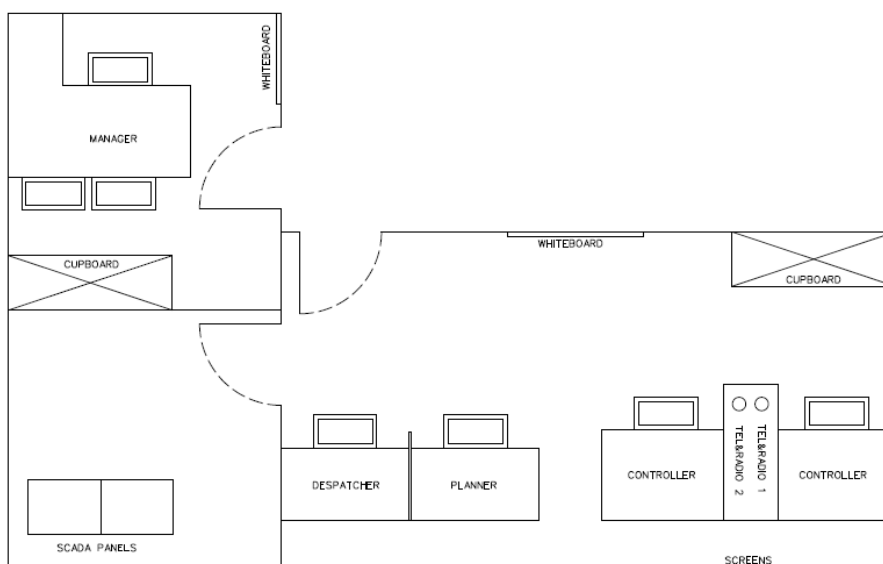


Figure 4: Proposed Layout of the Control Room – Option 2

14 INSTALLATION REQUIREMENTS

14.1 General

SCADA equipment at the control room and at each substation shall be installed in panels. Only the control room workstation will be located in the SCADA control desks (furniture) as described in the previous chapter. The panels shall be of the substation 48U mild steel swing frame type as shown in Figure 5 below. The swing frame panels shall all be floor-mounted and be off-set at the cable trench to facilitate bottom entry of the control and LV power cables. All panels shall be coated with light grey paint shade G29.

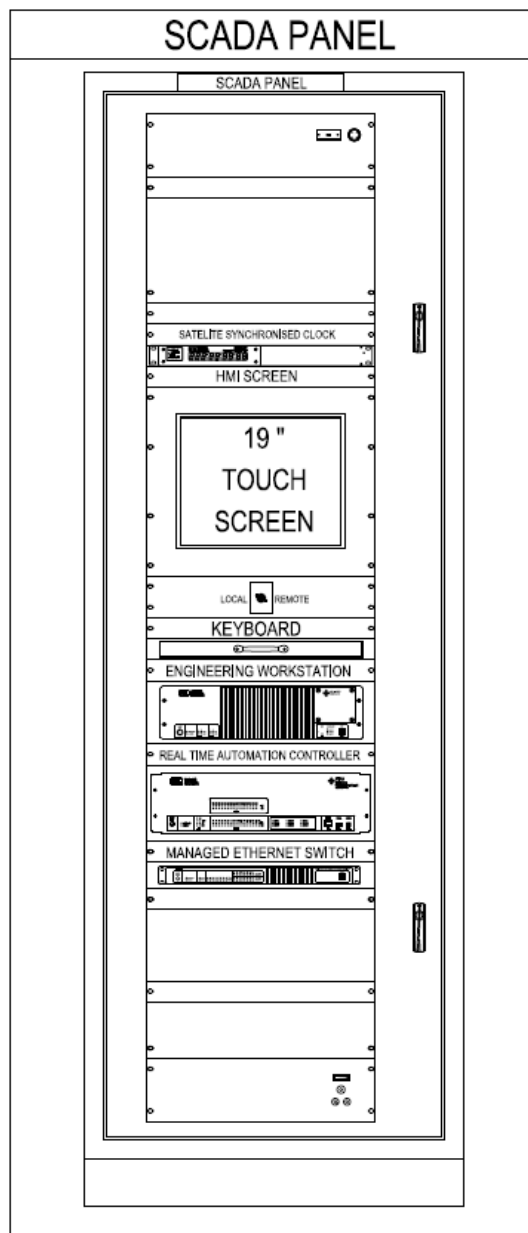


Figure 5: 48U Mild Steel Swing Frame SCADA Panel

The design and construction of the building civil, structural (e.g. computer false floor), air-conditioning, ventilation, small power and lighting requirements for the control room will be done by KDM. The installation shall be earthed in accordance with the latest issues of the applicable South African National Standards (SANS) and any applicable bylaw of the municipality.

14.2 Fibre Optic Cable Installation

14.2.1 Installation

During the installation and handling of the fibre optic cable, the Contractor shall ensure that the fibre optic cable does not suffer permanent damage and does not exceed the macro bending radius. Macro-bending occurs when the fibre is bent into a visible curvature. If the cable is bent below the allowable macro-bending radius during operations, the bend causes additional attenuation of the optical signal. The macro-bending radius may be exceeded somewhat during installation, but the Contractor must ensure that the final installation does not exceed the operational radius. Doing so will mean that the quality inspection will fail and the installer will have to re-install the fibres.

- i) Minimum bend radius during installation = 20mm
- ii) Minimum operational bend radius = 30mm

14.2.2 Splicing

It is important to keep fibre as clean as possible. Joining optic fibre involves the stripping, cleaning and cleaving of the fibre as well as the perfect alignment of fibre cores and splicing the aligned cores afterwards. Only fusion splicing done with a Core Alignment Fusion Splicer will be allowed to do the splicing of the fibre optic cable. The Contractor shall ensure that the technician splicing the fibre possess a valid and up-to-date Certified Fibre Optic Technician (CFOT) certificate issued by the Fibre Optic Association (FOA).

The splices must be protected with heat-shrink splice protectors containing a strengthening member. Neither mechanical nor temporary splices nor metal crimp-type splice protectors will be accepted.

- i) Maximum allowable attenuation per splice = 0.15 dB
- ii) At least 70% of all splices on a given fibre strand must have an attenuation ≤ 0.1 dB

Under no circumstances will KwaDukuza Municipality accept any broken or damaged fibre strands in the cable. Once the cable has been spliced and terminated a test shall be conducted. This test shall be performed by an **independent Contractor** and not by the installer. If it is found that any of the splices on the installed Cable/Patch Panel do not conform to the specifications, the Contractor shall be expected to re-splice at their own cost. Under no circumstances will KwaDukuza Municipality accept any splices that do not conform to this specification.

15 QUALITY MANAGEMENT

15.1 Quality Assurance Requirements

The Contractor must, for all Works to be performed under for this Project, plan, establish, implement and maintain a quality assurance system which meets the requirements set out in ISO 9001:2000 and the project technical specifications.

The quality assurance process to be adopted during construction as well as operations and maintenance phase of the equipment shall comprise of the following:

- Design of the system shall be carried out by competent personnel and shall be reviewed to confirm compliance with the technical specifications as well as legal and regulatory aspects prior to commencement of manufacturing or construction
- The system shall undergo inspection and testing during manufacture, erection and on completion for verification that the components satisfy all the requirements as specified. All equipment inspection and testing shall be conducted in accordance with the applicable codes and standards. The Contractor shall consider the provisions specified as minimum requirements and use its own experience in determining requirements for additional inspection and testing that it considers necessary.
- All final design and drawings for construction shall be signed off by a professionally registered engineer.

15.2 Quality Management Plan

The Contractor must provide the Client with a copy of its Quality Management Plan. The Quality Management Plan must cover the following phases of the Works:

- Design
- Manufacture/Procure
- Transportation/delivery
- Installation
- Commissioning and testing.

The Quality Management Plan shall explicitly include milestones for review by the Client.

16 TESTING AND COMMISSIONING

16.1 Test certificates

Single copies of type test certificates shall be submitted with the tender. If all the required type test certificates are not submitted, the tender will be viewed as incomplete.

16.2 Installation tests

As part of installation of the SAS equipment on site, the following tests shall be conducted:

- i) Network integrity testing
- ii) Network redundancy checks
- iii) Control checks to switchgear, isolators and earth switches
- iv) Events recording and sequence of events reporting
- v) Alarm recording and reporting
- vi) IED configuration access
- vii) Fault record analysis

16.3 Witnessing of tests

KDM reserves the right to appoint a representative to inspect the manufacture of equipment at any stage of their manufacture and to witness and sanction any tests. If inspection or witnessing of tests is required, KDM will advise the Contractor who shall then give at least 14 days' notice of the date on which impending inspection or testing will take place.

The SCADA system to the field device communications shall be tested with the actual device on site with a simulation of the physical I/O to those devices being monitored or controlled.

16.4 Supporting data

Supporting data in the form of marketing brochures or catalogues stating the characteristics and construction details of the equipment on offer shall be included with the tender. Any deviations between the published data and the completed technical data sheets shall be pointed out and clarified.

16.5 Design changes

Any design changes shall be verified by tests wherever applicable and shall be subject to KDM approval.

17 DOCUMENTATION AND TRAINING

17.1 SCADA System Detail Specification and Training

The SCADA system shall be described in detail in a SCADA System Detail Specification produced by the Contractor for approval by the Engineer before configuration commences. The following shall be included in the document:

- a) SCADA hardware configuration
- b) SCADA software configuration (default and edited settings)
- c) Tagging system
- d) Tag List with Tag count
- e) Mimics (mocks ups before programming)
 - i) Page Layout
 - ii) Electrical Network Overview
 - iii) Substation Overviews
 - iv) Navigations Bar
- f) Alarms Page
- g) Reports
- h) Database Design
- i) Trending/logging
- j) Security Features
- k) Security Passwords
- l) Access Hierarchy

Comprehensive documentation of the installed and commissioned components and system, training and operations & maintenance manuals shall be provided for the completed SCADA system provided under this contract.

Training of the SCADA personnel shall be done using the “Train the trainer” model and shall be undertaken at least a month before commissioning of the system. The training shall cover the following:

- i. The basic operation and maintenance of the equipment installed.
- ii. The detailed operation of the SCADA software.
- iii. How to analyse and address alarms and events flagged by the software.

17.2 Drawings

Detailed drawings shall be supplied during the installation of the SCADA system. Upon completion of the installation, the Contractor is required to provide As-Built drawings in the format that the Client prescribes. Two sets of hard copies shall be printed, and two sets of software copies, compatible with the Client’s engineering and GIS software-shall be provided to the Client.

17.3 Data book and documentation

All data books or manuals shall be provided for the equipment before the start of commissioning. Any modifications made during commissioning shall be marked up in red in the data book, and a revised data book or manual provided as soon as practicably possible.

The data book or manual shall be in a format that allows for the effortless update of the existing municipal asset register. It shall include key information on each installed equipment such as:

- 1) Equipment type and description
- 2) Current value (Rands)
- 3) Serial number of equipment and location

- 4) Delivery date
- 5) Installation date
- 6) Commissioning date
- 7) Notable events and incidents.

The data book or manual shall contain clear instructions for routine inspections, maintenance, fault-finding, repair and disposal over the life of the equipment. Reference values of all relevant tests shall be included as the basis for trend analysis during the life of the equipment. The data book shall contain clear instructions for the storage of spare parts, and comprehensive information about the shelf-life of spare parts and any tests which should be conducted on spare parts before utilisation. In addition to hard copies, soft copies of the data book and documentation for the equipment shall be supplied.

On Completion of the Project, the Contractor shall retain records as objective evidence to assure the Client that the requirements for defects liability services are being administered in accordance with the quality management system standard. The Contractor must retain the quality records of the project for a minimum period of three years.

18 PACKAGING

The equipment shall be packaged in such a manner as to protect the equipment and its components against corrosion and damage during normal handling, unpacking, transportation. All fittings required for the lifting and installation of the equipment shall be provided.

19 SPARE PARTS AND SPECIAL TOOLS

The complete spare parts list, including parts location diagrams or drawing and prices, which the manufacturer recommends for the first three years' operation, shall be submitted by the Contractor to the Client. The agreed spare parts and special tools shall be supplied before the start of commissioning.

The spare parts that shall be handed to the Client upon completion shall include but not be limited by the following:

- a) 1 x Power Supply for the Managed Switch
- b) 1 x Power Supply for the RTAC
- c) 2 x Modems
- d) 2 x DC-DC Convertors

Any spare parts consumed during commissioning shall be replaced as soon as practicably possible.

20 GUARANTEE AND MAINTENANCE

20.1 General

The Contractor shall guarantee and maintain the Contract Works for a period of three years after first delivery of the SCADA Equipment. During the maintenance period the Contract Works shall be maintained by the Contractor and any defective material, equipment or workmanship (except proven, wilful or accidental damage, or fair wear and tear) shall be rectified as soon as possible, at the

Contractor's expense and to the satisfaction of the Client. This shall include making good, the work done by others, arising out of accidental removal or reinstallation of equipment.

All work arising from the implementation of the guarantee or maintenance of equipment shall be carried out at times which will not result in any undue inconvenience to users of the equipment or occupants of premises. The response times required to address and resolve any issues shall be stipulated in the service level agreement between the Client and the Contractor/Supplier. If any defects are not remedied within a reasonable time the client may proceed to do the work at the Contractor's risk and expense, but without prejudice to any other rights which the client may have against the Contractor.

20.2 Latent Defects and Failure to Comply with Specification

The Client reserves the right to demand the replacement or making good by the Contractor at his own expense of any part of the project which is shown to have any latent defects or not to have complied with the Specification, notwithstanding that such work has been taken over or that the guarantee period has expired.

20.3 Maintenance

At intervals not exceeding four months, during the guarantee period of three years the Contractor shall maintain the equipment in proper working order. As a minimum requirement the following shall be done:

- 1) Visit each substation and the control centre to check the condition of equipment and verify that all equipment is functional.
- 2) Submit a formal report to the Client, of all checks done during the site visit.
- 3) Any equipment that has failed shall be replaced at the Contractor's cost and shall be recorded in the report mentioned above.
- 4) Check functionality of the Master SCADA software and rectify any errors, faults, glitches in the software that have been experienced by the controllers.
- 5) Generator Checks:
 - Check and top-up if necessary, the fluid levels in the radiator, engine sump and fuel oil tank.
 - Test run the standby genset and ancillary equipment for a period of 15 minutes.
 - Wipe down the standby genset and its ancillary equipment and report on any evidence of any fluid leaks or other defects.
 - Fill in the standby genset logbook.

The cost of such inspections, maintenance, adjustments, repairs, etc., shall be included in the tender price, but the cost of renewing any part which may become worn through fair wear and tear, or damaged beyond the control of the Contractor (provided this is not due to unsuitable design) shall be excluded.

If during the guarantee and maintenance period, the equipment supplied by the Contractor is not in working order for any reason for which the Contractor can be held responsible, then the Contractor will be notified and immediate steps shall be taken by him to remedy the defects.

Should the equipment defects be so frequent as to become objectionable or should the equipment otherwise prove unsatisfactory during the guarantee period, the Contractor shall, if called upon by the Client, at his own expense, replace the whole or such parts thereof as the Client may deem necessary with equipment to be specified by the Client.

It is in the Contractor's interest to visit the site, as no additional costs or variations due to the lack of knowledge will be entertained.

21 BATTERY LIMITS

21.1 Contractor's Obligation

The Contractor shall be held responsible for a fully functioning SCADA system and shall not be limited by the following:

- a) Complete detailed design of the SCADA system which includes the AC and DC Schematics which shall be submitted by the Contractor to the Client for approval. This shall include the verification of the BTU capacity at each substation, providing its expansion if it is necessary.
- b) On completion of installation and commissioning of the relevant equipment, the originals drawings mentioned above shall be updated by the Contractor to reflect the as-built status. The Contractor shall then provide the Client with one copy of all relevant CAD data for drawing records and drawing reproduction. All the "As-Built" drawings will be provided in AutoCAD and PDF format. Relevant hard copies shall be provided, along with 3 soft copies in the most relevant format (flash drive or equivalent).
- c) All the Operational and Maintenance manuals shall be provided in PDF format, as well as, three sets of paper copies to the Client.
- d) As part of the implementation, all relays shall have the IEC61850 protocols enabled. If it is not possible to enable the IEC61850 then DNP3 shall be accepted. The Modbus protocol will not be accepted for communication unless the relay does not have the capability to have the IEC61850 or DNP3 protocol enabled.
- e) Any additional wiring of primary plant signals that maybe required to provide a complete SCADA system.
- f) Training provided to the Clients staff shall utilise the "train the trainer" model. Delegates for the training course will be limited to a maximum of 5 people. The Contractor shall provide all training equipment required and each trainee with a certificate indicating that the trainee has been introduced and can operate and maintain the relevant equipment trained for.
- g) The guarantee and maintenance relating to the SCADA system shall be for a period of three years. The Contractor shall furnish the Client at no additional cost within the three-year period the following:
 - Replacement of equipment that has latent defects
 - Replacement of equipment that has failure
 - Maintenance of SCADA Software
 - Updates that would be required by the SCADA Software
- h) All software supplied under this contract shall be registered and licensed to the Client and the Contractor shall include proof of such licences in the Operations and Maintenance Manuals to be submitted on completion.
- i) Communication cables required to communicate with the installed equipment shall be provided to the Client at no additional cost.
- j) All equipment that can be reused shall be returned to the Client. Unwanted equipment shall be disposed of by the Contractor. The Contractor shall liaise with the Client to determine what equipment is to be returned prior to disposal.

21.2 Client's Obligation

The Client shall be responsible for the following:

- a) The design and construction of the control centre civil, structural (e.g. computer false floor), air-conditioning and ventilation, and building services electrical power supply. (Note that this does not form part of this specification).
- b) The Control Centre small power and lighting requirements does not form part of this specification and shall be done by the Clients Engineer. (Note: Only the generator backup supply specification and installation will form part of this specification and shall be carried out by the Contractor.)
- c) The Client shall provide the training venue and at least 3 weeks' notice prior to commencement of the training course. This is to ensure the Contractor has sufficient time to make the necessary arrangements for the training.
- d) Any work outside the scope of this specification shall be for the Clients cost.



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APPENDIX

Appendix A

SCADA Equipment Technical Data Sheets

Appendix A1 – Managed Ethernet Switch

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
1.1	Manufacturer		SEL or Similar	
1.2	Type		SEL-2730M or similar	
1.3	Lead Time	Weeks	Specify	
1.4	Minimum Warranty	Years	10	
2	Ratings			
2.1	Type of supply	Single	Hot-Swappable Power Supply	
2.2	Rated Voltage of Power Supplies	V AC	120 / 240	
		V DC	125 / 250	
2.3	Rated Operating Frequency	Hz	45 - 60	
2.4	Type of Operation		Managed	
2.5	Maximum Power Consumption	W	40	
2.6	Minimum Operating Temperature	°C	-40	
2.7	Maximum Operating Temperature	°C	85	
2.8	Relative Humidity (non-condensing)	%	5 - 95	
3	Ports, Connectors and Construction			
3.1	Gigabit Ethernet single and/or multimode fiber SFP transceivers		Yes	
3.2	Copper Gigabit Ethernet interfaces		Yes	
3.3	Type of Ethernet Cable		CAT 6	
3.4	Cable Construction Type (UTP, STP, S/STP)		STP	
3.5	Ethernet Cable Connector Type		Shielded Female RJ45	
3.6	Ethernet Cable Boot Required		Yes	
3.7	Conformal Coating on Circuit Boards		Yes	
3.8	Heavy Duty DIN Rail Mountable or 19' Rack Mount Profile		Yes	
3.9	Industrial terminal blocks for power & I/O connections		Yes	
4	Features			
4.1	VLAN (802.1Q) to segregate and secure network traffic		Yes	
4.2	Traffic Prioritization		Yes	
4.3	Port Mirroring for Network Statistics and performance troubleshooting		Yes	
4.4	Multi-level user passwords		Yes	
4.5	RSTP to Speed Network Recovery		Yes	
4.6	Port rate limiting and Broadcast storm limiting		Yes	
4.7	Port Based MAC Security		Yes	
4.8	Dedicated Alarm Contact Output		Yes	
4.9	Immunity to EMI and Electrical Surges		Yes	

Appendix A2 – Modem

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
1.1	Manufacturer		MOXA or Similar	
1.2	Type		OnCell G3150A-LTE or similar	
1.3	Lead Time	Weeks	Specify	
1.4	Minimum Warranty	Years	5	
2	Ratings			
2.1	Type of supply		Dual Redundant Inputs	
2.2	Rated Voltage of Power Supplies	V DC	12 - 48	
2.3	Type of Operation		Dual cellular operator backup with dual-SIM	
2.4	Maximum Power Consumption	W	9.6	
2.5	Minimum Operating Temperature	°C	0	
2.6	Maximum Operating Temperature	°C	55	
2.7	Reverse Polarity Protection		Yes	
2.8	Minimum IP Rating		IP30	
2.9	Mounting Type		Din-Rail	
2.10	Compliance with IEC61000-4-(2,3,4,5,6,8), CE Mark		Yes	
3	Cellular Interface			
3.1	Number of SIM's	Number	2	
3.2	Standards		GSM/GPRS/EDGE/UMTS/HSPA/LTE	
3.3	Bandwidth	MHz	Universal quad-band GSM/GPRS/EDGE 850/900/1800/1900	
3.4	Minimum LTE Data Rate (10MHz Bandwidth)	Mbps (DL)	50	
		Mbps (UL)	25	
3.5	Minimum HSPA Data Rate	Mbps (DL)	42	
		Mbps (UL)	5.76	
3.6	Minimum EDGE Data Rate	Mbps (DL)	237	
		Mbps (UL)	237	
3.7	Minimum GPRS Data Rate	Mbps (DL)	85.6	
		Mbps (UL)	42.8	
4	LAN Interface			
4.1	Number of Ports	Number	1	
4.2	Connector (10/100Mbps)		RJ45	
5	Serial Interface			
5.1	Number of Ports:	Number	1	
5.2	Serial Standards:		RS232/422/485, software selectable	
5.3	Connector		DB9 male	
6	Interface			
6.1	Cellular Antenna Connectors		2, SMA (female), MIMO for LTE, antenna diversity for WCDMA	
6.2	GNSS		1 SMA (female), GPS, GLONASS	
6.3	LED Indicators		Yes	

ITEM	DESCRIPTION	UNIT	REQUIRED		OFFERED	
			SCHEDULE A	SCHEDULE B	SCHEDULE A	SCHEDULE B
6.4	Reset Button				Power Reset/Factory Default Reset	
7	Minimum Software Requirements					
7.1	<u>Network Protocols</u> : ICMP, DDNS, TCP/IP, UDP, DHCP, Telnet, DNS, SNMP, HTTP, HTTPS, SMTP, NTP (SNTP client), ARP			Yes		
7.2	<u>Routing</u> : NAT, Port forwarding			Yes		
7.3	<u>Firewall</u> : Filter: MAC, IP protocol, port-based, Access IP list			Yes		
7.4	<u>IPSec VPN</u> : Encryption: DES, 3DES, AES, MD5, SHA-1, DH2, DH5. Authentication: PSK/X.509/RSA			Yes		
7.5	Minimum number of IPSec VPN Tunnels	Number		5		
7.6	<u>OpenVPN</u> : OpenVPN (Server/Client), Tunnel mode (routing) and TAP mode (bridge)			Yes		
8	DC-DC Converter to be provided with Modem					
8.1	Input Voltage for Substations with 110V DC BTU	V DC		19 - 36		
	Input Voltage for Substations with 32V DC BTU	V DC		72 - 144		
8.2	Output Voltage	V DC		11 - 16		
8.3	Maximum Power Consumption	W		102		
8.4	Voltage Tolerance	%		± 1		
8.5	Load Regulation	%		± 0.3		
8.6	Minimum Operating Temperature	°C		-10		
8.7	Maximum Operating Temperature	°C		60		
8.8	Compliance with: IEC60950-1, EN55022 - Class B, EN61000-4-(2,3,4,6,8).			Yes		

Appendix A3 – Real Time Automation Controller (RTAC)

ITEM	DESCRIPTION	UNIT	REQUIRED		OFFERED	
			SCHEDULE A	SCHEDULE B	SCHEDULE A	SCHEDULE B
1.1	Manufacturer				SEL or Similar	
1.2	Type				SEL-3530 or similar	
1.3	Lead Time	Weeks			Specify	
1.4	Minimum Warranty	Years			10	
2	Ratings and Construction					
2.1	Type of supply				Single Power Supply	
2.2	Rated Voltage of Power Supplies	V AC			120/240	
		V DC			125/250	
2.3	Rated Frequency	Hz			50/60	
2.4	Maximum Power Consumption	VA			40	
		W			30	
2.5	Minimum Operating Temperature	°C			-40	
2.6	Maximum Operating Temperature	°C			85	
2.8	Relative Humidity (Non-condensing)	%			5 - 95	
2.9	Compliant with				IEC61000-4; IEEE1613 and CE Mark	

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
2.10	Overvoltage Category		II	
2.11	Insulation Class		1	
2.12	Conformal Coating on Circuit Boards		Yes	
2.13	Heavy Duty DIN Rail Mountable or 19' Rack Mount Profile		Yes	
3	Operating System Parameters			
3.1	Operating System		Linux Kernel 3.x with real time preemption patches	
3.2	Processor Speed	MHz	533	
3.3	RAM (DDR2 ECC)	MB	1024	
3.4	Storage	GB	2	
3.5	LEDs for Communications status and port activity		Yes	
3.6	Basic HMI Run-Time License		Yes	
3.7	File I/O and Trend Recorder		Yes	
4	Communication and Communication Ports			
4.1	<u>Ethernet Client Protocol</u> : DNP3, Modbus, IEC 60870-5-101/104, C37.118 Synchrophasors, L&G 8979, CP2179, SNMP, IEC 61850 MMS and MMS Client File Services		Yes	
4.2	<u>Ethernet Server Protocol</u> : DNP3, Modbus, L&G 8979, SES-92, IEC 60870-5-101/104, C37.118 Synchrophasors, CDC Type II, IEC 61850 MMS and MMS Server File Services		Yes	
4.3	<u>Peer to Peer Protocol</u> : Network Global Variable List (NGVL), IEC 61850 GOOSE		Yes	
4.4	USB Ports		Yes	
4.5	Digital AC and DC Inputs		24	
4.6	Digital Outputs		8	
4.7	Copper 10/100 Base-T Ethernet ports (RJ45 front, RJ45 or LC Fibre rear)		2 rear, 1 front	
4.8	EIA-232 Serial Ports (optionally expandable up to 33)		17	
4.9	Demodulated IRIG-B input and output		Yes	
4.10	LEDs for Communications Status and Port Activity		Yes	
5	Features			
5.1	Protection against Malware and Cybersecurity Threats		Yes	
5.2	User Security		Yes	
5.3	Comply with NERC/CIP User authentication		Yes	
5.4	IEC 61131-3 Logic Design		Yes	
5.5	Flexible Protocol Conversion		Yes	
5.6	Data Management		Yes	

Appendix A4 – Workstation

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
1.1	Manufacturer		SEL or Similar	
1.2	Type		SEL-3355 or similar	
1.3	Lead Time	Weeks	Specify	
1.4	Minimum Warranty	Years	10	
2	Ratings			
2.1	Type of supply	Single	Hot-Swappable Power Supply	
2.2	Rated Voltage of Power Supplies	V AC	120/240	
		V DC	125/250	
2.3	Rated Frequency	Hz	50/60	
2.4	Maximum Power Consumption	VA	248	
		W	240	
2.5	Minimum Operating Temperature	°C	-40	
2.6	Maximum Operating Temperature	°C	60	
2.7	Relative Humidity (Non-condensing)	%	5 - 95	
2.8	Compliant with		IEC61000-4; RoHS Compliant and CE Mark	
2.9	Overvoltage Category		II	
2.10	Insulation	V DC	3600	
2.11	Insulation Class		1	
2.12	Clock/Calendar battery life without source connected	Year	2	
2.13	Alarm Contact Continuous Current Rating @ 70°C	A	6	
2.14	Alarm Pickup and Dropout Time	ms	< 8	
2.15	Conformal Coating on Circuit Boards		Yes	
2.16	Heavy Duty DIN Rail Mountable or 19' Rack Mount Profile		Yes	
3	Operating System Parameters			
3.1	Operating System		Microsoft Windows 10 Enterprise	
3.2	CPU		Intel core i7-3612QE Quad Core	
3.3	Speed	GHz	2.1 GHz base, 3.1 GHz turbo	
3.4	Cache		4 x 256 KB L2, 6 MB L3	
3.5	RAM	GB	16 GB DDR3 ECC (1,333MHz)	
3.6	Chipset		Intel CM236 Express Chipset	
3.7	Minimum Mass Storage with Hot Swap Support	GB	120GB Industrial Grade SLC SSD	
3.8	Video Outputs (Dual Independent Displays From 2 of the 3 Outputs)		DVI - I (Digital + VGA) DVI - D (Digital Only) Display Port	
3.9	Audio (3 Analog 3.5mm TRS Jacks)		Line input Line/headphone output Microphone input	

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
3.10	LEDs for Communications status and port activity		Yes	
4	Communication and Communication Ports			
4.1	USB 3.1 Compliant Ports		4 Rear Ports & 2 Front Ports	
4.2	Ethernet 1 Gbps Copper RJ45 Ports		Yes	
4.3	2 EIA-232 ports, DB-9 connectors, 300 to 115200bps, 5V port power, 500mA		Yes	
4.4	BIOS		AMI UEFI	
4.5	Time Code Input/ Output		I-RIG-B	

Appendix A5 – Protection IED (SEL751)

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
1.1	Manufacturer		SEL or Similar	
1.2	Type		SEL-751 or similar	
1.3	Lead Time	Weeks	Specify	
1.4	Minimum Warranty	Years	10	
2	Ratings			
2.1	Number of Voltage Inputs	Number	3	
2.2	Rated Voltage (Un)	V	100 / 110	
2.3	Rated Voltage Withstand: Continuously	V	2 x Un	
2.4	Number of Current Inputs	Number	4	
2.5	Rated Frequency (fn)	Hz	50	
2.6	Rated Current (In)	A	1	
2.7	Rated Current of Fourth Element (In)		Specify	
2.8	Current Withstand: Continuous for In = 1A	A	4 x In	
2.9	Current Withstand: Continuous for In = 0.2A	A	4	
2.10	Thermal Current Withstand: 1s (In = 1)	A	100	
2.11	Thermal Current Withstand: 1s (In = 0.2)	A	500	
2.12	Burden (per Phase) (In = 1)		<0.01VA @ 1A	
2.13	Burden (per Phase) (In = 0.2)		<0.01VA @ 0.2A	
2.14	Input Impedance: (In = 1A)	mΩ	< 100	
2.15	Output Contact Rated Voltage	V AC/DC	250	
2.16	Power/ Signal Contact Thermal Withstand capability: Continuous	A	5	
2.17	Power/ Signal Contact Thermal Withstand capability: 3s	A	Specify	
2.18	Power/ Signal Contact Thermal Withstand capability: 0.5s	A	50	
2.19	Impulse Withstand Voltage	v	5000	
2.20	Maximum Pickup / Dropout time	ms	≤ 8 (coil energization to contact closure)	
2.21	Continuous Carry		6 A @ 70°C 4 A @ 85°C	
2.22	Binary Input Voltage Range	V DC	90-130	
2.23	Rated Supply Voltage	V DC	110	

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
2.24	Rated Supply Voltage Operation Range	%	80 - 120	
2.25	Max Power Consumption	V DC	25	
		V AC	50	
2.26	Fuse Rating	A	3.15	
2.27	Max Fuse Rated Voltage	V DC	300	
		V AC	250	
2.28	Minimum Operating Temperature	°C	-40	
2.29	Maximum Operating Temperature	°C	85	
2.30	Insulation Class		1	
2.31	Pollution Degree		2	
2.32	Overvoltage Category		II	
2.33	Relative Humidity (non - condensing)	%	5 - 95	
3	Minimum Functionality			
3.1	Graphical Man-Machine Interface		Option	
3.2	Programmable Energising Inputs		Yes	
3.3	3 Stage 3 Phase Overcurrent Protection		Yes	
3.4	3 Stage Earth Fault Protection		Yes	
3.5	Directional Overcurrent Protection		No	
3.6	Directional Earth Fault Protection		No	
3.7	Cable Thermal Protection		Yes	
3.8	Circuit Breaker Fail Protection		Yes	
3.9	Arc Flash Protection with 2-5ms pickup time		Yes	
3.10	Trip Circuit Supervision (Dual State)		Yes	
3.11	Close Circuit Supervision (Dual State)		Yes	
3.12	Close Spring Charge Supervision		Yes	
3.13	Voltage and Current Measuring Functions		Yes	
3.14	3 Phase Power Measuring Functions (kWhr + kVARhr + MD) at 30min intervals		Yes	
3.15	Disturbance Recorder		Yes	
3.16	Event Recorder		Yes	
3.17	Internal hardware and Software Supervision		Yes	
3.18	Minimum Programmable Digital Inputs	Number	8	
3.19	Minimum Programmable Digital Outputs	Number	3	
3.20	Minimum Number of Indication LED's	Number	8	
3.21	Full Local and Remote Control and Interlocking		Yes	
3.22	Communications Protocols: Modbus, IEC 61850 Edition 2 and IEEE C37.118 (synchrophasors)		Yes	
3.23	Communication Ports	Front	RS232	
		Rear	1 x RS232 & 2 x RJ45	
3.24	Conformal Coating on Circuit Boards		Yes	
3.25	Compliance with: IEC 60255-26(2013), IEC 60255-27(2013), IEC 60068-2(2007), ISO9001, CE Mark, RCM Mark		Yes	

Appendix A6 – Protection IED (SEL787)

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
1.1	Manufacturer		SEL or Similar	
1.2	Type		SEL-787 or similar	
1.3	Lead Time	Weeks	Specify	
1.4	Minimum Warranty	Years	10	
2	Ratings			
2.1	Rated Current (In)	A	1	
2.2	Thermal Current Withstand: Continuous	A	4 x In	
2.3	Thermal Current Withstand: 10s	A	25 x In	
2.4	Thermal Current Withstand: 1s	A	100 x In	
2.5	Input Impedance: (In = 1A)	mW	< 100	
2.6	Output Contact Rated Voltage	V AC/DC	250	
2.7	Power/ Signal Contact Thermal Withstand capability: Continuous	A	5	
2.8	Power/ Signal Contact Thermal Withstand capability: 3s	A	15	
2.9	Power/ Signal Contact Thermal Withstand capability: 0.5s	A	30	
2.10	Binary Input Voltage Range	V DC	80 - 200	
2.11	Rated Auxiliary Supply Voltage	V DC	110	
2.12	Rated Auxiliary Supply Voltage Operation Range	%	80 - 120	
2.13	Power Consumption	V DC	20	
		V AC	40	
2.14	Fuse Rating	A	3.15	
2.15	Max Fuse Rated Voltage	V DC	300	
		V AC	250	
2.16	Impulse Withstand Voltage	V	4700	
2.17	Maximum Pickup / Dropout time	ms	≤ 8 (coil energization to contact closure)	
2.18	Continuous Carry		6 A @ 70°C 4 A @ 85°C	
2.19	Minimum Operating Temperature	°C	-40	
2.20	Maximum Operating Temperature	°C	85	
2.21	Pollution Degree		2	
2.21	Overvoltage Category		II	
2.22	Relative Humidity (non-condensing)	%	5 - 95	
3	Minimum Functionality			
3.1	Integrated Differential and Restricted Earth Fault Protection (HV & MV)		Yes	
3.2	Sustained Earth Fault Protection (MV)		Yes	
3.3	Second Harmonic Restraint for Transformer Inrush		Yes	
3.4	Fifth Harmonic Restraint with adjustable de-activation level		Option	
3.5	Under / Over Flux Protection (over flux selectable to alarm, trip or block differential)		Yes	
3.6	Under / Over Voltage Protection		Yes	
3.7	Tap-changer Protection (Overcurrent, Under- & Over-voltage and Buchholz & Pressure Relief Blocking to tap change relay)		Yes	
3.8	Transformer Buchholz & Oil, Transformer & NER Winding trips and alarms		Yes	

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
3.9	Main Tank Pressure Relief Device trip		Yes	
3.10	Internal CT ratio correction and Vector Group matching		Yes	
3.11	Phase Current and Angle display to confirm Vector Group matching		Yes	
3.12	Trip Circuit Supervision (Dual State)		Yes	
3.13	Disturbance Recorder		Yes	
3.14	Event Recorder		Yes	
3.15	Internal Hardware and Software Supervision		Yes	
3.16	Load Profile Data Capability at 30min intervals		Yes	
3.17	Minimum Programmable Digital Inputs		8	
3.18	Minimum Programmable Digital Outputs		3	
3.22	Communications Protocols: Modbus, IEC 61850 Edition 2 and IEEE C37.118 (synchrophasors)		Yes	
3.23	Communication Ports	Front	RS232	
		Rear	1 x RS232 & 2 x RJ45	
3.24	Conformal Coating on Circuit Boards		Yes	
3.25	Compliance with: IEC 60255-26(2013), IEC 60255-27(2013), IEC 60068-2(2007), ISO9001, CE Mark, RCM Mark		Yes	

Appendix A7 – I/O Module

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
1.1	Manufacturer		SEL or Similar	
1.2	Type		SEL-2440 or similar	
1.3	Lead Time	Weeks	Specify	
1.4	Minimum Warranty	Years	10	
2	Ratings			
2.1	Type of supply		Single Power Supply	
2.2	Rated Voltage of Power Supplies	V AC	120 - 230	
		V DC	24 - 250	
2.3	Maximum Power Consumption	VA	< 50	
		W	< 20	
2.4	Minimum Operating Temperature	°C	-40	
2.5	Maximum Operating Temperature	°C	85	
2.6	Relative Humidity	%	5 - 95	
2.7	Compliant with		IEC61000-4; CE Mark	
2.8	Overvoltage Category		II	
2.9	Insulation Class		1	
2.10	Conformal Coating on Circuit Boards		Yes	
2.11	Heavy Duty DIN Rail Mountable or 19' Rack Mount Profile		Yes	
3	Communication and Communication Ports			
3.1	Communication Protocol		DNP3 & IEC 61850	
3.2	LC Dual Fibre 100 Base FX		Yes	

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
3.3	Demodulated IRIG-B input and output		Yes	
3.4	Front USB Configuration Port		Yes	
3.5	Form C Alarm Output Contact		Yes	
3.6	LEDs for Communications status and port activity		Yes	
4	Contacts			
4.1	Digital AC and DC Inputs		32	
4.2	Digital Outputs (12 form A and 4 Form C)		16	
4.3	Pickup Time	msec	< 5	
4.4	Continous Carry @ 70°C	A	6	
4.5	Thermal Rating for 1sec	A	50	
4.6	Rate Insulation Voltage	V DC	300	

Appendix A8 – Serial Port Server

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
1.1	Manufacturer		SEL or Similar	
1.2	Type		SEL-3610 or similar	
1.3	Lead Time	Weeks	Specify	
1.4	Minimum Warranty	Years	10	
2	Ratings			
2.1	Type of supply		Single Power Supply	
2.2	Rated Voltage of Power Supplies	V AC	110/240	
		V DC	125/250	
2.3	Rated Frequency	Hz	50/60	
2.4	Maximum Power Consumption	W	<30	
2.5	Minimum Operating Temperature	°C	-40	
2.6	Maximum Operating Temperature	°C	85	
2.7	Compliant with		IEC61000-4; CE Mark: RCM Mark	
2.8	Overvoltage Category		II	
2.9	Insulation Class		1	
2.10	Conformal Coating on Circuit Boards		Yes	
2.11	Heavy Duty DIN Rail Mountable or 19' Rack Mount Profile		Yes	
3	Processing and Memory			
3.1	Processor Speed	MHz	533 (Min)	
3.2	Memory		1024MB DDR2 ECC	
3.3	Storage	GB	4	
4	Network Interfaces			
4.1	Ethernet Ports		2 Rear, 1 Front	
4.2	Data Rates	Mbps	10/100	
4.3	Front Connector		RJ45 female	
4.4	Rear Connector		RJ45 female	

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
4.5	VLAN Capability		Yes	
5	Ports			
5.1	Serial Ports (Rear)		16 x DB9	
5.2	Type (software selectable)		EIA-232/EIA-485	
5.3	Data Rates	bps	1200 to 115200	
5.4	IRIG-B Input / Output		Yes	
6	Ethernet Protocols			
6.1	ARP, DHCP Client, HTTPS, ICMP, LDAP Client, Modbus TCP/IP, NTP Client/Server, SSHv2 Client/Server, SNMP, STP, TCP, TLS, UDP, Syslog, Telnet		Yes	

Appendix A9 – Satellite Synchronised Clock

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
1.1	Manufacturer		SEL or Similar	
1.2	Type		SEL-2407 or similar	
1.3	Lead Time	Weeks	Specify	
1.4	Minimum Warranty	Years	10	
2	Ratings			
2.1	Type of supply		Single Power Supply	
2.2	Rated Voltage of Power Supplies	V AC	85 - 264	
		V DC	18 - 300	
2.3	Minimum Operating Temperature	°C	-40	
2.4	Maximum Operating Temperature	°C	80	
2.5	Alarm Contact Current Rating (Form C type)	A	6	
2.6	Display Type		Led Time Display	
3	Time Ports			
3.1	EIA 232 Serial Port		1	
3.2	Time Source		GPS	
3.3	Modulated IRIG-B Outputs		1	
3.4	Demodulated IRIG-B Outputs		3	
3.5	Programmable demodulated IRIG-B Outputs		3	
4	Accuracy			
4.1	Demodulated IRIG-B	nsec	± 100 Average	
			± 500 Peak	
4.2	Modulated IRIG-B	µsec	± 1 peak	
4.3	PPS (Pulse Per Second) Output	nsec	± 100 Average	
			± 500 Peak	
5	Antenna			
5.1	Type		SEL-9524A or similar	
5.2	Operating Voltage	V DC	4 - 6	
5.3	Connector Type		Female TNC	

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
5.4	Weatherproofing		IP68	
5.5	Minimum Operating Temperature	°C	-50	
5.6	Maximum Operating Temperature	°C	85	
5.7	Compliant with		IEC60255, 60068, 61000 & IEEE C37.90	
5.8	Gain	dB	> 40	
5.9	Noise Figure @ 25 °C	dB	< 2	
5.10	Nominal System impedance	ohms	50	
6	Accessories			
6.1	Antenna pipe Mounting Kit		Yes	
6.2	Surge Protector kit (With Mounting)		Yes	
6.3	Coaxial Cable with TNC to TNC connection	m	150	

Appendix A10 – Substation Human Machine Interface (SHMI)

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
1.1	Manufacturer		ELO or Similar	
1.2	Type		1991L or similar	
1.3	Lead Time	Weeks	Specify	
1.4	Minimum Warranty	Years	10	
2	Ratings			
2.1	Type of supply		Single Power Supply	
2.2	Power Supply	V DC	12 ± 5%	
2.3	Rated Frequency	Hz	50/60	
2.4	Maximum Power Consumption	W	17	
2.5	Minimum Operating Temperature	°C	0	
2.6	Maximum Operating Temperature	°C	40	
2.7	Humidity	%	20 - 80	
3	Display			
3.1	Display Type		Touch Screen	
3.2	Display Size	Inch	19	
3.3	Panel Technology		LED Backlight panel	
3.4	Backlight life	hours	50 000	
3.5	Resolution		1280 x 1024 @ 60 Hz	
3.6	Response Time	ms	14	
3.7	Contrast Ratio		1000 : 1	
3.8	Aspect Ratio		5 : 4	
3.9	Colors		16.7M	
3.10	Video Input		HDMI V1.3, Analog VGA, Display Port V1.1a	

Appendix A11 – Workstation Monitor (Control Room Only)

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
1.1	Manufacturer		DELL or Similar	
1.2	Type		P2319H or similar	
1.3	Lead Time	Weeks	Specify	
1.4	Minimum Warranty	Years	3	
1.5	Quantity per workstation	No.	2	
2	Ratings			
2.1	Type of supply		Single Power Supply	
2.2	Power Supply	V AC	100 - 240	
2.3	Rated Frequency	Hz	50/60	
2.4	Maximum Power Consumption	W	40	
2.5	Minimum Operating Temperature	°C	0	
2.6	Maximum Operating Temperature	°C	40	
2.7	Humidity	%	20 - 80	
3	Panel			
3.1	Display Size	Inch	23	
3.2	Panel Technology		LED edgelight system	
3.3	Resolution		1920 x 1080 @ 60 Hz	
3.4	Brightness	cd/m ²	250	
3.5	Response Time	ms	8	
3.6	Contrast Ratio		1000 : 1	
3.7	Aspect Ratio		16 : 9	
3.8	Colors		16.7M	
3.9	Compliant with		Energy Star, RoHS Compliant, TCO certified displays	
3.10	Mounting (single stand capable of supporting two displays)		Desk Mounted	
4	Ports			
4.1	Display Port version 1.2	No.	1	
4.2	HDMI port version 1.4	No.	1	
4.3	VGA port	No.	1	
4.4	USB 3.0	No.	3	
4.5	USB 2.0	No.	2	

Appendix A12 – SCADA Monitor (Control Room Only)

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
1.1	Manufacturer		LG or Similar	
1.2	Type		65SM5KD or similar	
1.3	Lead Time	Weeks	Specify	
1.4	Warranty	Years	Specify	
1.5	Quantity in Control Room	No.	2	
2	Ratings			
2.1	Type of supply		Single Power Supply	
2.2	Power Supply	V AC	100 - 240	
2.3	Rated Frequency	Hz	50/60	
2.4	Maximum Power Consumption	W	120	
2.5	Minimum Operating Temperature	°C	0	
2.6	Maximum Operating Temperature	°C	40	
2.7	Humidity	%	10 - 80	
3	Panel			
3.1	Display Size	Inch	65	
3.2	Panel Technology		IPS	
3.3	Aspect Ratio		16 : 9	
3.4	Guaranteed Operating Hour	Hours	24	
3.5	Resolution		1920 x 1080 (FHD)	
3.6	Brightness	cd/m2	450	
3.7	Response Time	ms	10	
3.8	Surface Treatment		Hard coating (3H), Anti-glare treatment of the front polarizer	
3.9	Internal Memory	GB	System 4GB + Available 4GB	
4	Connectivity			
4.1	Input		HDMI (2), DP, DVI-D, RGB, Audio, USB 3.0	
4.2	Output		DP, Audio	
4.3	External Control		RJ232C In/out, RJ45 In, IR Receiver In, Pixel Sensor In	

Appendix A13 – Uninterruptable Power Supply (UPS)

ITEM	DESCRIPTION	UNIT	REQUIRED	OFFERED
			SCHEDULE A	SCHEDULE B
1.1	Manufacturer		APC or Similar	
1.2	Type		SRT10KRMXLI or similar	
1.3	Lead Time	Weeks	Specify	
1.4	Warranty (Repair or Replace) excluding batteries	Years	3	
2	Output			
2.1	Topology		Double Conversion Online	
2.2	Output Power	kVA	10	
2.3	Output Voltage	V AC	220 - 240	
2.4	Output Voltage Distortion at Full Load	%	< 2	
2.5	Nominal Frequency	Hz	50	
2.6	Load Crest Factor		3 : 1	
2.7	Output Waveform		Sine Wave	
2.8	Output Connection		IEC 320 C13	
2.9	Internal Bypass		Automatic and Manual	
3	Input			
3.1	Input Voltage Range for Mains Operation	V AC	160 - 275	
3.2	Input Frequency (Auto Sensing)	Hz	40 - 70	
3.3	Input Connection		Hard Wired	
3.4	Phase(s)	3 or 1	1	
4	Ratings			
4.1	Operating Temperature	°C	0 - 40	
4.2	Relative Humidity (Non-condensing)	%	0 - 95	
4.3	Minimum Protection Class		IP20	
5	Battery			
5.1	Battery Type contained in UPS [Leak proof]		Sealed, maintenance free, lead acid	
5.2	Battery Life	Years	3 - 5	
5.3	Recharge Time	Hrs	1.5	
5.4	Nominal Battery Voltage	V DC	192	
5.5	Minimum Run Time without source connected	Hrs	2	
6	Features			
6.1	Interface Ports		RJ45 10/100Base-T & USB	
6.2	Control Panel with LCD Status		Yes	
6.3	Audible Alarm		Yes	
6.4	Emergency Power Off		Yes	
6.5	Surge Protection and Filtering Energy Rating	Joules	480	
6.6	Compliant with		CE, CE Mark, IEC62040-1&2, IRAM, VDE, EAC	
6.7	19" Rack Mount Profile		Yes	
6.8	Inclusive of all mounting supports, brackets, rails, software and manuals		Yes	
6.9	Datasheets included with tender		Yes	

Appendix B

Generator Technical Specification

1 SCOPE

This Diesel Generating Unit Specification covers the general design criteria and standards applicable to all sections of work. Should the requirements of this specification be in conflict with any other standard specification, the other standard specification shall govern, and the Contractor shall seek information of such precedence from the Engineer.

2 STANDARDS

All equipment relating to the diesel generating unit shall be designed, constructed and tested in accordance with the requirements of the most recent South African, British Standards or IEC publications including all amendments issued, up to the date of tender. The installation and equipment shall also comply with the relevant clauses of the Occupational Health and Safety Act, 1993 (Act No 85 of 1993), and the regulations enforced in terms of the Act, and with the Code of Practice for The Wiring of Premises, SANS 10142-1.

3 DESIGN

3.1 General

The diesel generating unit shall be designed to facilitate easy accessibility, equipment replacement, maintenance, handling, inspection cleaning and repairs and to ensure satisfactory operation in which the safety of the unit, personnel and continuity of service is the first consideration. The unit shall operate satisfactorily under the ambient and other conditions prevailing at the site.

The unit shall be designed to prevent the risk of accidental short circuits due to animals, birds, ants and vermin. The unit shall be designed and constructed to keep maintenance costs and the number of persons employed for maintenance to a minimum.

All material used for the design and construction of the unit shall withstand the variations of temperature and atmospheric conditions arising under working conditions without distortion, deterioration, or the setting up of undue stresses in any part such as to affect the efficiency and reliability of the unit and also without affecting the strength and suitability of the various parts for the duty which they have to perform.

The threads of all bolts, nuts and studs shall be in accordance with SABS 135. All nuts and studs shall be locked in position by lock washers and where necessary, lock nuts. All bolts, nuts and washers used outdoors shall be of approved materials and treated to prevent corrosion of the threads.

The unit shall be designed so that water and debris will not readily accumulate to cause deterioration of equipment or an electrical discharge hazard. Where this cannot be avoided such places shall be easily accessible for cleaning.

All apparatus, connections and cabling shall be designed and arranged to minimise the risk of fire and any damage, which might be caused in the event of fire.

Identification labels shall be attached to all equipment, control gear and all panels and the equipment contained within. All labels and plates shall be of an approved non-corrosive material. Labels shall have a matt or satin finish to minimise reflection. Cables shall have cable tags fastened at both ends.

3.2 Unit Housing

The diesel generating unit shall be contained in a silent weatherproof canopy. The engine and alternator shall be built together on a common painted mild steel frame. Adequate anti-vibration mounting shall be used for the specific installation. The base frame shall be placed directly on a concrete plinth which shall be located within a bund area to provide containment of any fuel or oil spillage. The bund shall be adequately sized to contain no less than 110% of the fuel tank capacity. The plinth shall be adequately sized to allow the unit to be bolted to the plinth. The plinth and bund design shall be approved by a Structural Engineer before construction can commence. It is imperative that the outer casing of the alternator, the engine and all parts of the base frame be earthed with an adequate size conductor. The frame shall be of rigid construction enabling the complete set to be transported without dismantling. The frame shall have lifting hooks or holes to facilitate handling during transportation and when positioned on site.

3.3 Rating

The rating of the diesel generating unit shall be based on operation of the unit when equipped with all necessary accessories such as radiator fan, air cleaners, lubricating oil pump, fuel transfer pump, fuel injection pump, water circulating pump, and battery charging alternator.

The generator set shall be capable of delivering the specified output continuously under the site conditions without overheating. The engine shall be capable of delivering an output of 110% of the specified output for one hour in any period of 12 hours consecutive running.

4 DIESEL ENGINE

4.1 Type

The engine shall be of the multi cylinder, four stroke cycle, cold starting, direct injection, compression ignition type, suitable for operation on diesel fuel. The engine speed shall not exceed 1,500 R.P.M. at normal full load conditions. The engine shall be controlled by an electronic governor to maintain governed speed for 50 Hz operation. The engine shall be provided with dry type air cleaners which shall provide positive air filtration.

NOTE: Under no circumstances will copies and / or inferior products be accepted.

4.2 Cooling System

The engine shall be of the liquid cooled type [coolant type shall be specified by the supplier] and the cooling system shall be of sufficient capacity to cool the engine when the set is delivering its full rated load at the ambient conditions. The engine shall be equipped with a heavy-duty type radiator complete with engine driven fan and centrifugal water circulating pump and a thermostat to maintain the engine at the manufacturers recommended temperature level.

4.3 Fuel System

The complete system shall be sized to allow the unit to run for a minimum of 8 hours at full load capacity. The fuel tank shall be mounted in the unit's base frame. The tank shall be fitted with a suitable filter, gauge, drain, filler cap. A hand "wing pump" and hose must be fitted onto the set and shall be used to fill the tank from drums etc. The fuel tank shall be filled to a minimum of 25% of the fuel tank capacity for hand over.

4.4 Exhaust System

The engine shall be fitted with an efficient super silent 3CR12 exhaust system. Flexible bellows shall be fitted between the exhaust outlet and the silencer. The flexible piping must on no account be used to form a bend

or compensate for misalignment. The residential silencer shall be located on top of the canopy and shall be of the highly efficient type suitable for use in residential areas and shall be capable of providing 30 to 40 decibels of suppression.

4.5 Engine Starting

The engine shall be equipped with a 12Volt starting system of sufficient capacity to crank the engine at a speed, which will allow starting of the engine.

The starting equipment shall include a 12Volt D.C. starter motor engaging directly on the flywheel ring gear. A heavy-duty battery charging alternator and maintenance free batteries shall be supplied. The batteries shall be mounted in a battery box. The batteries shall be connected to the engine with suitably rated PVC insulated flexible leads.

A battery charging unit of the trickle charge type shall be provided to maintain the batteries at full capacity. The charging equipment shall be connected so that the battery is normally charged from the mains but is also charged under mains failure conditions from the diesel generating unit and if required via an inhibitor relay to prevent dual charging. The unit shall be complete with voltmeter, push button test, D.C. and A.C. protective gear. The charging unit shall be incorporated in the diesel generator control cabinet.

5 A.C. GENERATOR

5.1 Rating

The system to which the equipment is to be connected is single phase, three wire, 230 Volt between phase and neutral, with a frequency of 50 Hz and a power factor of 0.8 (continuous rating).

The neutral point of the generator shall be solidly connected, by means of an appropriate size of insulated earth conductor, to the earth bar in the alternator and in the panel. The diesel generating unit including the ancillary equipment and steel work shall be suitably bonded together with an appropriate size of bare copper tape which shall also be connected to the earth bar.

The starting period from either automatic or manual switching until the taking over by the generating unit of a load equal to the specified site electrical output shall not exceed 30 seconds.

NOTE: Only alternators with local factory back-up will be accepted. Under no circumstances will copies and/or inferior products be accepted.

5.2 Construction and Manufacture

The generator shall be of heavy duty compact design. It shall be a revolving field type, coupled directly to the engine flywheel through a flexible disc for positive alignment. The generator housing shall bolt directly to the engine flywheel housing and shall be equipped with a heavy-duty ball bearing support for the rotor. The motor shall be dynamically balanced up to 25 % over speed.

5.3 Voltage Regulation and Response

The alternator shall be self-regulated and shall incorporate an automatic voltage regulator. The voltage regulation shall not exceed $\pm 2.5\%$, from no load to full load, including cold to hot variations at any power factor between 0.8 lagging and unity and inclusive of speed variations within the limits stated.

Upon application of full load at a power factor of 0.8 lagging the alternator voltage shall recover to within 2.5% of the steady state value within approximately 300 milliseconds. Upon application of any load specified in transient, maximum voltage dip shall not exceed 20% of the nominal voltage when measured at the alternator terminals.

5.4 Windings / Terminal Box

The generator stator winding shall be connected to the terminals in the terminal box on the generator to provide a 230Volt supply. The terminal box shall be sized to suit the interconnecting cables between the alternator and automatic main failure panel.

6 DIESEL GENERATOR CONTROL PANEL

6.1 Type and Construction

The panel shall be designed for the control of the diesel generating unit with instrumentation and protective devices to meet both manual and automatic mode requirements. The control panel shall be of robust construction, totally enclosed and dust proof.

As per regulations, the control and power section of the panel must be in separate sections and a suitably sized area complete with adequate busbar to suit the glanding and termination of the incoming and outgoing cables must be allowed for.

The panel shall be of folded 1.6 mm thick cold rolled sheet steel construction suitable for front entry through hinged doors. Internal chassis plates, circuit breaker pans and gland plates shall be provided. Special attention shall be given to vermin proofing and dust sealing.

Prior to painting all steelwork must be thoroughly degreased and de-rusted and then primed with a zinc chromate primer. All internal steel chassis plates, gland plates and switchgear brackets shall be painted with white powder epoxy paint and all exterior steel surfaces finished with orange powder epoxy paint.

6.2 Genset Controller

The genset controller shall provide automation and monitoring of the entire unit to achieve automatic start/stop, data measurement, alarm protection and remote functionality (remote control, remote measuring and remote communication). It shall adopt micro-processor technology with precision parameters measuring, fixed value adjustment, time setting and set value adjusting. All parameters can be configured from front panel or through a communication port preferably of the USB interface type by using a Personal Computer (PC).

The controller shall be capable of mains/generator automatic transfer control function as follows:

- (1) **Auto Start Sequence** - when mains is abnormal (i.e. over/under voltage, loss of phase), the controller enters into "Mains Abnormal Delay". During this delay the generator shall be switched on ensuring that a series of predefined conditions are satisfied as per the manufacturer. Once the delay has expired and the generator is switched on, the transfer from mains to genset power shall be initiated.

- (2) **Auto Stop Sequence** - During normal running of the generator supply, if the mains is detected, a "Mains Normal Delay" shall be initiated. Once the delay has expired the generator supply shall be removed and the mains shall be switched on. The generator shall then go through a cool off period before the unit is switched off.

Warning alarms (i.e. high temperature, low fuel level, low coolant level and etc) are not shutdown alarms and shall not affect the operation of the gen-set. Warning alarms does not lead to shutdown however the alarm information shall be displayed on the LCD or remotely.

When controller detects a shutdown alarm (i.e. over speed, over frequency, over/under voltage and etc) it will send a signal to open the breaker and shut down the generator. The shutdown alarm information shall be displayed on the LCD or remotely.

6.3 Bus-Bars, Wiring, Switchgear, etc.

All bus-bars and wiring shall be adequately rated and suitably supported, and control wiring shall be neatly laced and numbered with durable plastic ferrules, for easy tracing. Suitable terminals are to be provided for the outgoing cables. Suitably sized holes shall be punched in the gland plates for the required number of cable terminations for both incoming sensing and outgoing control and load cables. The cables shall be secured to the gland plate by means of approved cable glands. The gland plate shall be suitably braced to prevent distortion after the cables have been glanded to it. Circuit breakers are to be of moulded case construction. Contractors must give an assurance with their tender that replacements for the equipment and instruments used in the construction of the panel are readily available from stock held in the Republic of South Africa.

6.4 Control Panel Door Mounted Components

NOTE: While some of these items are already incorporated in the controller, they shall still be supplied and fitted in the panel door as well.

- a) 1 x 96 x 96 mm Flush mounted MDI dial ammeters suitably scaled
- b) 1 x 96 x 96 mm Flush mounted dial voltmeter, 0 - 300V AC.
- c) 1 x 96 x 96 mm Flush mounted dial, frequency meter, scaled 47 - 50 - 53 Hertz.
- d) 1 x Flush mounted voltmeter, 0 - 30V DC - Battery volts.
- e) 1 x Emergency stop push button - "Latching type".
- f) 1 x Engine alternator charge indication.
- g) 2 x LED indicators for Main (Green) and Generator (Blue) Supply

6.5 Unit Operation

The mode selector functions shall be as follows:

Mode Selector	Description
OFF/RESET	Control system off and alarm condition reset.
AUTO	Automatic starting and stopping of the set dependent on the mains supply
MANUAL	Starting and stopping activated manually (two panel mount push-buttons) for maintenance purposes. In this mode the load will not be transferred in the event of a mains failure.
TEST	The set will start automatically in this position. The load will be taken by the alternator in the event of a mains failure.

6.6 Logging of Events

All events relating to the status of the generator set shall be logged with date and time in a non-volatile memory (which can retain information for a period of 6 months in the absence of power to the controller) and the user shall be able to obtain a hard copy on site.

Events shall include and not be limited to

- Mains on load
- Unit switched ON
- Unit switched OFF
- Low Fuel Level
- Unit Mode (Auto or Manual)
- Max and Min Current
- Max and Min Voltage

7 CLEANING AND PAINTING

The cleaning and painting of all exposed surfaces of the unit shall be carried out as follows:

- Surface preparation

All metal work shall be thoroughly cleaned by blast cleaning or pickling so as to be free of all mill scale, dirt, rust, welding slag and spatter, grease and all other contaminants and so as to present a dry, bright metallic finish.

- Priming

The metal work shall be primed with an approved red lead-based primer for equipment intended for outdoor use.

- Finishing

The primed surfaces shall be finished with a minimum of two coats of approved alkyd-based enamel of which each coat shall be of a different shade. All painting shall be spray applied using dry oil-free air. The final paint thickness shall be not less than 0,1 mm as determined by a magnetic film thickness gauge.

8 TESTING

8.1 Factory Acceptance Test (FAT)

A factory acceptance test shall be carried out to establish that the diesel generating unit and its ancillary equipment meets with the requirements of the specification. The Contractor shall give at least seven (7) days' notice prior to testing the unit. In the event of the unit failing the test and having to be re-tested, at some future date, all expenses (including travelling) incurred in attending the second test will be to the Contractor's account.

The following test will be undertaken:

- Simulate a mains failure to automatically start the unit from cold to test its ability to attain full rated speed and voltage and assume the full load in the specified time of 15 seconds.
- Test run the unit at full load for a period of one hour.
- Immediately after the above specified run, without stopping the unit, run it for a further hour at 110 % load.
- Test the unit with regards to voltage dip, voltage and frequency recovery, with a sudden application of various loads.
- Test the unit for its ability to assume full rated load immediately on failure of the normal supply.
- Any other tests the client may consider necessary to establish that the diesel generator and its ancillary equipment as a whole is functioning correctly.

NB: The Contractor shall provide necessary instruments and equipment for carrying out the tests. The test equipment shall be capable of producing 100 % load for one hour and 110 % load for a further hour continuously without interruption. The test load shall be adjustable and balanced over three phases.

8.2 Site Acceptance Tests (SAT)

Once the installation of the unit has been completed, the following test shall be carried out:

- Automatic starting and stopping with load change over.
- Test by simulation only of the operation of the engine protection and alarm devices.

- c) Insulation and continuity of wiring
- d) Cold starting and load acceptance
- e) Switchgear and instrumentation
- f) Battery capacity and battery charger
- g) A six (6) hour test. The set shall be subjected to full load for five (5) hours followed by 10% overload for one (1) hour. The following readings shall be taken at 30minute intervals during the five hour period and at 10 minute intervals under overload:
 - Alternator voltage, frequency, power factor or wattage
 - Battery voltage and charging current
- h) The alternator and engine shall be inspected after the test.

9 HAND OVER

9.1 Warning Notice

The Contractor shall provide and install in a conspicuous position a clearly legible and indelible notice 350 x 350 mm made from non-deteriorating material, preferably plastic with red letters on a white background worded to read as follows:

DANGER
**THIS ENGINE WILL START WITHOUT NOTICE.
TURN STATUS SELECTOR SWITCH ON CONTROL PANEL TO
"OFF" POSITION BEFORE WORKING ON THE UNIT.**

9.2 Operating and Maintenance Manuals

The Contractor shall supply three complete comprehensive sets of operating and maintenance manuals complete with schematic control diagrams and complete spare parts list for both engine and generator. An assurance shall be given that spare parts for the unit offered by them as a whole are readily available within the Republic of South Africa and to state where these are available.

In addition, a complete schematic diagram of the power and control circuitry is to be left inside the control panel.

9.3 Drawings

Within one month of the receipt of order, the successful Contractor shall submit prints of each of the following drawings for approval:

- a) General arrangement of the stand-by unit switchboard front panel.
- b) Schematic of the complete electrical systems, including starter motor, battery and automatic battery charger.
- c) Dimensioned layout of all equipment in the canopy.

Appendix C

Substation Signal List

Appendix C1 - Ballito 33/11kV Substation

Substation Section	Equipment	Signal	Type	Basic (Y/N)
A. List of signals per equipment.				
High Voltage (HV) Line Section	Earthing Switch	O/C Position	Digital	Y
	Disconnect Switch	O/C Position	Digital	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
HV Bus Bar	Disconnect Switch	O/C Position	Digital	Y
Power Transformer	Protection	86T - Master Trip	Digital	Y
MV Line Section	Earthing Switch	O/C Position	Digital	Y
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
MV Bus Bar	Circuit Breaker	O/C Position	Digital	Y
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y
	Voltage Transducer	Voltage	Analog	Y
	Protection	Voltage Min/Max	Analog	Y
	Protection	Mains Fail	Analog	Y
	Protection	Battery Low	Analog	Y
Intrusion Alarm	Protection	Stage	Digital	Y
Fire Alarm	Protection	Stage	Digital	Y
B. List of signals - Metering				
HV Line Section	Meter / IED	I, (V, P, Q, S not attained)	Digital	Y
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C2 - Ballito Business Park 33/11kV Substation

Substation Section	Equipment	Signal	Type	Basic (Y/N)
A. List of signals per equipment.				
High Voltage (HV) Line Section	Earthing Switch	O/C Position	Digital	Y
	Disconnect Switch	O/C Position	Digital	Y
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y

Substation Section	Equipment	Signal	Type	Basic (Y/N)
High Voltage (HV) Line Section	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
		Driver - Local / Remote	Digital	Y
HV Bus Bar	Disconnect Switch	O/C Position	Digital	Y
Power Transformer	Protection	86T - Master Trip	Digital	Y
MV Line Section	Earthing Switch	O/C Position	Digital	Y
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
MV Bus Bar	Circuit Breaker	O/C Position	Digital	Y
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y
	Voltage Transducer	Voltage	Analog	Y
	Protection	Voltage Min/Max	Analog	Y
	Protection	Mains Fail	Analog	Y
	Protection	Battery Low	Analog	Y
Intrusion Alarm	Protection	Stage	Digital	Y
Fire Alarm	Protection	Stage	Digital	Y
B. List of signals - Metering				
HV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Bus Bar	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C3 - Dukuza and Gizenga 33/11kV Substation

Substation Section	Equipment	Signal	Type	Basic (Y/N)
A. List of signals per equipment.				
High Voltage (HV) Line Section	Earthing Switch	O/C Position	Digital	Y
	Disconnect Switch	O/C Position	Digital	Y
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
		Driver - Local / Remote	Digital	Y
		Alarm (SF6)	Digital	Y
HV Bus Bar	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Disconnect Switch	O/C Position	Digital	Y
	Circuit Breaker	O/C Position	Digital	Y
		Driver - Local / Remote	Digital	Y
		Alarm (SF6)	Digital	Y
Power Transformer	Protection	86T - Master Trip	Digital	Y

Substation Section	Equipment	Signal	Type	Basic (Y/N)
Power Transformer	Protection	63T -Over Pressure	Digital	Y
	Protection	63B-T Trip - Buchholz	Digital	Y
	Protection	63B-T Alarm - Buchholz	Digital	Y
	Protection	99L-T Trip - Oil Level Low	Digital	Y
	Protection	49HV - Trip - HV Winding Temp	Digital	Y
	Protection	49HV - Alarm - HV Winding Temp	Digital	Y
	Protection	49LV - Trip - LV Winding Temp	Digital	Y
	Protection	49LV - Alarm - LV Winding Temp	Digital	Y
	Protection	26T - Trip - Oil Temperature	Digital	Y
	Protection	26T - Alarm - Oil Temperature	Digital	Y
MV Line Section	Earthing Switch	O/C Position	Digital	Y
	Disconnect Switch	O/C Position	Digital	Y
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
		Driver - Local / Remote	Digital	Y
		Alarm	Digital	Y
Extracted		Digital	Y	
MV Bus Bar	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Disconnect Switch	O/C Position	Digital	Y
	Circuit Breaker	O/C Position	Digital	Y
		Driver - Local / Remote	Digital	Y
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y
	Voltage Transducer	Voltage	Analog	Y
	Protection	Voltage Min/Max	Analog	Y
	Protection	Mains Fail	Analog	Y
	Protection	Battery Low	Analog	Y
Intrusion Alarm	Protection	Stage	Digital	Y
Fire Alarm	Protection	Stage	Digital	Y
B. List of signals - Metering				
HV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
HV Bus Bar	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Bus Bar	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C4 - Gledhow 33/11kV Substation

Substation Section	Equipment	Signal	Type	Basic (Y/N)
A. List of signals per equipment.				
High Voltage (HV) Line Section	Disconnect Switch	O/C Position	Digital	Y
	Current Transformer - CT	Current	Analog	Y

Substation Section	Equipment	Signal	Type	Basic (Y/N)
	Circuit Breaker	O/C Position	Digital	Y
Power Transformer	Protection	86T - Master Trip	Digital	Y
MV Line Section	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y
	Voltage Transducer	Voltage	Analog	Y
	Protection	Voltage Min/Max	Analog	Y
	Protection	Mains Fail	Analog	Y
	Protection	Battery Low	Analog	Y
Intrusion Alarm	Protection	Stage	Digital	Y
Fire Alarm	Protection	Stage	Digital	Y
B. List of signals - Metering				
HV Line Section	Meter / IED	I, (V, P, Q, S not attained)	Digital	Y
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C5 - Glenhills 33/11kV Substation

Substation Section	Equipment	Signal	Type	Basic (Y/N)	
A. List of signals per equipment.					
High Voltage (HV) Line Section	Earthing Switch	O/C Position	Digital	Y	
	Disconnect Switch	O/C Position	Digital	Y	
	Current Transformer - CT	Current	Analog	Y	
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y	
	Circuit Breaker		O/C Position	Digital	Y
			Driver - Local / Remote	Digital	Y
Power Transformer	Protection	86T - Master Trip	Digital	Y	
MV Line Section	Earthing Switch	O/C Position	Digital	Y	
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y	
	Current Transformer - CT	Current	Analog	Y	
	Circuit Breaker	O/C Position	Digital	Y	
MV Bus Bar	Circuit Breaker	O/C Position	Digital	Y	
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y	
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y	
	Voltage Transducer	Voltage	Analog	Y	
	Protection	Voltage Min/Max	Analog	Y	
	Protection	Mains Fail	Analog	Y	
	Protection	Battery Low	Analog	Y	
Intrusion Alarm	Protection	Stage	Digital	Y	
Fire Alarm	Protection	Stage	Digital	Y	

Substation Section	Equipment	Signal	Type	Basic (Y/N)
B. List of signals - Metering				
HV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C6 - Grouteville 33/11kV Substation

Substation Section	Equipment	Signal	Type	Basic (Y/N)	
A. List of signals per equipment.					
High Voltage (HV) Line Section	Earthing Switch	O/C Position	Digital	Y	
	Disconnect Switch	O/C Position	Digital	Y	
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y	
	Current Transformer - CT	Current	Analog	Y	
	Circuit Breaker		O/C Position	Digital	Y
			Driver - Local / Remote	Digital	Y
HV Bus Bar	Disconnect Switch	O/C Position	Digital	Y	
Power Transformer	Protection	86T - Master Trip	Digital	Y	
MV Line Section	Earthing Switch	O/C Position	Digital	Y	
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y	
	Current Transformer - CT	Current	Analog	Y	
	Circuit Breaker	O/C Position	Digital	Y	
MV Bus Bar	Circuit Breaker	O/C Position	Digital	Y	
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y	
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y	
	Voltage Transducer	Voltage	Analog	Y	
	Protection	Voltage Min/Max	Analog	Y	
	Protection	Mains Fail	Analog	Y	
	Protection	Battery Low	Analog	Y	
Intrusion Alarm	Protection	Stage	Digital	Y	
Fire Alarm	Protection	Stage	Digital	Y	
B. List of signals - Metering					
HV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y	
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y	
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y	
C. List of signals – Protection Units					
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y	
MV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y	
MV Bus Bar	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y	

Appendix C7 - Imbonini 33/11kV Substation

Substation Section	Equipment	Signal	Type	Basic (Y/N)
A. List of signals per equipment.				
High Voltage (HV) Line Section	Earthing Switch	O/C Position	Digital	Y
	Disconnect Switch	O/C Position	Digital	Y
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
Driver - Local / Remote		Digital	Y	
HV Bus Bar	Disconnect Switch	O/C Position	Digital	Y
Power Transformer	Protection	86T - Master Trip	Digital	Y
MV Line Section	Earthing Switch	O/C Position	Digital	Y
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
MV Bus Bar	Circuit Breaker	O/C Position	Digital	Y
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y
	Voltage Transducer	Voltage	Analog	Y
	Protection	Voltage Min/Max	Analog	Y
	Protection	Mains Fail	Analog	Y
	Protection	Battery Low	Analog	Y
Intrusion Alarm	Protection	Stage	Digital	Y
Fire Alarm	Protection	Stage	Digital	Y
B. List of signals - Metering				
HV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C8 - Industrial 33/11kV Substation

Substation Section	Equipment	Signal	Type	Basic (Y/N)
A. List of signals per equipment.				
High Voltage (HV) Line Section	Disconnect Switch	O/C Position	Digital	Y
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
Driver - Local / Remote		Digital	Y	
HV Bus Bar	Disconnect Switch	O/C Position	Digital	Y
Power Transformer	Protection	86T - Master Trip	Digital	Y
MV Line Section	Earthing Switch	O/C Position	Digital	Y

Substation Section	Equipment	Signal	Type	Basic (Y/N)
MV Line Section	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
MV Bus Bar	Circuit Breaker	O/C Position	Digital	Y
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y
	Voltage Transducer	Voltage	Analog	Y
	Protection	Voltage Min/Max	Analog	Y
	Protection	Mains Fail	Analog	Y
	Protection	Battery Low	Analog	Y
Intrusion Alarm	Protection	Stage	Digital	Y
Fire Alarm	Protection	Stage	Digital	Y
B. List of signals - Metering				
HV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C9 - Lavoipierre 33/11kV Substation

Substation Section	Equipment	Signal	Type	Basic (Y/N)
A. List of signals per equipment.				
High Voltage (HV) Line Section	Disconnect Switch	O/C Position	Digital	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
		Driver - Local / Remote	Digital	Y
HV Bus Bar	Disconnect Switch	O/C Position	Digital	Y
Power Transformer	Protection	86T - Master Trip	Digital	Y
MV Line Section	Earthing Switch	O/C Position	Digital	Y
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
MV Bus Bar	Circuit Breaker	O/C Position	Digital	Y
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y
	Voltage Transducer	Voltage	Analog	Y
	Protection	Voltage Min/Max	Analog	Y
	Protection	Mains Fail	Analog	Y
	Protection	Battery Low	Analog	Y
Intrusion Alarm	Protection	Stage	Digital	Y
Fire Alarm	Protection	Stage	Digital	Y

Substation Section	Equipment	Signal	Type	Basic (Y/N)
B. List of signals - Metering				
HV Line Section	Meter / IED	I, (V, P, Q, S not attained)	Digital	Y
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C10 - Stanger Point of Supply

Substation Section	Equipment	Signal	Type	Basic (Y/N)
A. List of signals per equipment.				
High Voltage (HV) Line Section	Earthing Switch	O/C Position	Digital	Y
	Disconnect Switch	O/C Position	Digital	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
		Driver - Local / Remote	Digital	Y
Alarm (SF6)	Digital	Y		
HV Bus Bar	Disconnect Switch	O/C Position	Digital	Y
	Circuit Breaker	O/C Position	Digital	Y
		Driver - Local / Remote	Digital	Y
		Alarm (SF6)	Digital	Y
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y
	Voltage Transducer	Voltage	Analog	Y
	Protection	Voltage Min/Max	Analog	Y
	Protection	Mains Fail	Analog	Y
	Protection	Battery Low	Analog	Y
Intrusion Alarm	Protection	Stage	Digital	Y
Fire Alarm	Protection	Stage	Digital	Y
B. List of signals - Metering				
HV Line Section	Meter / IED	I, (V, P, Q, S not attained)	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
HV Bus Bar	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C11 - SAPPI 33/11kV SUBSTATION

Substation Section	Equipment	Signal	Type	Basic (Y/N)
A. List of signals per equipment.				
High Voltage (HV) Line Section	Disconnect Switch	O/C Position	Digital	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y

Substation Section	Equipment	Signal	Type	Basic (Y/N)
HV Bus Bar	Disconnect Switch	O/C Position	Digital	Y
	Circuit Breaker	O/C Position	Digital	Y
Power Transformer	Protection	86T - Master Trip	Digital	Y
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y
	Voltage Transducer	Voltage	Analog	Y
	Protection	Voltage Min/Max	Analog	Y
	Protection	Mains Fail	Analog	Y
Intrusion Alarm	Protection	Stage	Digital	Y
	Protection	Stage	Digital	Y
Fire Alarm	Protection	Stage	Digital	Y
B. List of signals - Metering				
HV Line Section	Meter / IED	I, (V, P, Q, S not attained)	Digital	Y
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
HV Bus Bar	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C12 - SHAKASKRAAL 33/11kV SUBSTATION

Substation Section	Equipment	Signal	Type	Basic (Y/N)	
A. List of signals per equipment.					
High Voltage (HV) Line Section	Earthing Switch	O/C Position	Digital	Y	
	Disconnect Switch	O/C Position	Digital	Y	
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y	
	Current Transformer - CT	Current	Analog	Y	
	Circuit Breaker	O/C Position		Digital	Y
		Driver - Local / Remote		Digital	Y
Alarm (SF6)			Digital	Y	
HV Bus Bar	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y	
	Disconnect Switch	O/C Position	Digital	Y	
	Circuit Breaker	O/C Position		Digital	Y
		Driver - Local / Remote		Digital	Y
		Alarm (SF6)		Digital	Y
Power Transformer	Protection	86T - Master Trip	Digital	Y	
MV Line Section	Earthing Switch	O/C Position	Digital	Y	
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y	
	Current Transformer - CT	Current	Analog	Y	
	Circuit Breaker	O/C Position	Digital	Y	
MV Bus Bar	Circuit Breaker	O/C Position	Digital	Y	
		Driver - Local / Remote	Digital	Y	
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y	

Substation Section	Equipment	Signal	Type	Basic (Y/N)
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y
	Voltage Transducer	Voltage	Analog	Y
	Protection	Voltage Min/Max	Analog	Y
	Protection	Mains Fail	Analog	Y
	Protection	Battery Low	Analog	Y
Intrusion Alarm	Protection	Stage	Digital	Y
Fire Alarm	Protection	Stage	Digital	Y
B. List of signals - Metering				
HV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
HV Bus Bar	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Bus Bar	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C13 - SHEFFIELD 33/11kV SUBSTATION

Substation Section	Equipment	Signal	Type	Basic (Y/N)	
A. List of signals per equipment.					
High Voltage (HV) Line Section	Earthing Switch	O/C Position	Digital	Y	
	Disconnect Switch	O/C Position	Digital	Y	
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y	
	Current Transformer - CT	Current	Analog	Y	
	Circuit Breaker		O/C Position	Digital	Y
			Driver - Local / Remote	Digital	Y
			Alarm (SF6)	Digital	Y
HV Bus Bar	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y	
	Disconnect Switch	O/C Position	Digital	Y	
	Circuit Breaker		O/C Position	Digital	Y
			Driver - Local / Remote	Digital	Y
			Alarm (SF6)	Digital	Y
Power Transformer	Protection	86T - Master Trip	Digital	Y	
MV Line Section	Earthing Switch	O/C Position	Digital	Y	
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y	
	Current Transformer - CT	Current	Analog	Y	
	Circuit Breaker	O/C Position	Digital	Y	
MV Bus Bar	Circuit Breaker	O/C Position	Digital	Y	
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y	
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y	
	Voltage Transducer	Voltage	Analog	Y	
	Protection	Voltage Min/Max	Analog	Y	

Substation Section	Equipment	Signal	Type	Basic (Y/N)
	Protection	Mains Fail	Analog	Y
	Protection	Battery Low	Analog	Y
Intrusion Alarm	Protection	Stage	Digital	Y
Fire Alarm	Protection	Stage	Digital	Y
B. List of signals - Metering				
HV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
HV Bus Bar	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Bus Bar	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C14 - ZIMBALI 33/11kV SUBSTATION

Substation Section	Equipment	Signal	Type	Basic (Y/N)
A. List of signals per equipment.				
High Voltage (HV) Line Section	Earthing Switch	O/C Position	Digital	Y
	Disconnect Switch	O/C Position	Digital	Y
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker		O/C Position	Digital
		Driver - Local / Remote	Digital	Y
HV Bus Bar	Disconnect Switch	O/C Position	Digital	Y
Power Transformer	Protection	86T - Master Trip	Digital	Y
MV Line Section	Earthing Switch	O/C Position	Digital	Y
	Potential Transformer - PT	Voltage P-P / P-N	Analog	Y
	Current Transformer - CT	Current	Analog	Y
	Circuit Breaker	O/C Position	Digital	Y
MV Bus Bar	Circuit Breaker	O/C Position	Digital	Y
AC Supply in Substation	Circuit Breaker	AC Mains Fail	Analog	Y
DC Auxiliary Services Battery Bank	Current Transducer	Current	Analog	Y
	Voltage Transducer	Voltage	Analog	Y
	Protection	Voltage Min/Max	Analog	Y
	Protection	Mains Fail	Analog	Y
	Protection	Battery Low	Analog	Y
Intrusion Alarm	Protection	Stage	Digital	Y
Fire Alarm	Protection	Stage	Digital	Y
B. List of signals - Metering				
HV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
MV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
Transformer	Meter / IED	V, I, P, Q, S	Digital	Y

Substation Section	Equipment	Signal	Type	Basic (Y/N)
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y
MV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix C15 - Mandeni Supply Point Auto-Recloser

Substation Section	Equipment	Signal	Type	Basic (Y/N)
A. List of signals per equipment.				
HV Line Section	Auto-recloser	O/C Position	Digital	Y
B. List of signals - Metering				
HV Line Section	Meter / IED	V, I, P, Q, S	Digital	Y
C. List of signals – Protection Units				
HV Line Section	Protection Unit / IED	Function – Relay fail, O/C or E/F, Etc.	Digital	Y

Appendix D

Relays that require the IEC61850 Protocol Upgrade

RELAYS THAT REQUIRE IEC61850 UPGRADE		
Ballito 33/11 kV Substation		Total
33kV Incomer 3	Schneider Electric	14
33/11kV Transformer 1	SEL 787 - DIFF	
33/11kV Transformer 2	SEL 787 - DIFF	
33/11kV Transformer 3	SEL 787 - DIFF	
Promenade 1 11kV Breaker	SEL-751A	
Extension 5 Switchroom 11kV Brk	SEL-751A	
Zimbali 2 11kV Breaker	SEL-751A	
Marion Road 11kV Breaker	SEL-751A	
Ashley Road 11kV Breaker	SEL-751A	
Zimbali 1 11kV Breaker	SEL-751A	
Caravan Park 11kV Breaker	SEL-751A	
Local Transformer 11kV Breaker	SEL-751A	
Firestation 11kV Breaker	SEL-751A	
Promenade 2 11kV Breaker	SEL-751A	
Ballito Business Park 33/11 KV Substation		Total
33/11kV Transformer 1	SEL 787 - DIFF	4
33/11kV Transformer 2	SEL 787 - DIFF	
33/11kV Transformer 3	SEL 787 - DIFF	
33/11kV Transformer 4	SEL 787 - DIFF	
Gledhow 33/11 KV Substation		Total
Groutville 11kV Breaker	SEL 751	4
Local Transformer 11kV Breaker	SEL 751	
Gledhow Mill 11kV Breaker	SEL 751	
Gledhow South 11kV Breaker	SEL 751	
Imbonini 33/11 KV Substation		Total
33/11kV Transformer 1	SEL 787 - DIFF	2
33/11kV Transformer 2	SEL 787 - DIFF	
Industrial Park 33/11 KV Substation		Total
33/11kV Transformer 1	SEL 787 - DIFF	2
33/11kV Transformer 2	SEL 787 - DIFF	
Sappi 33/11 KV Substation		Total
33/11kV Transformer 1	SEL 787 - DIFF	3
33/11kV Transformer 2	SEL 787 - DIFF	
33/11kV Transformer 3	SEL 787 - DIFF	
Total		29

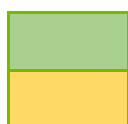
RELAYS THAT REQUIRE IEC61850 UPGRADE		
Glenhills 33/11 KV Substation		Total
33/11kV Transformer 1	SEL 787 - DIFF	5
33/11kV Transformer 2	SEL 787 - DIFF	
Townsvieview 11kV Breaker	SEL-751A	
Lot 14 Switchroom 11kV Breaker	SEL-751A	
Saunders Street Switchroom	SEL-751A	
Lavoipierre 33/11 KV Substation		Total
33/11 KV Transformer 1	SEL 787 - DIFF	15
33/11 KV Transformer 2	SEL 787 - DIFF	
33/11 KV Transformer 3	SEL 787 - DIFF	
CBD 11kV Breaker	SEL 751A	
Mayfair Investments 11kV Breaker	SEL 751A	
Spare 11kV Breaker	SEL 751A	
BW Charles 11kV Breaker	SEL 751A	
Beni's Ms	SEL 751A	
Sante Fe Ms	SEL 751A	
Ushaka Mall Sub 11kV Breaker	SEL 751A	
Shakas Rock 33/11 KV Substation		Total
33/11kV Transformer 1	SEL 787 - DIFF	2
33/11kV Transformer 2	SEL 787 - DIFF	
Stanger Point of Supply 33kV Substation		Total
Stanger No. 1 33kV Breaker	SEL 751	6
Sappi 1 33kV Breaker	SEL 751	
Sappi 2 33kV Breaker	SEL 751	
Glenhills 33kV Breaker	Schneider Electric	
Gledhow 33kV Breaker	SEL 751	
Power Factor Control Panel	Schneider Electric	
Zimbali 33/11 KV Substation		Total
33/11kV Transformer 1	SEL 787 - DIFF	2
33/11kV Transformer 2	SEL 787 - DIFF	
Total		30

Appendix E

KDM Substation BTU Analysis

KDM SUBSTATIONS BTU ANALYSIS								
No.	Substation	Charger Type (V)	Battery Rating (A/h)	Continuous Load (W)	Existing Stand Time (Hrs.)	SCADA Load (W)	New Continuous Load with SCADA (W)	Adjusted Stand Time (Hrs.)
1	Ballito 33/11kV Substation	110	66	425	12	482	907	6
2	Ballito Business Park 33/11 kV Substation	110	48	443	9	432	875	4
3	Gledhow 33/11kV Substation	32	45	200	12	402	602	6
4	Glenhills 33/11kV Substation	110	50	325	12	402	727	5
5	Grouteville 33/11kV Substation	110	75	328	12	402	730	9
6	Imbonini 33/11kV Substation	110	54	162	12	402	564	8
7	Industrial Park 33/11kV Substation	110	66	490	11	402	892	6
8	Lavoipierre 33/11kV Substation	110	45	160	10	472	632	6
9	Sappi 33/11kV Substation	110	45	150	12	422	572	6
10	Shakaskraal 11kV Substation	110	29	475	5	437	912	2
11	Shakaskraal 33kV Substation	110	21	224	7	402	626	2
12	Shakas Rock 33/11kV Substation	110	45	375	10	452	827	4
13	Sheffield 33/11kV Substation	110	29	329	7	462	791	2
14	Stanger Point of Supply 33kV Substation	110	54	175	12	402	577	8
15	Zimbali 33/11kV Substation	110	29	144	12	402	546	4

Legend

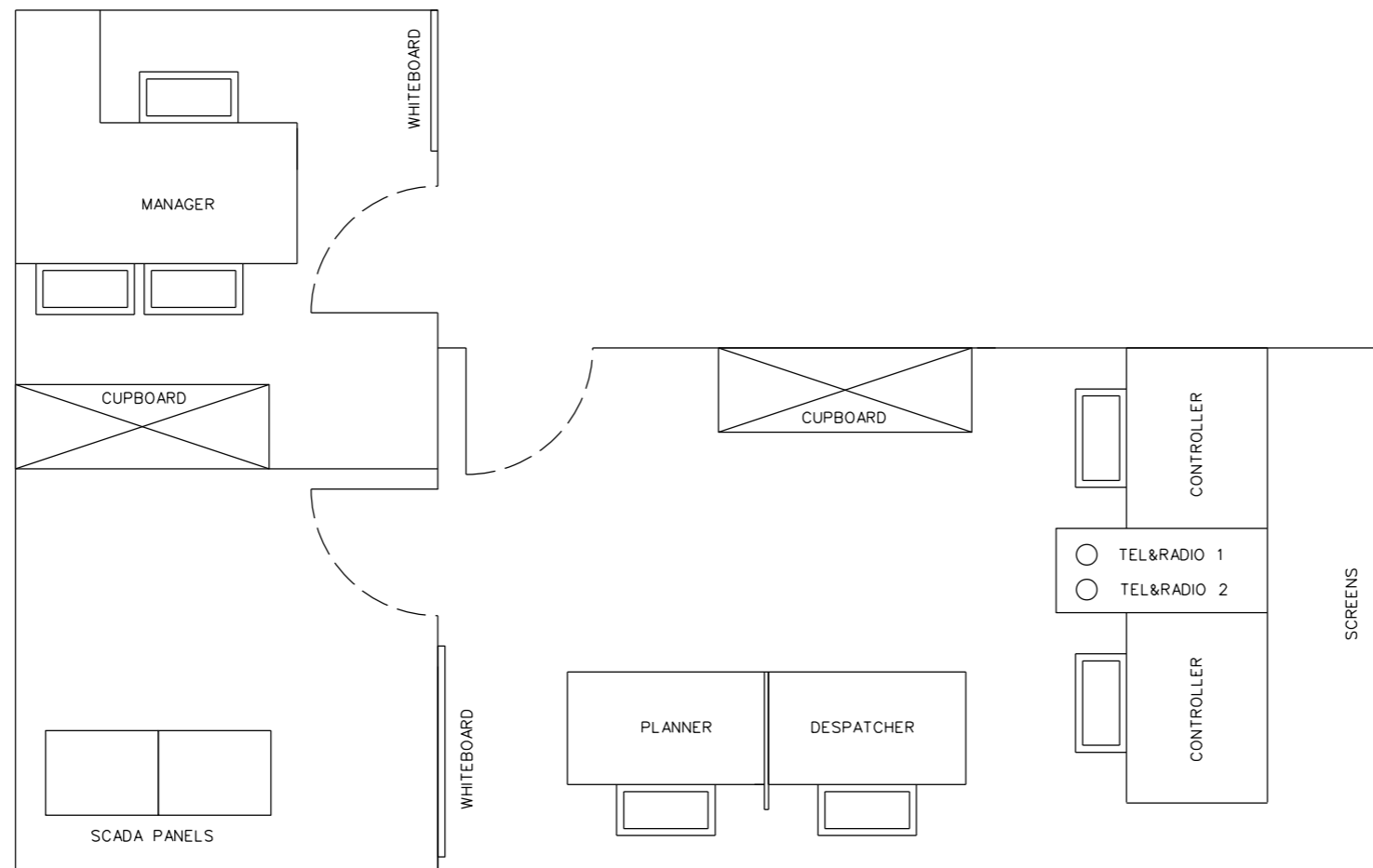
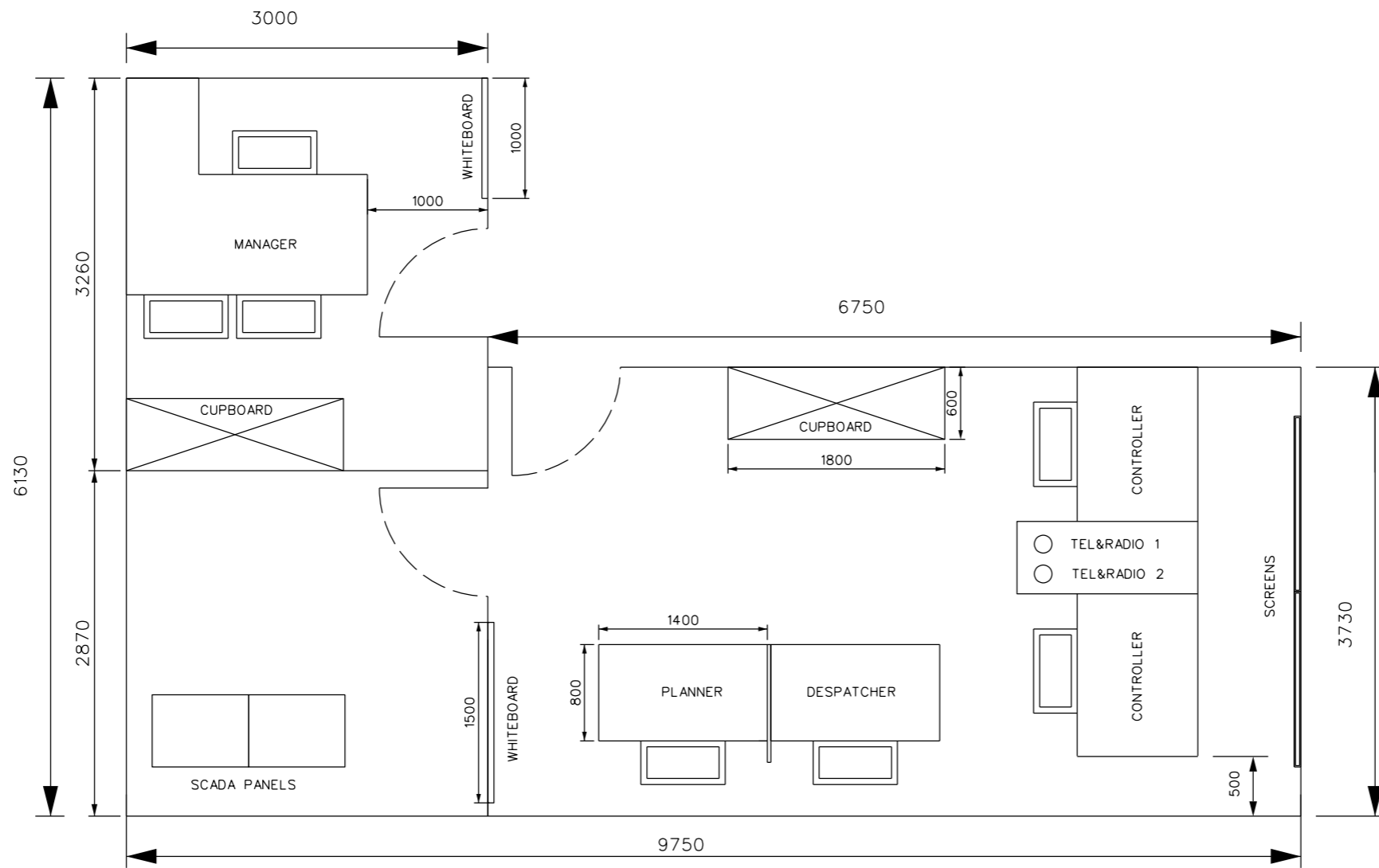


- Good
- Unacceptable, especially Shakaskraal Substation as it is a critical intake point for KDM and the substation is located in a remote area.

Appendix F


Substation SCADA Architecture Drawing List

Drawing Number	Size	Drawing Title	Rev
KDM-CR-100-01-01-A3	A3	Control Room Option 1 Layout Drawing	1
KDM-CR-100-02-01-A3	A3	Control Room Option 2 Layout Drawing	1
KDM-CR-192-01-01-A3	A3	Control Room SCADA Architecture Drawing	1
KDM-CR-193-01-01-A3	A3	Typical SCADA Panel Drawing	1
KDM-3001-192-01-01-A3	A3	Stanger Point of Supply 33kV Distribution Substation - SCADA Architecture Drawing	1
KDM-3002-192-01-01-A3	A3	Shakaskraal 33/11kV Substation - SCADA Architecture Drawing	1
KDM-3003-192-01-01-A3	A3	Proposed 132/33/11kV Dukuza Substation - SCADA Architecture Drawing	1
KDM-4001-192-01-01-A3	A3	Lavoipierre 33/11kV Substation - SCADA Architecture Drawing	1
KDM-4002-192-01-01-A3	A3	Sappi 33/11kV Substation - SCADA Architecture Drawing	1
KDM-4003-192-01-01-A3	A3	Glenhills 33/11kV Substation - SCADA Architecture Drawing	1
KDM-4004-192-01-01-A3	A3	Gledhow 33/11 kV Substation - SCADA Architecture Drawing	1
KDM-4005-192-01-01-A3	A3	Industrial Park 33/11 kV Substation - SCADA Architecture Drawing	1
KDM-4006-192-01-01-A3	A3	Shakas Rock 33/11 kV Substation - SCADA Architecture Drawing	1
KDM-4008-192-01-01-A3	A3	Ballito 33/11 kV Substation - SCADA Architecture Drawing	1
KDM-4009-192-01-01-A3	A3	Ballito Business Park 33/11 kV Substation - SCADA Architecture Drawing	1
KDM-4010-192-01-01-A3	A3	Zimbali 33/11kV Substation - SCADA Architecture Drawing	1
KDM-4011-192-01-01-A3	A3	Imbonini 33/11kV Substation - SCADA Architecture Drawing	1
KDM-4013-192-01-01-A3	A3	Grouteville 33/11kV Substation - SCADA Architecture Drawing	1
KDM-4014-192-01-01-A3	A3	Sheffield 33/11kV Substation - SCADA Architecture Drawing	1
KDM-4015-192-01-01-A3	A3	Proposed Gizenga 33/11kV Substation - SCADA Architecture Drawing	1
KDM-MAN-192-01-01-A3	A3	Mandeni 33/11kV Recloser - SCADA Architecture Drawing	1



NOTES

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DATE _____

REV	DATE	REVISION DETAILS	APPROVED
00	31/01/19	PRELIM DESIGN	
01	06/05/19	DETAIL DESIGN	


PROJECT

VUTHELA SCADA PROJECT

TITLE

CONTROL ROOM OPTION 1 LAYOUT DRAWING

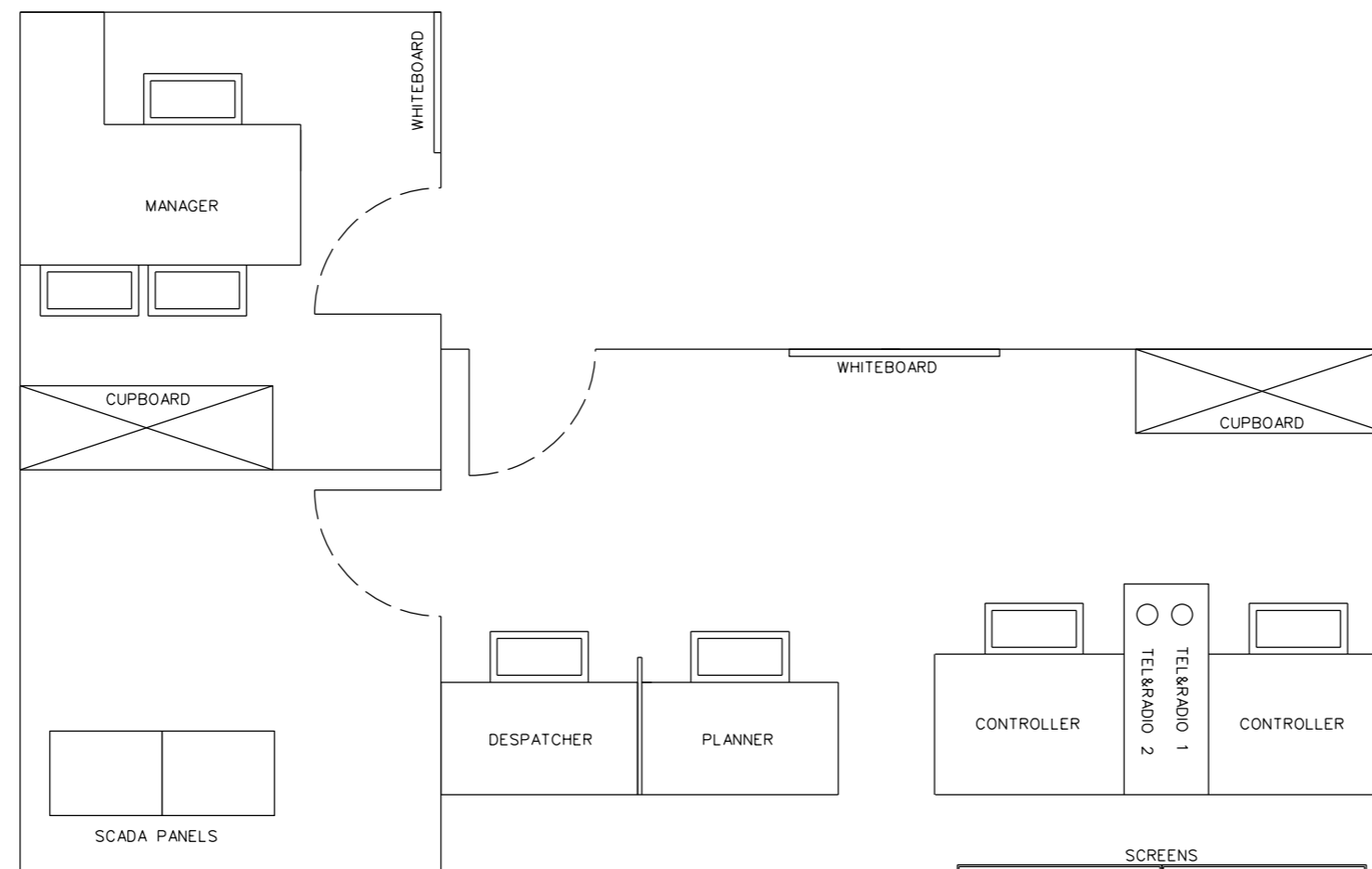
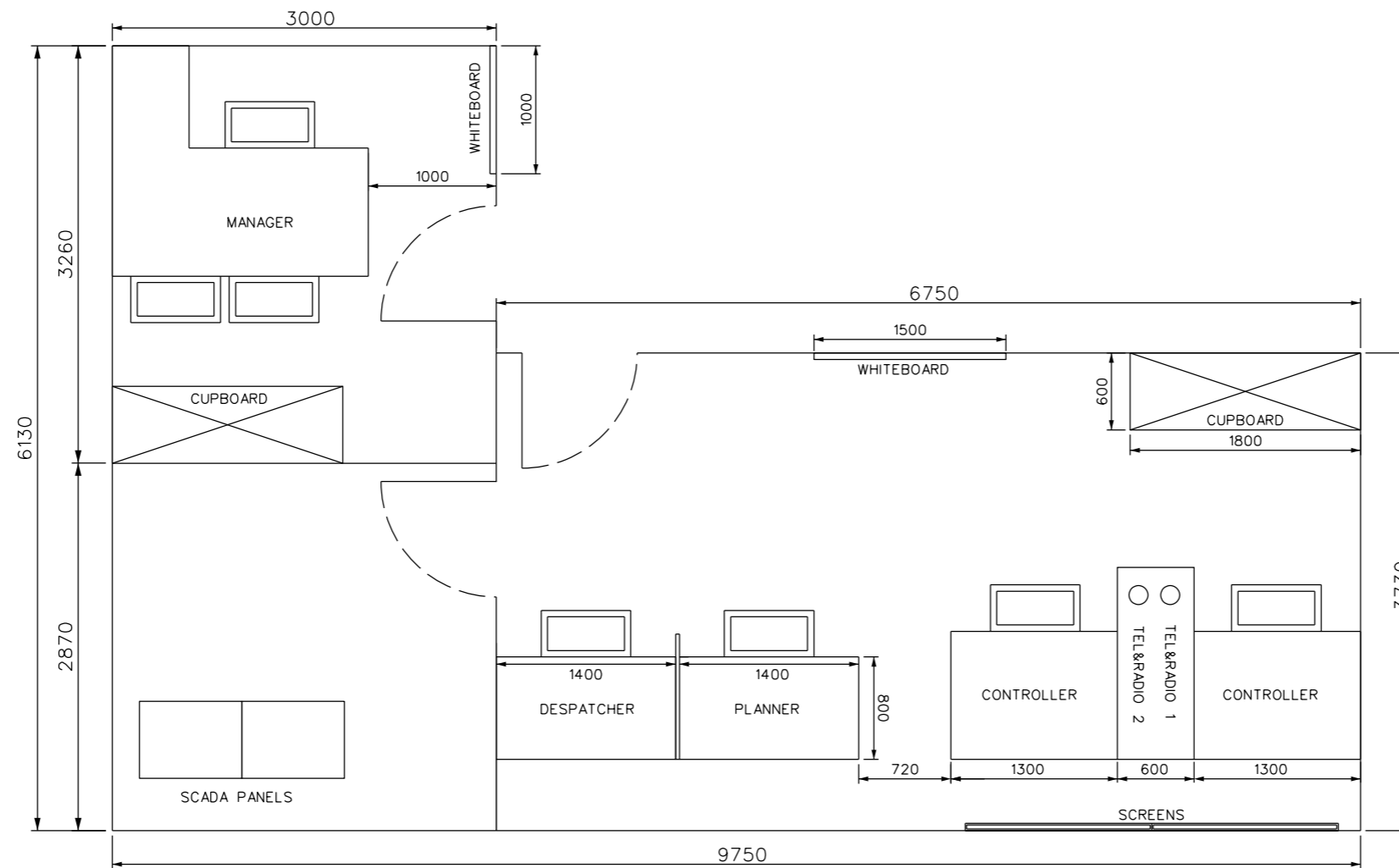
CONSULTANT



First Floor, West Building, Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive, Tel: +27 31 575 5500


P.O.Box 335, Umhlanga Rocks, 4320, Fax: +27 86 244 9177

DRAWN S.Khan	DESIGNED S.Khan	NFC
CHECKED D.NAICKER	PROJECT No. 501758	
APPROVED	SCALE 1:50	SIZE A3L
	DRAWING No. KDM-CR-100-01-01-A3	REV 01



NOTES

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00	31/01/19	PRELIM DESIGN	
01	06/05/19	DETAIL DESIGN	


PROJECT

VUTHELA SCADA PROJECT

TITLE

CONTROL ROOM OPTION 2 LAYOUT DRAWING

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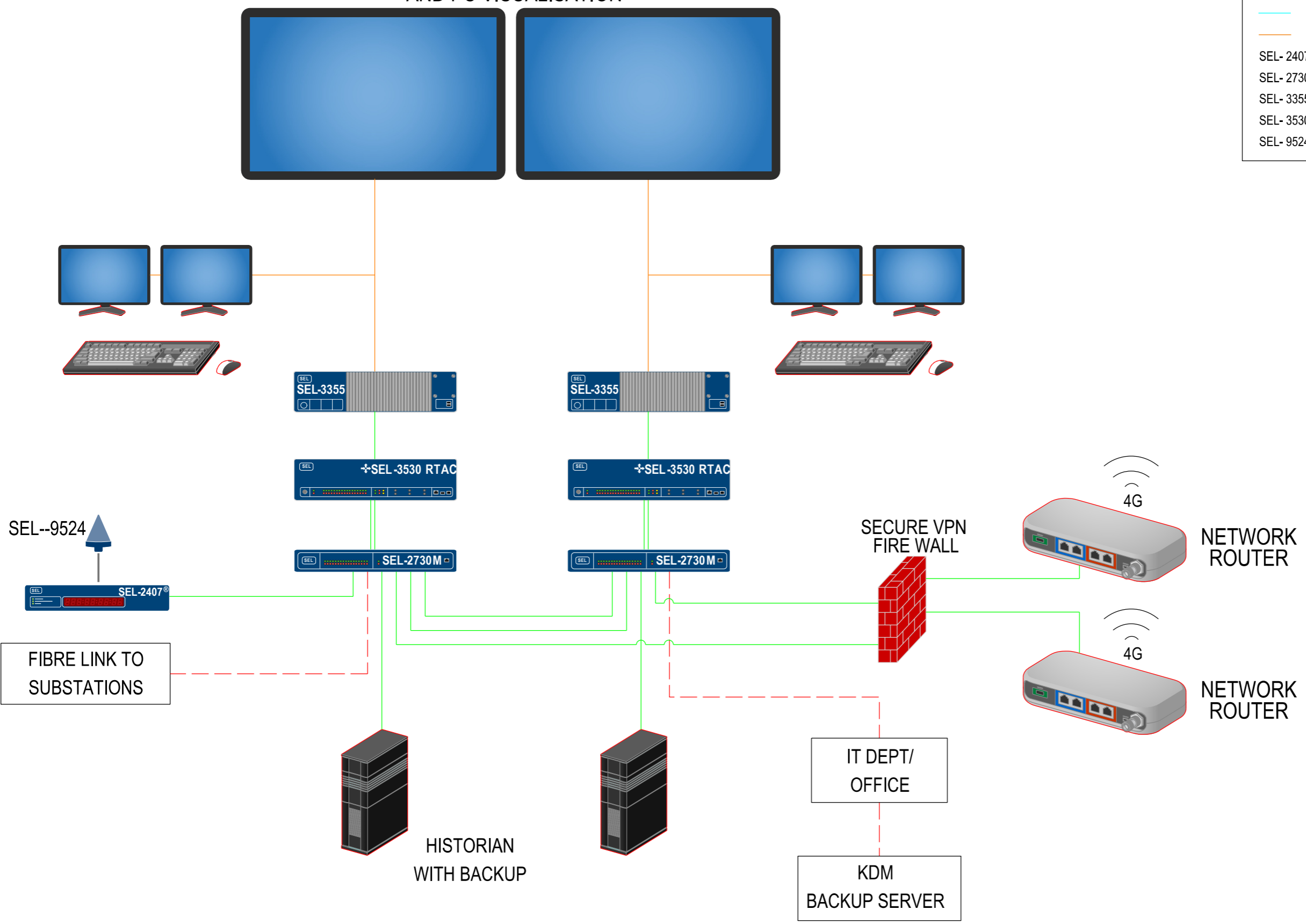
First Floor, West Building, Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive, Tel: +27 31 575 5500

P.O.Box 335, Umhlanga Rocks, 4320, Fax: +27 86 244 9177

DRAWN S.Khan	DESIGNED S.Khan	NFC
CHECKED D.NAICKER	PROJECT No. 501758	
APPROVED	SCALE 1:50	SIZE A3L
	DRAWING No. KDM-CR-100-02-01-A3	REV 01

CONTROL ROOM

SCADA SCREEN AND PC VISUALISATION



LEGEND	
—	ETHERNET COMMUNICATION
—	SERIAL COMMUNICATION
---	FIBRE COMMUNICATION
—	HARDWIRED COMMUNICATION
—	VGA / DVI - D COMMUNICATION
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA

NOTES

CLIENT

KWADUKUZA MUNICIPALITY

APPROVED BYSIGNATURE

DATE

REV	DATE	REVISION DETAILS	APPROVED
01	23/01/19	DETAIL DESIGN	

PROJECT

VUTHELA SCADA PROJECT

TITLE

CONTROL ROOM SCADA ARCHITECTURE DRAWING

CONSULTANT

aurecon
eThekweni

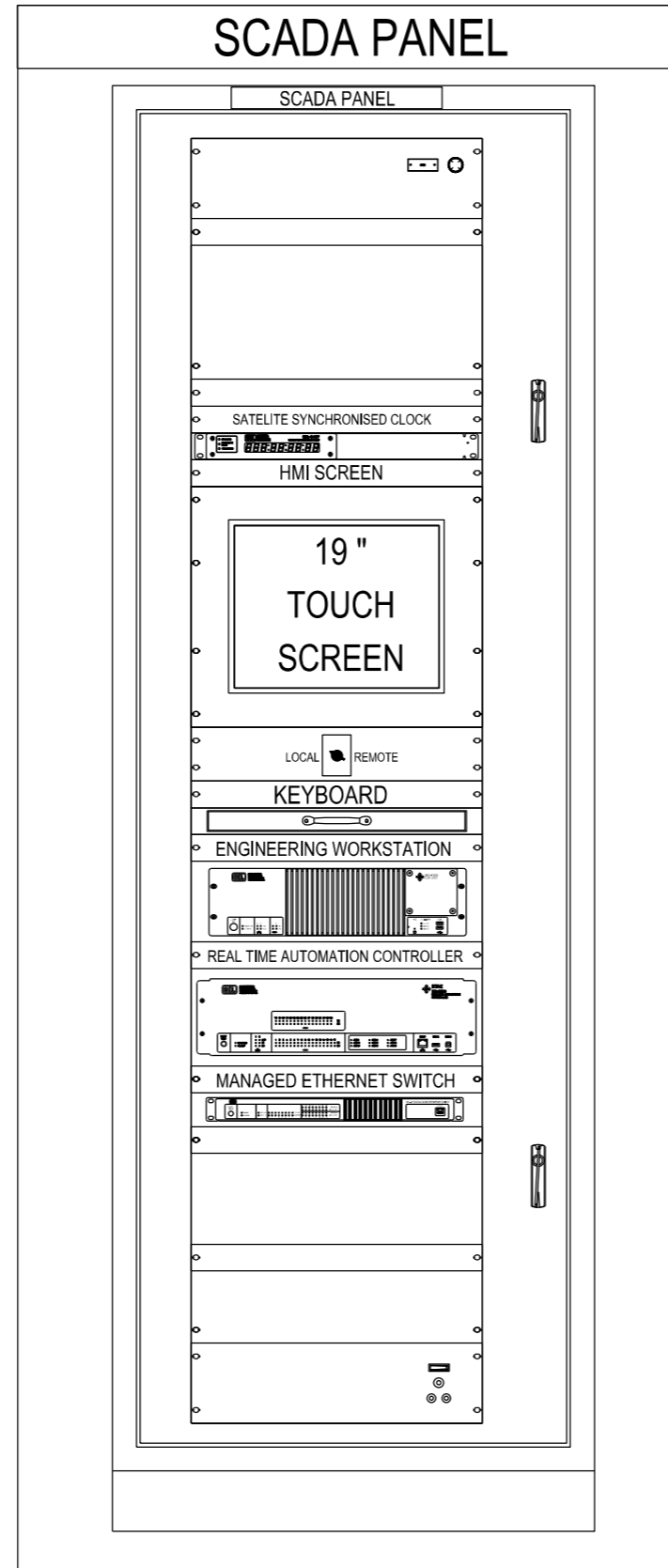
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Milkwood Office Park, Cnr Umhlanga
Rocks & Douglas Saunders Drive
Tel: +27 31 575 5500P.O.Box 335,
Umhlanga Rocks,
4320
Fax: +27 86 244 9177

DRAWN	DESIGNED	NOT FOR CONSTRUCTION
S. KHAN	D. NAICKER	
CHECKED	PROJECT No.	
D. NAICKER	503986	
APPROVED	SCALE	SIZE
	N.T.S.	A3L
	DRAWING No.	REV
	KDM-CR-192-01-01-A3	01

LEGEND

SEL 2407	SATELLITE SYNCHRONISED CLOCK
SEL 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL 3355	RACK-MOUNT COMPUTER
SEL 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)

SCADA PANEL



NOTES

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APPROVED BY SIGNATURE

DATE

REV	DATE	REVISION DETAILS	APPROVED
01	22/01/19	DETAIL DESIGN	

PROJECT

VUTHELA SCADA PROJECT

TITLE

TYPICAL SCADA PANEL DRAWING

CONSULTANT

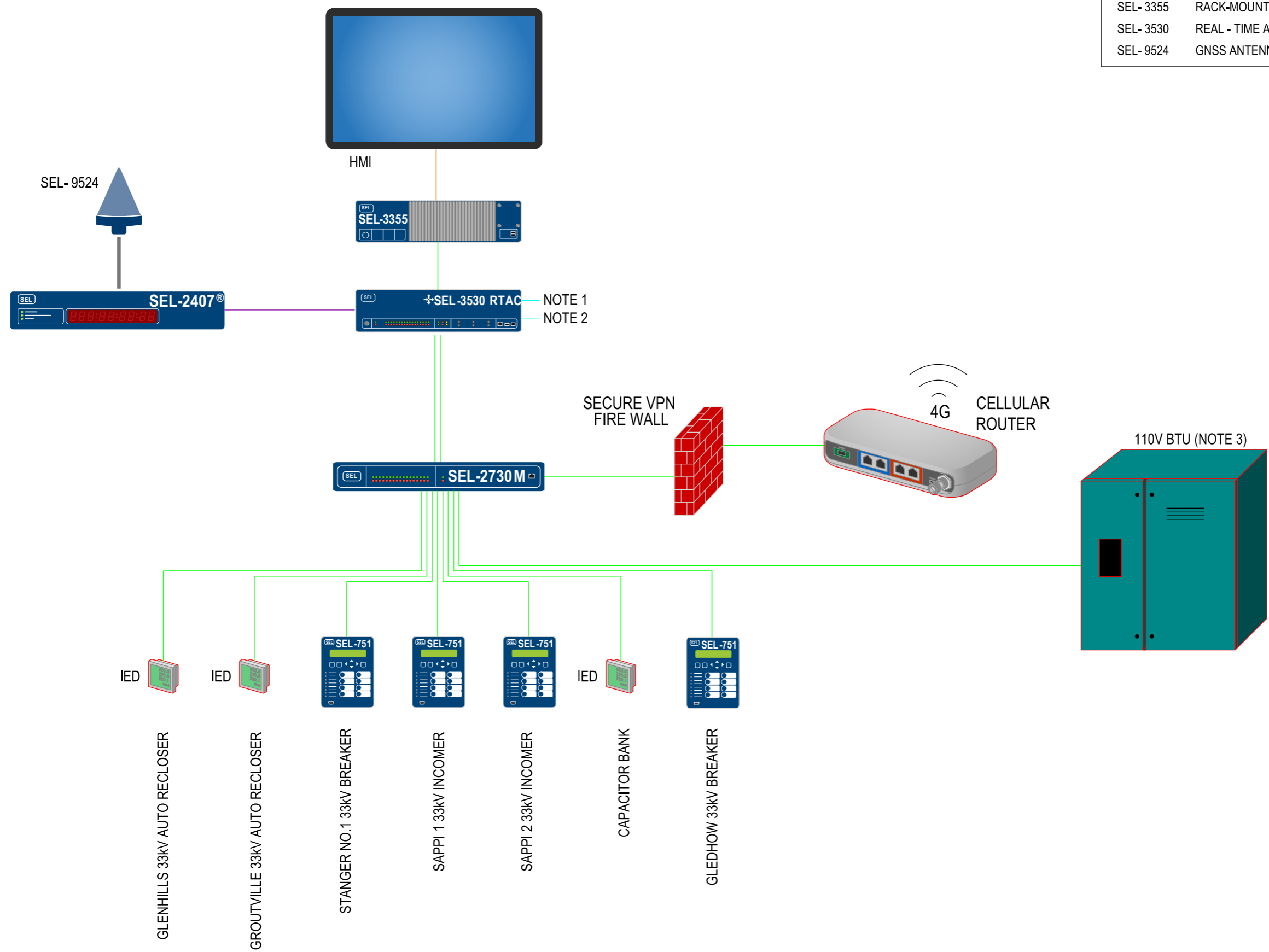
aurecon
eThekweni

First Floor, West Building, Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive, Tel: +27 31 575 5500
P.O.Box 335, Umhlanga Rocks, 4320, Fax: +27 86 244 9177

DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION
CHECKED D. NAICKER	PROJECT No. 503986	
APPROVED	SCALE N.T.S.	SIZE A3L
	DRAWING No. KDM-CR-193-01-A3	REV 01

NOTE 1	NOTE 2
I/O SIGNALS : - AC BOARD - DOOR OPEN	ISOLATOR SIGNALS FROM 33kV CONTROL ROOM PANELS
NOTE 3	
BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL	

LEGEND	
	ETHERNET COMMUNICATION
	HARDWIRED COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA



NOTES

- FOR ISOLATOR SIGNALS , REFER TO DRAWING : KDM-3001-DD-01-02-A3
- BUS SECTION BREAKER TO BE WIRED INTO SEL-3530

CLIENT

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DATE _____

REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	

PROJECT

VUTHELA SCADA PROJECT

TITLE

STANGER POINT OF SUPPLY
33kV DISTRIBUTION SUBSTATION
SCADA ARCHITECTURE DRAWING

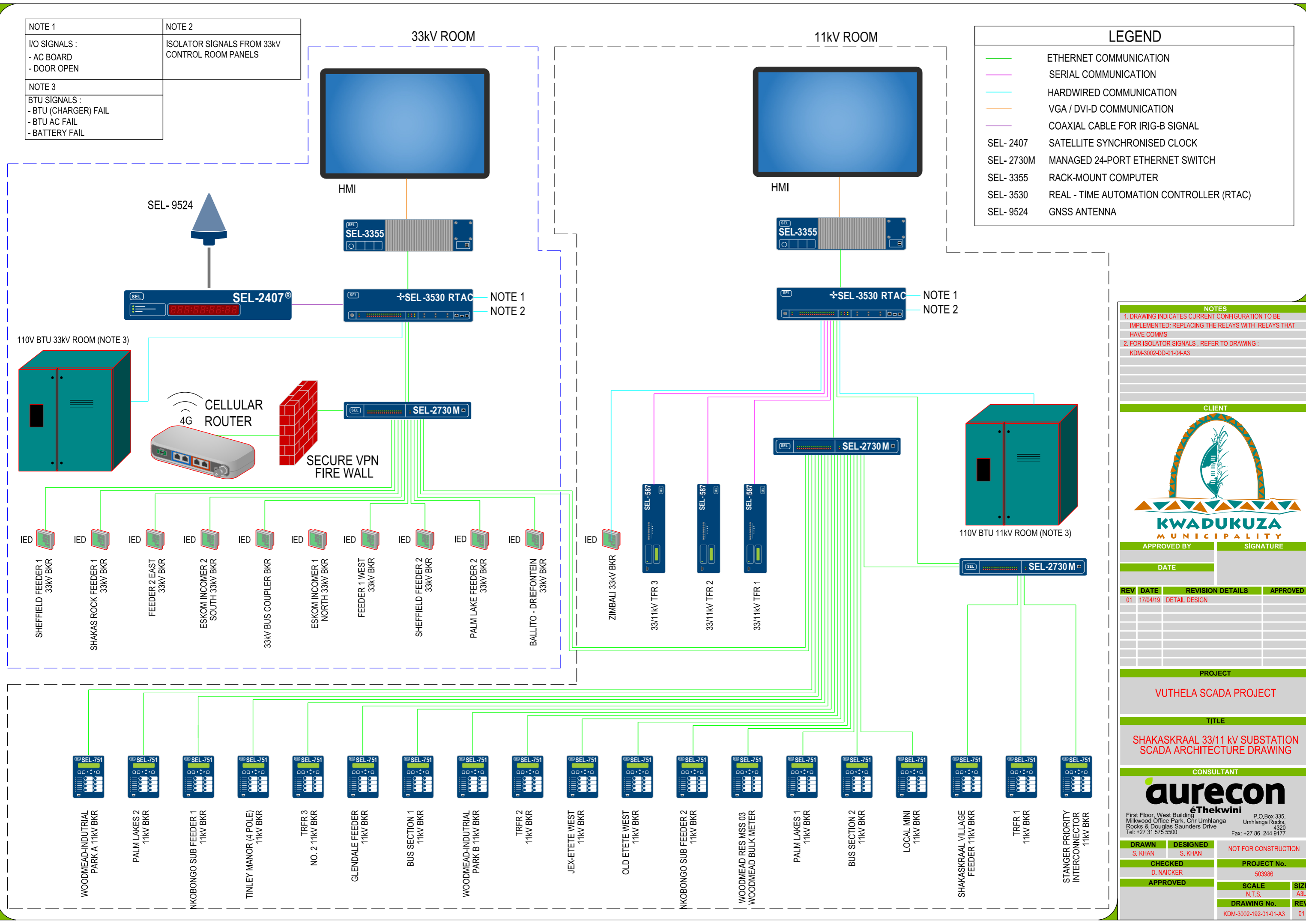
CONSULTANT

First Floor, West Building
Milkwood Office Park, Cnr Umhlanga
Rocks & Douglas Saunders Drive
Tel: +27 31 575 5500

P.O.Box 335,
Umhlanga Rocks,
4320
Fax: +27 86 244 9177

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CHECKED D. NAICKER	PROJECT No. 503986	
APPROVED	SCALE N.T.S.	SIZE A3L
	DRAWING No. KDM-3001-192-01-01-A3	REV 01

NOTE 1 I/O SIGNALS : - AC BOARD - DOOR OPEN	NOTE 2 ISOLATOR SIGNALS FROM 33kV CONTROL ROOM PANELS
NOTE 3 BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL	



LEGEND	
—	ETHERNET COMMUNICATION
—	SERIAL COMMUNICATION
—	HARDWIRED COMMUNICATION
—	VGA / DVI-D COMMUNICATION
—	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA

NOTES	
1.	DRAWING INDICATES CURRENT CONFIGURATION TO BE IMPLEMENTED; REPLACING THE RELAYS WITH RELAYS THAT HAVE COMMS
2.	FOR ISOLATOR SIGNALS , REFER TO DRAWING : KDM-3002-DD-01-04-A3

CLIENT

APPROVED BY _____ SIGNATURE _____

DATE _____

REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	

PROJECT
VUTHELA SCADA PROJECT

TITLE
SHAKASKRAAL 33/11 kV SUBSTATION SCADA ARCHITECTURE DRAWING

CONSULTANT

éThekwini
First Floor, West Building
Milkwood Office Park, Cnr Umhlanga
Rocks & Douglas Saunders Drive
Tel: +27 31 575 5500

P.O.Box 335,
Umhlanga Rocks,
4320
Fax: +27 86 244 9177

DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION
CHECKED D. NAICKER	APPROVED	PROJECT No. 503986
		SCALE N.T.S.
		SIZE A3L
		DRAWING No. KDM-3002-192-01-01-A3
		REV 01

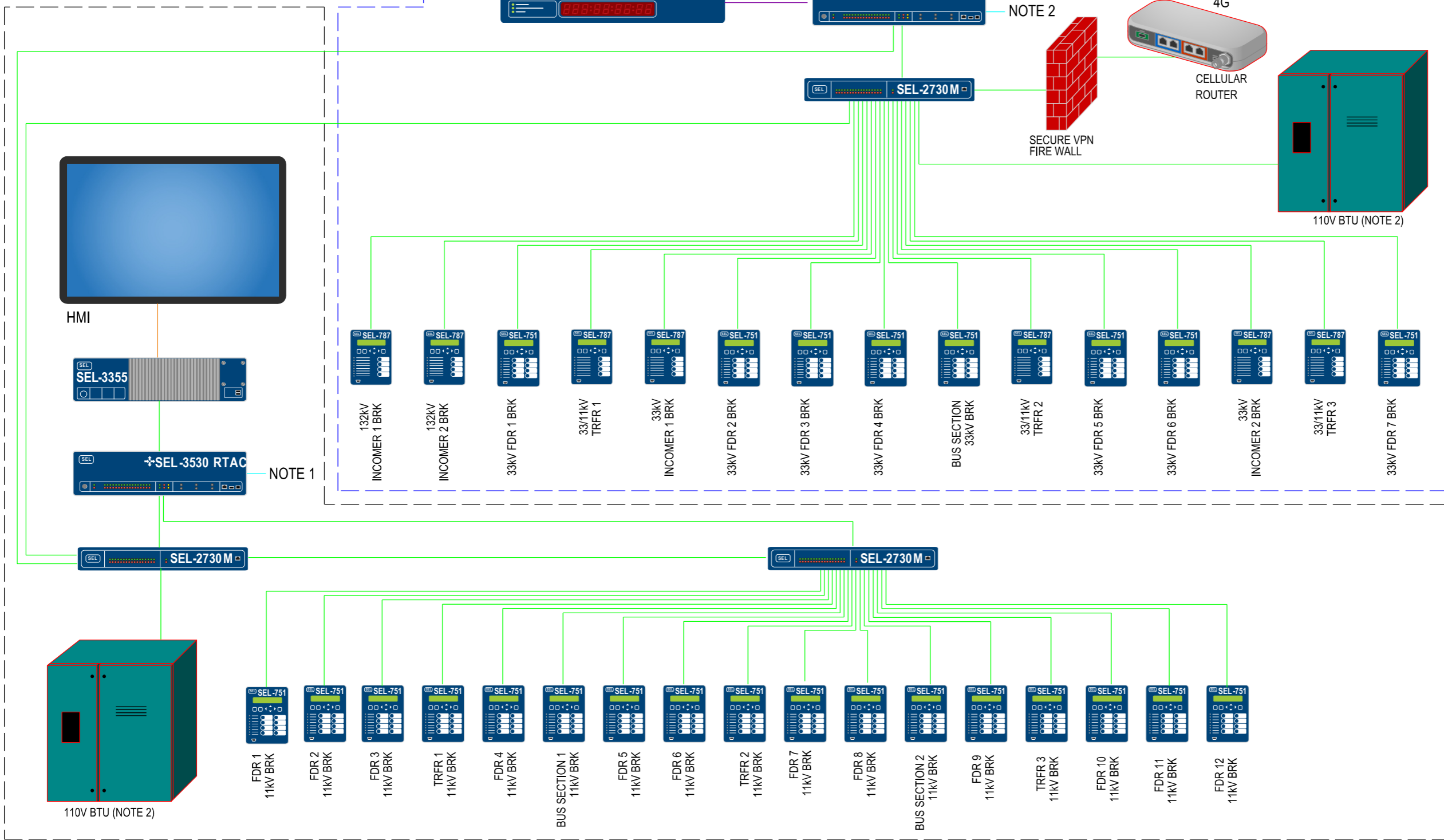
NOTE 1	NOTE 2
I/O SIGNALS : - AC BOARD - DOOR OPEN	BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL

33 kV ROOM

LEGEND

	ETHERNET COMMUNICATION
	HARDWIRED COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA

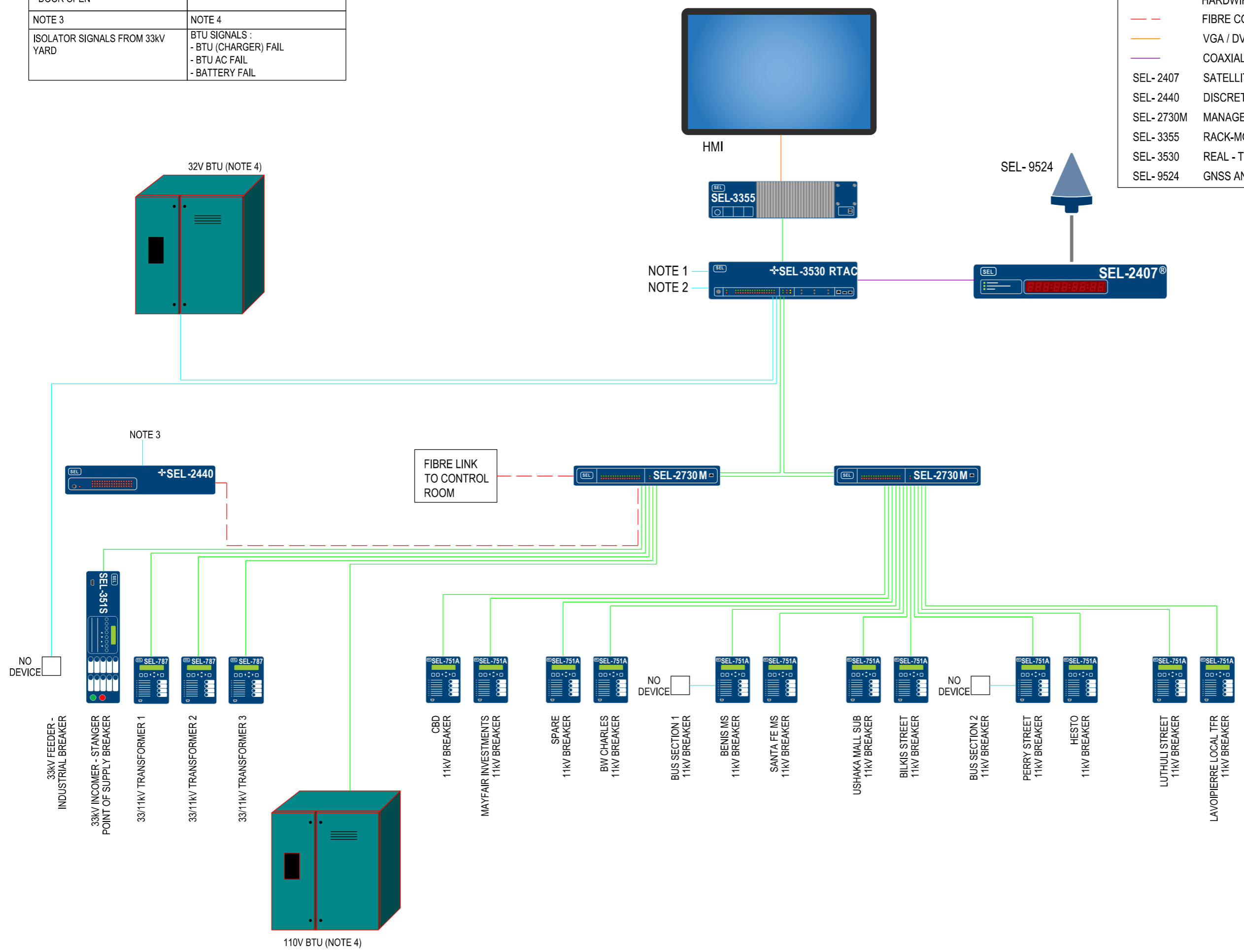
11 kV ROOM



NOTES		
CLIENT		
APPROVED BY	SIGNATURE	
DATE		
REV	DATE	REVISION DETAILS
01	17/04/19	DETAIL DESIGN
PROJECT		
VUTHELA SCADA PROJECT		
TITLE		
PROPOSED DUKUZA 132/33/11 kV SUBSTATION SCADA ARCHITECTURE DRAWING		
CONSULTANT		
<small>First Floor, West Building, Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive, Tel: +27 31 575 5500</small>		
<small>P.O.Box 335, Umhlanga Rocks, 4320 Fax: +27 86 244 9177</small>		
DRAWN	DESIGNED	NOT FOR CONSTRUCTION
S. KHAN	S. KHAN	
CHECKED	PROJECT No.	
D. NAICKER	503986	
APPROVED	SCALE	SIZE
	N.T.S.	A3L
	DRAWING No.	REV
	DUKUZA SUB	01

NOTE 1 I/O SIGNALS : - AC BOARD - DOOR OPEN	NOTE 2 ISOLATOR SIGNALS FROM 33kV CONTROL ROOM PANELS
NOTE 3 ISOLATOR SIGNALS FROM 33kV YARD	NOTE 4 BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL

LEGEND	
	ETHERNET COMMUNICATION
	HARDWIRED COMMUNICATION
	FIBRE COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2440	DISCRETE PROGRAMMABLE AUTOMATION CONTROLLER
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA



NOTES
1. FOR ISOLATOR SIGNALS , REFER TO DRAWING :
KDM-4001-DD-01-03-A3

CLIENT

KWADUKUZA MUNICIPALITY

APPROVED BY: _____ SIGNATURE: _____
DATE: _____

REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	

PROJECT
VUTHELA SCADA PROJECT

TITLE
LAVOPIERRE 33/11 kV SUBSTATION
SCADA ARCHITECTURE DRAWING

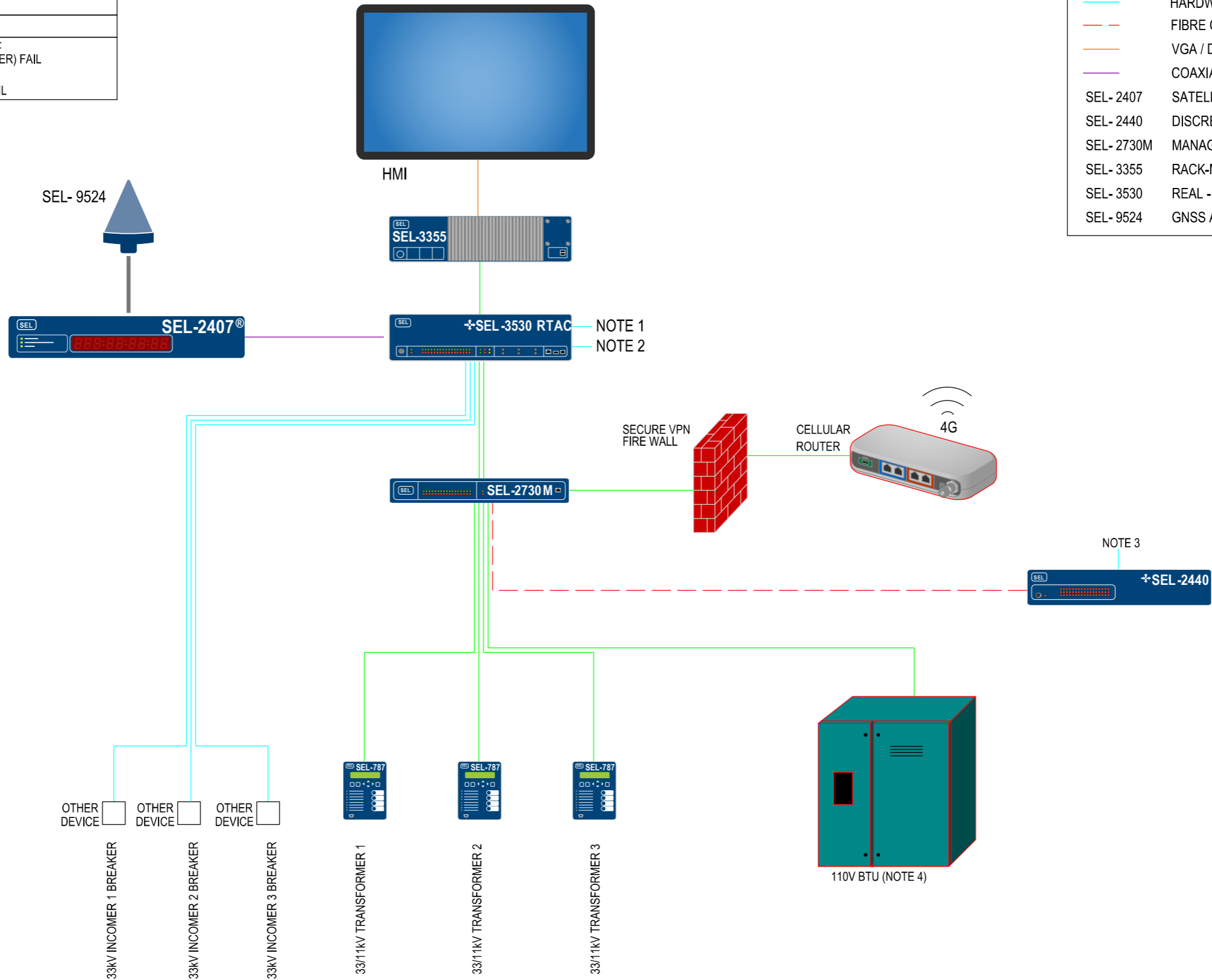
CONSULTANT

aurecon eThekweni
First Floor, West Building, Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive, Tel: +27 31 675 5500
P.O.Box 335, Umhlanga Rocks, 4320, Fax: +27 86 244 9177

DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION
CHECKED D. NAICKER	APPROVED	PROJECT No. 503986
		SCALE N.T.S.
		SIZE A3L
		DRAWING No. KDM-4001-192-01-01-A3
		REV 01

NOTE 1	NOTE 2
I/O SIGNALS : - AC BOARD - DOOR OPEN	ISOLATOR SIGNALS FROM 33kV CONTROL ROOM PANELS
NOTE 3	NOTE 4
ISOLATOR SIGNALS FROM 33kV YARD	BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL

LEGEND	
	ETHERNET COMMUNICATION
	HARDWIRED COMMUNICATION
	FIBRE COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2440	DISCRETE PROGRAMMABLE AUTOMATION CONTROLLER
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA



NOTES
1. FOR ISOLATOR SIGNALS , REFER TO DRAWING :
KDM-4002-DD-01-02-A3

CLIENT

KWADUKUZA MUNICIPALITY

APPROVED BY	SIGNATURE
DATE	

REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	

PROJECT
VUTHELA SCADA PROJECT

TITLE
SAPPI 33/11 kV SUBSTATION
SCADA ARCHITECTURE DRAWING

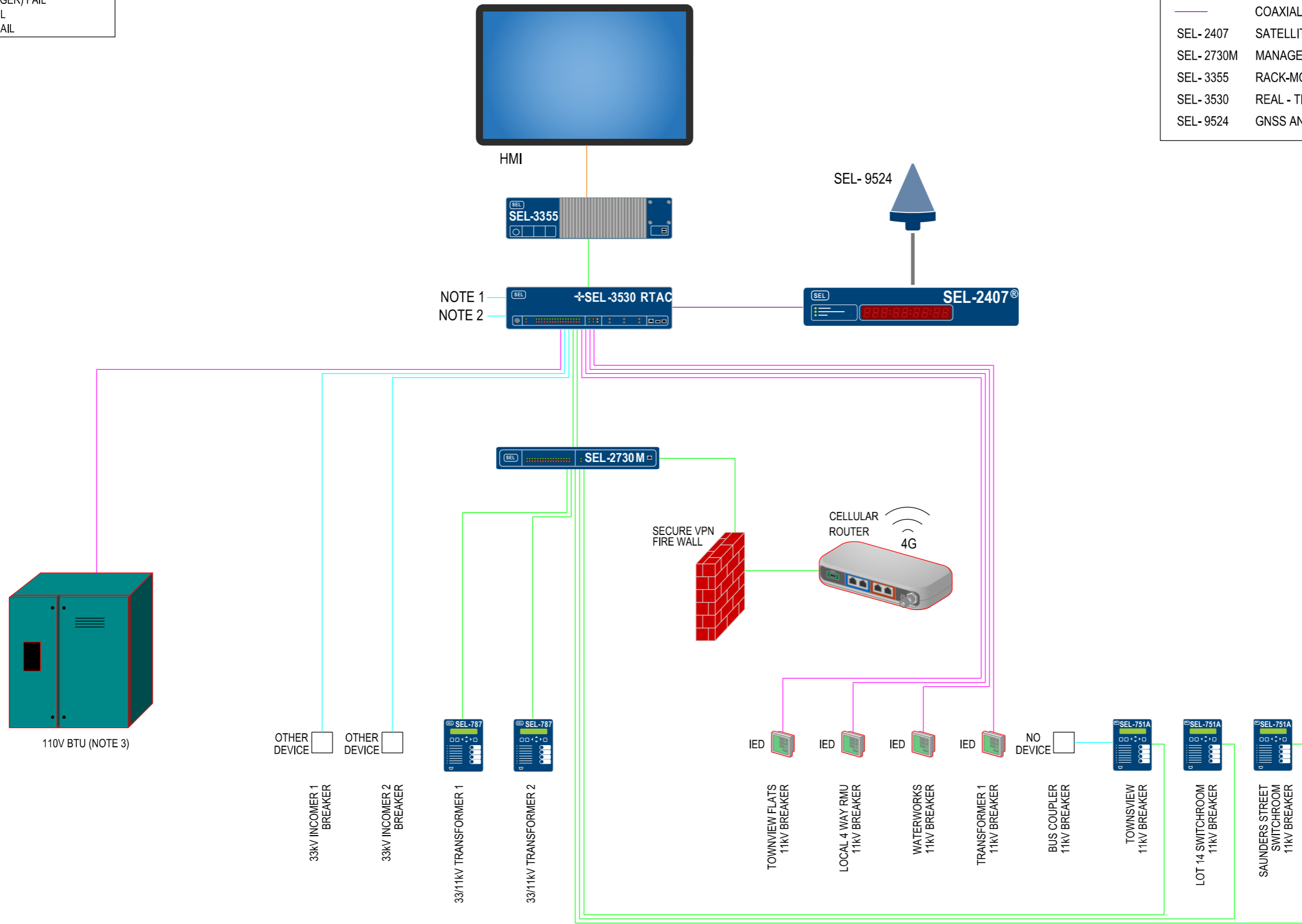
CONSULTANT

aurecon eThekweni
First Floor, West Building, Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive, 4320
Tel: +27 31 675 5500 P.O.Box 335, Umhlanga Rocks, 4320 Fax: +27 86 244 9177

DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION
CHECKED D. NAICKER	PROJECT No. 503986	
APPROVED	SCALE N.T.S.	SIZE A3L
	DRAWING No. KDM-4002-192-01-01-A3	REV 01

NOTE 1	NOTE 2
I/O SIGNALS : - AC BOARD - DOOR OPEN	ISOLATOR SIGNALS FROM 33kV CONTROL ROOM PANELS
NOTE 3	
BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL	

LEGEND	
	ETHERNET COMMUNICATION
	SERIAL COMMUNICATION
	HARDWIRED COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA



NOTES	
1.	FOR ISOLATOR SIGNALS , REFER TO DRAWING : KDM-4003-DD-01-04-A3
2.	BUS SECTION TO BE WIRED INTO SEL-3530



CLIENT	
APPROVED BY	SIGNATURE
DATE	

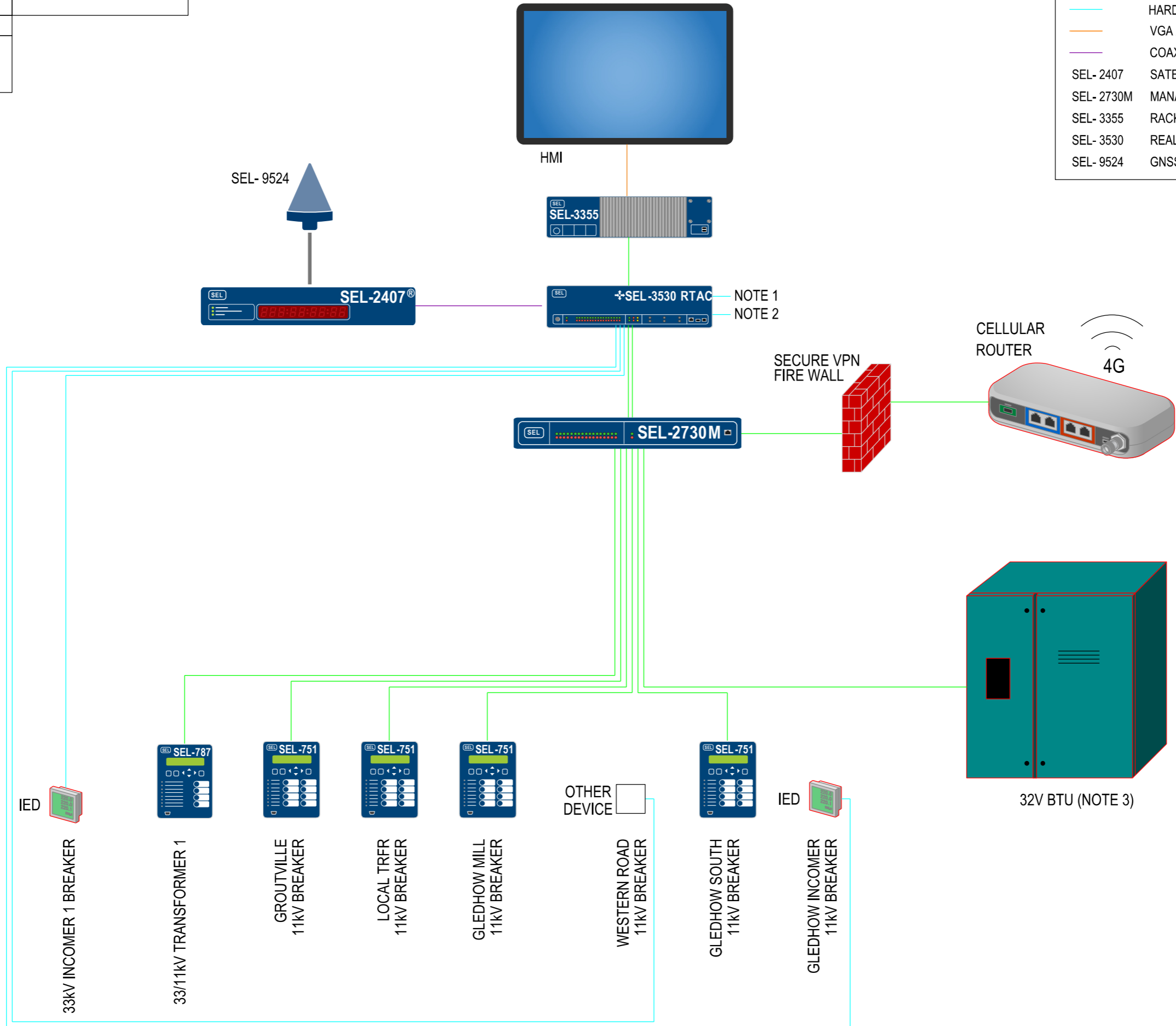
PROJECT		
VUTHELA SCADA PROJECT		
TITLE		
GLENHILLS 33/11 kV SUBSTATION SCADA ARCHITECTURE DRAWING		

CONSULTANT
aurecon
 eThekweni
 First Floor, West Building
 Milkwood Office Park, Cnr Umhlanga
 Rocks & Douglas Saunders Drive
 Tel: +27 31 575 5500
 P.O.Box 335,
 Umhlanga Rocks,
 4320
 Fax: +27 86 244 9177

DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION
CHECKED D. NAICKER	PROJECT No. 503986	
APPROVED	SCALE N.T.S.	SIZE A3L
	DRAWING No. KDM-4003-192-01-01-A3	REV 01

NOTE 1	NOTE 2
I/O SIGNALS : - AC BOARD - DOOR OPEN	ISOLATOR SIGNALS FROM 33kV CONTROL ROOM PANELS
NOTE 3	
BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL	

LEGEND	
	ETHERNET COMMUNICATION
	HARDWIRED COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA



NOTES	
1. FOR ISOLATOR SIGNALS, REFER TO DRAWING : KDM-4004-DD-01-02-A3	



CLIENT	
APPROVED BY	SIGNATURE
DATE	

REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	

PROJECT
VUTHELA SCADA PROJECT

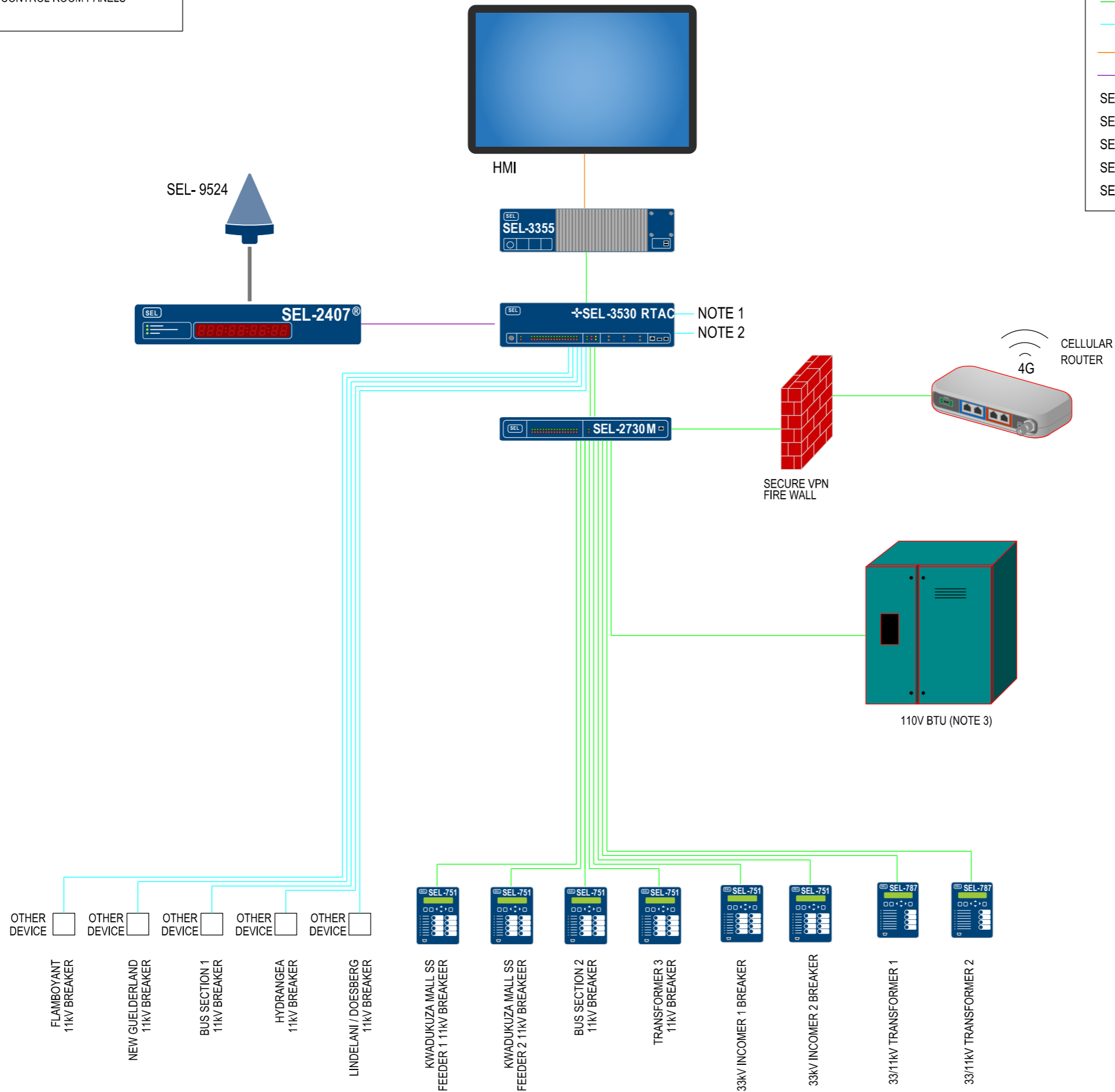
TITLE
GLEDHOW 33/11 kV SUBSTATION
SCADA ARCHITECTURE DRAWING

CONSULTANT
aurecon
eThekweni
First Floor, West Building, Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive, P.O.Box 335, Umhlanga Rocks, 4320
Tel: +27 31 575 5500 Fax: +27 86 244 9177

DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION
CHECKED D. NAICKER	PROJECT No. 503986	
APPROVED	SCALE N.T.S.	SIZE A3L
	DRAWING No. KDM-4004-192-01-01-A3	REV 01

NOTE 1	NOTE 2
I/O SIGNALS : - AC BOARD - DOOR OPEN	ISOLATOR SIGNALS FROM 33kV CONTROL ROOM PANELS
NOTE 3	
BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL	

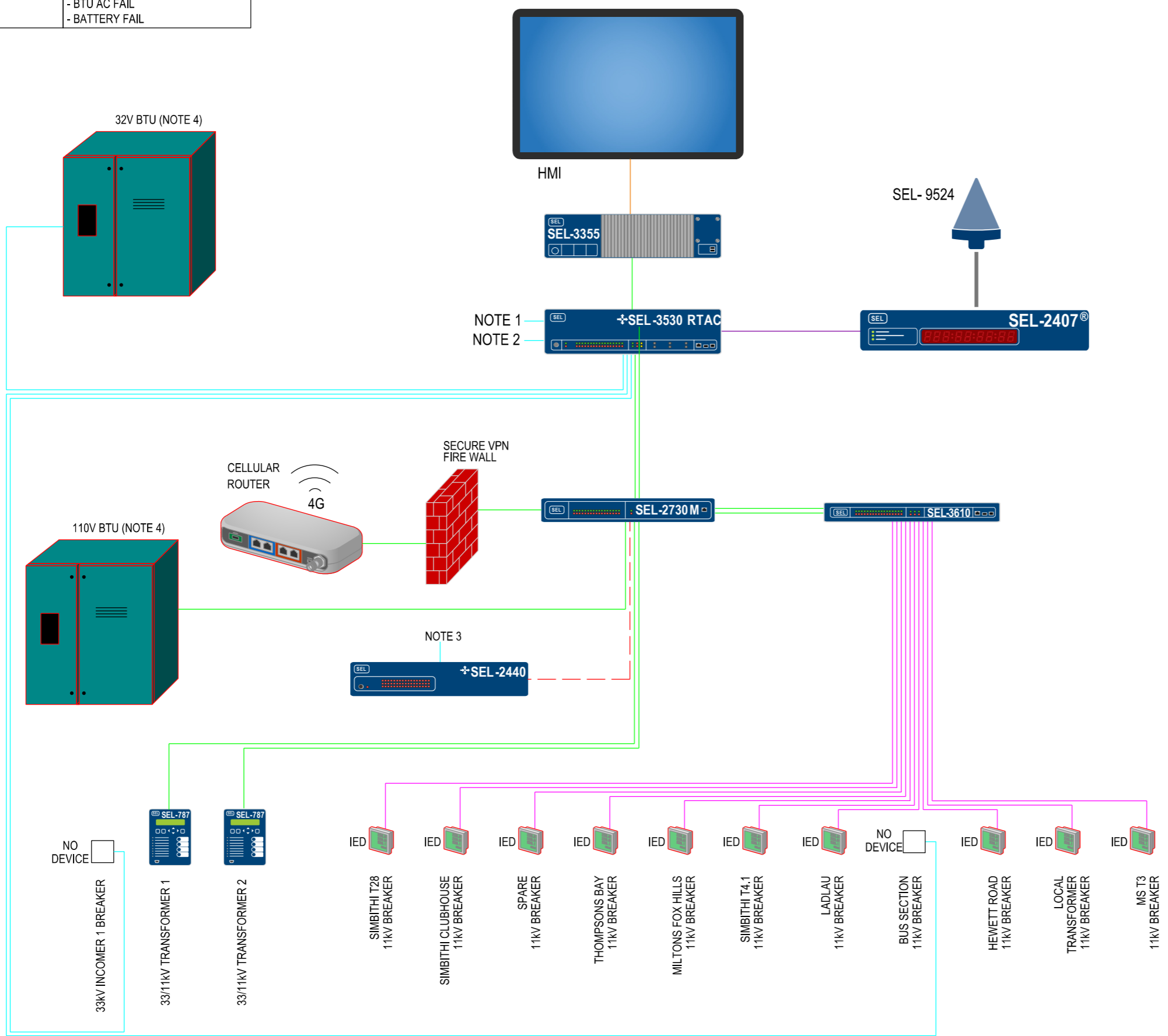
LEGEND	
	ETHERNET COMMUNICATION
	HARDWIRED COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA



NOTES			
1. FOR ISOLATOR SIGNALS , REFER TO DRAWING : KDM-4005-DD-01-B-A3			
CLIENT			
APPROVED BY		SIGNATURE	
DATE			
REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	
PROJECT			
VUTHELA SCADA PROJECT			
TITLE			
INDUSTRIAL PARK 33/11 kV SUBSTATION SCADA ARCHITECTURE DRAWING			
CONSULTANT			
éThekwini First Floor, West Building Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive Tel: +27 31 575 5500			
P.O.Box 335, Umhlanga Rocks, 4320 Fax: +27 86 244 9177			
DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION	
CHECKED D. NAICKER	PROJECT No. 503986		
APPROVED	SCALE N.T.S.	SIZE A3L	REV 01
DRAWING No. KDM-4005-192-01-01-A3			

NOTE 1	NOTE 2
I/O SIGNALS : - AC BOARD - DOOR OPEN	ISOLATOR SIGNALS FROM 33kV CONTROL ROOM PANELS
NOTE 3	NOTE 4
ISOLATOR SIGNALS FROM 33kV YARD	BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL

LEGEND	
	ETHERNET COMMUNICATION
	SERIAL COMMUNICATION
	HARDWIRED COMMUNICATION
	FIBRE COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2440	DISCRETE PROGRAMMABLE AUTOMATION CONTROLLER
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 3610	SERIAL PORT SERVER
SEL- 9524	GNSS ANTENNA



NOTES
1. FOR ISOLATOR SIGNALS , REFER TO DRAWING :
KDM-4006-DD-01-02-A3

CLIENT

APPROVED BY: _____ SIGNATURE: _____
DATE: _____

REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	

PROJECT
VUTHELA SCADA PROJECT

TITLE
SHAKAS ROCK 33/11 kV SUBSTATION
SCADA ARCHITECTURE DRAWING

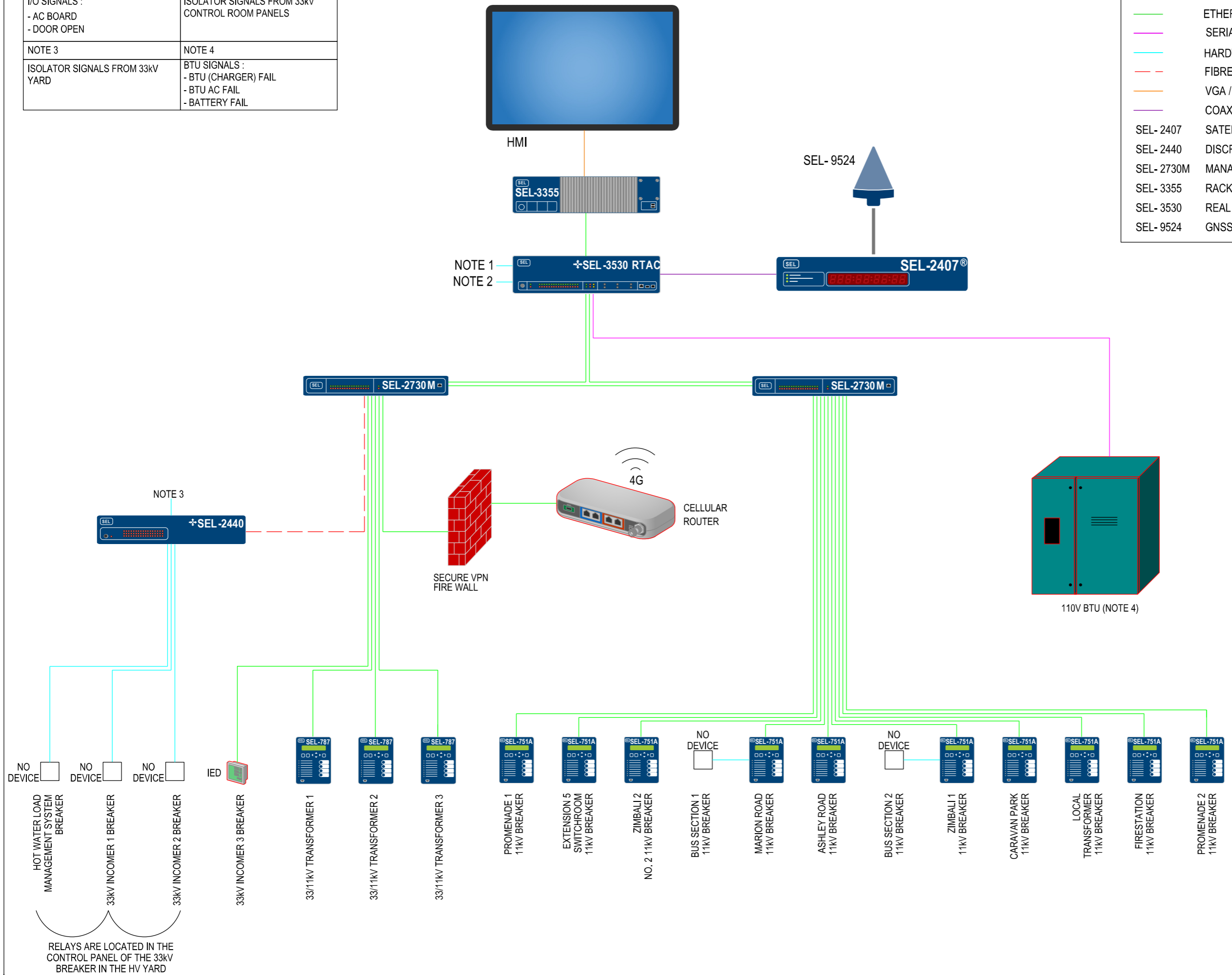
CONSULTANT

First Floor, West Building, Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive, Tel: +27 31 575 5500
P.O.Box 335, Umhlanga Rocks, 4320, Fax: +27 86 244 9177

DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION
CHECKED D. NAICKER	PROJECT No. 503986	
APPROVED	SCALE N.T.S.	SIZE A3L
	DRAWING No. KDM-4006-192-01-01-A3	REV 01

NOTE 1	NOTE 2
I/O SIGNALS : - AC BOARD - DOOR OPEN	ISOLATOR SIGNALS FROM 33kV CONTROL ROOM PANELS
NOTE 3	NOTE 4
ISOLATOR SIGNALS FROM 33kV YARD	BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL

LEGEND	
	ETHERNET COMMUNICATION
	SERIAL COMMUNICATION
	HARDWIRED COMMUNICATION
	FIBRE COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2440	DISCRETE PROGRAMMABLE AUTOMATION CONTROLLER
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA



NOTES
1. FOR ISOLATOR SIGNALS, REFER TO DRAWING : KDM-4008-DD-01-02-A3

CLIENT

APPROVED BY: _____ SIGNATURE: _____
DATE: _____

REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	

PROJECT
VUTHELA SCADA PROJECT

TITLE
BALLITO 33/11 kV SUBSTATION SCADA ARCHITECTURE DRAWING

CONSULTANT

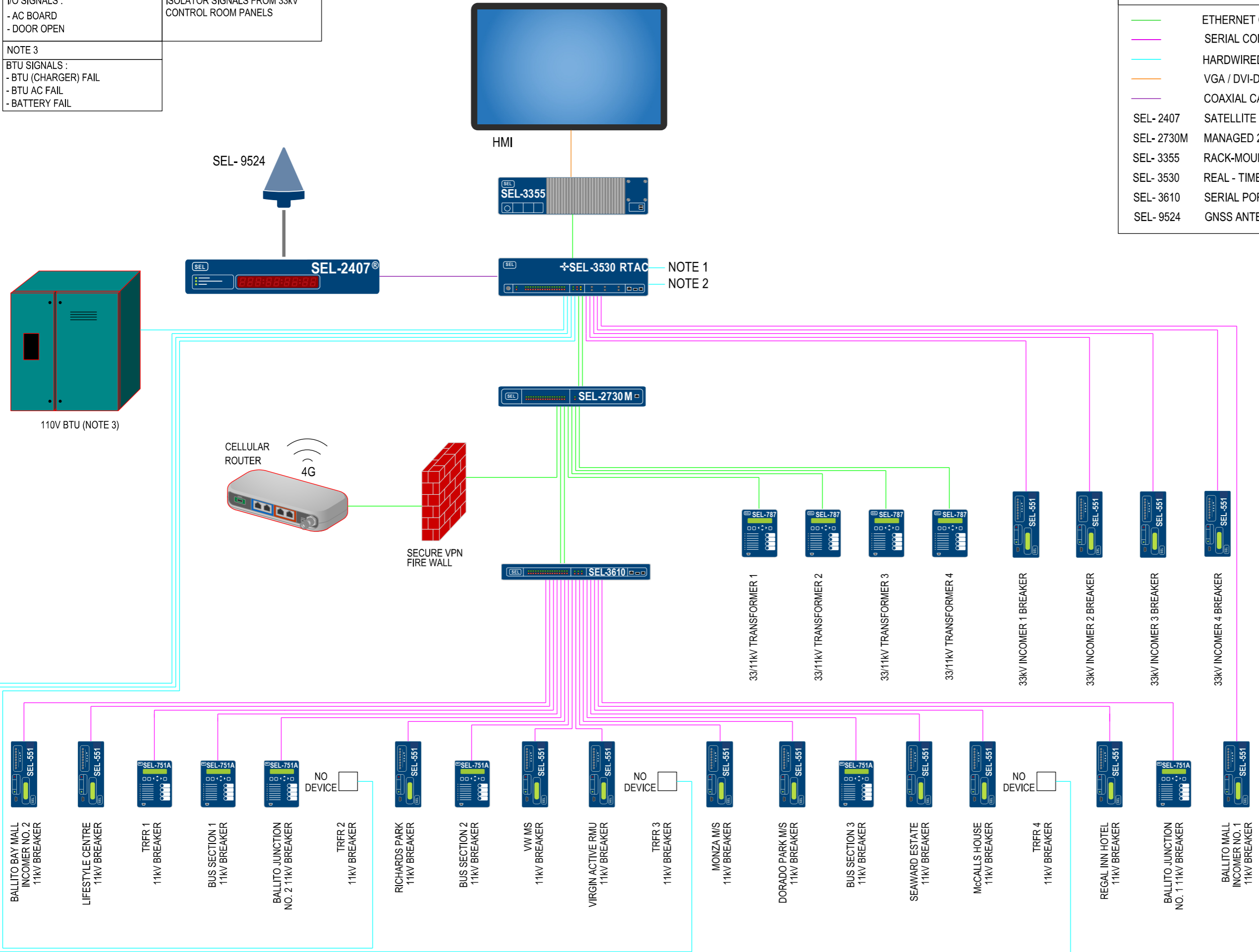
First Floor, West Building, Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive, Umhlanga Rocks, 4320. Tel: +27 31 675 5500. P.O.Box 335, Umhlanga Rocks, 4320. Fax: +27 86 244 9177

DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION
CHECKED D. NAICKER	APPROVED	PROJECT No. 503986
		SCALE N.T.S.
		SIZE A3L
		DRAWING No. KDM-4008-192-01-01-A3
		REV 01

RELAYS ARE LOCATED IN THE CONTROL PANEL OF THE 33kV BREAKER IN THE HV YARD

NOTE 1 I/O SIGNALS : - AC BOARD - DOOR OPEN	NOTE 2 ISOLATOR SIGNALS FROM 33kV CONTROL ROOM PANELS
NOTE 3 BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL	

LEGEND	
	ETHERNET COMMUNICATION
	SERIAL COMMUNICATION
	HARDWIRED COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 3610	SERIAL PORT SERVER
SEL- 9524	GNSS ANTENNA



NOTES
1. FOR ISOLATOR SIGNALS, REFER TO DRAWING :
KDM-4009-DD-01-01-A3

CLIENT

APPROVED BY: _____ SIGNATURE: _____
DATE: _____

REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	

PROJECT
VUTHELA SCADA PROJECT

TITLE
BALLITO BUSINESS PARK 33/11 kV
SUBSTATION SCADA ARCHITECTURE
DRAWING

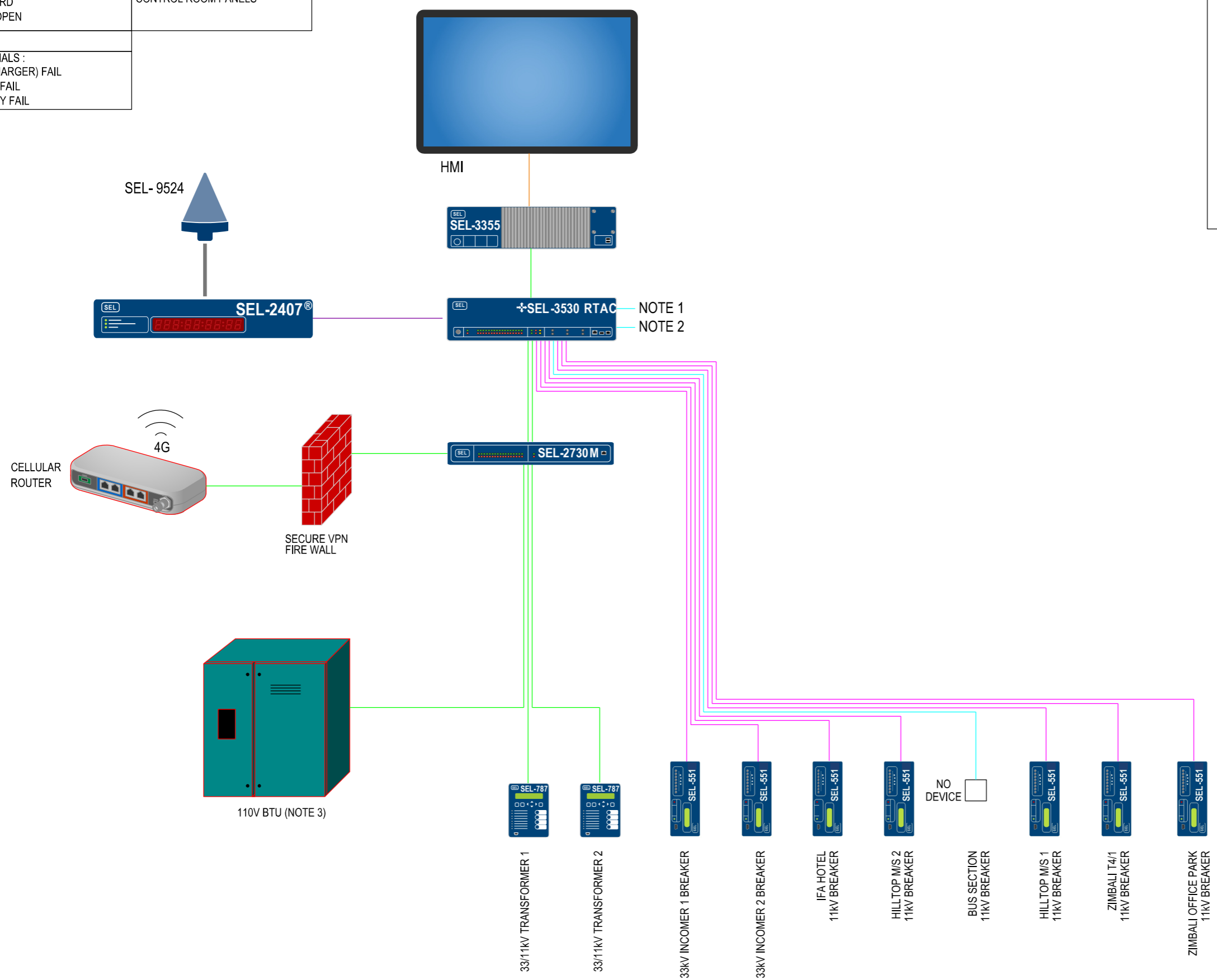
CONSULTANT

éThekwini
First Floor, West Building
Milkwood Office Park, Cnr Umhlanga
Rocks & Douglas Saunders Drive
Tel: +27 31 575 5500
P.O.Box 335,
Umhlanga Rocks,
4320
Fax: +27 86 244 9177

DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION
CHECKED D. NAICKER	PROJECT No. 503986	
APPROVED	SCALE N.T.S.	SIZE A3L
	DRAWING No. KDM-4009-192-01-01-A3	REV 01

NOTE 1	NOTE 2
I/O SIGNALS : - AC BOARD - DOOR OPEN	ISOLATOR SIGNALS FROM 33KV CONTROL ROOM PANELS
NOTE 3	
BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL	

LEGEND	
	ETHERNET COMMUNICATION
	SERIAL COMMUNICATION
	HARDWIRED COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA



NOTES		
1. FOR ISOLATOR SIGNALS , REFER TO DRAWING : KDM-4010-DD-01-02-A3		

CLIENT

APPROVED BY _____ SIGNATURE _____

DATE _____

REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	

PROJECT

VUTHELA SCADA PROJECT

TITLE

ZIMBALI 33/11 kV SUBSTATION
SCADA ARCHITECTURE DRAWING

CONSULTANT

aurecon
eThekweni

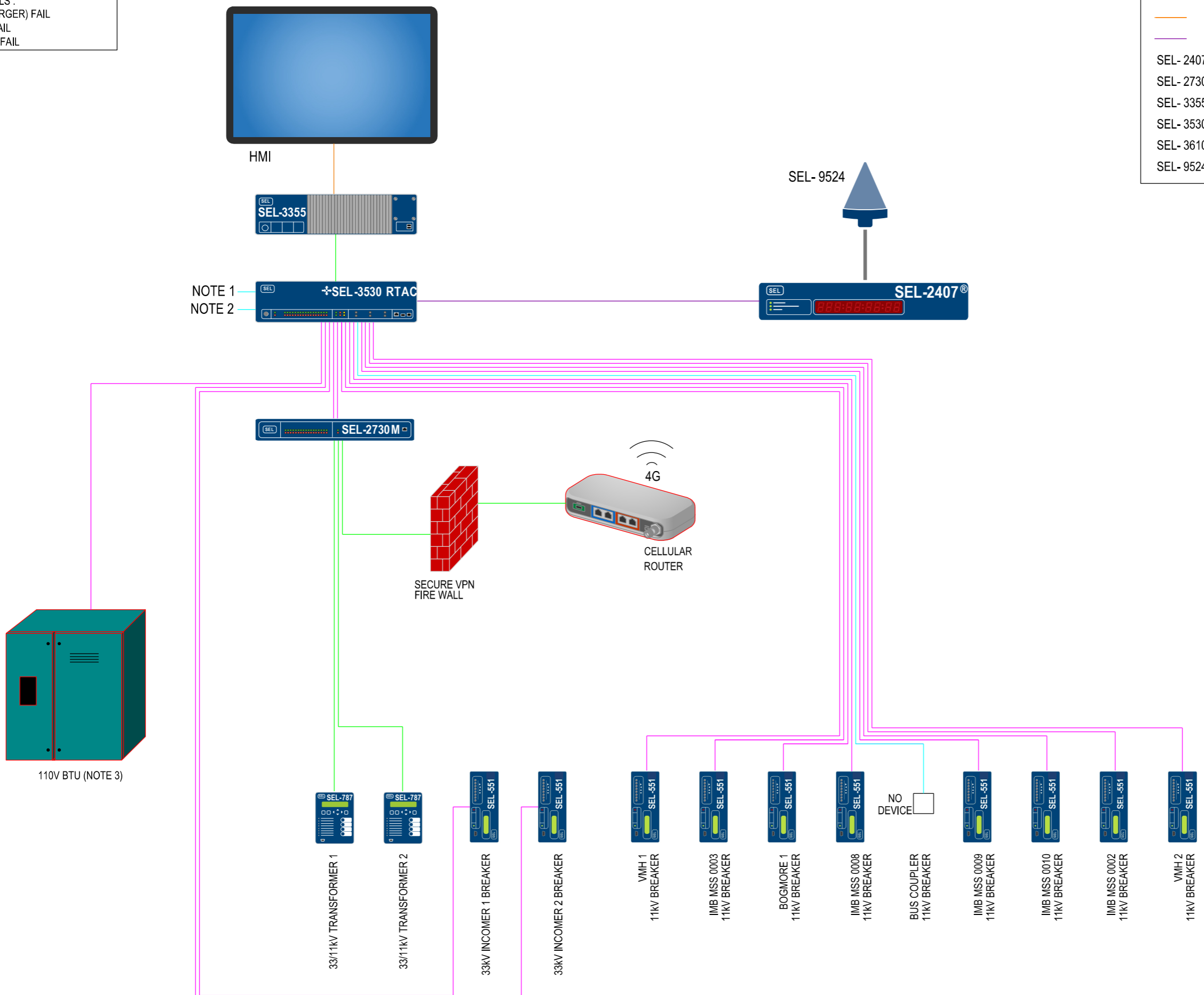
First Floor, West Building
Milkwood Office Park, Cnr Umhlanga
Rocks & Douglas Saunders Drive
Tel: +27 31 575 5500

P.O.Box 335,
Umhlanga Rocks,
4320
Fax: +27 86 244 9177

DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION
CHECKED D. NAICKER	PROJECT No. 503986	
APPROVED	SCALE N.T.S.	SIZE A3L
	DRAWING No. KDM-4010-192-01-01-A3	REV 01

NOTE 1	NOTE 2
I/O SIGNALS : - AC BOARD - DOOR OPEN	ISOLATOR SIGNALS FROM 33KV CONTROL ROOM PANELS
NOTE 3	
BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL	

LEGEND	
	ETHERNET COMMUNICATION
	SERIAL COMMUNICATION
	HARDWIRED COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 3610	SERIAL PORT SERVER
SEL- 9524	GNSS ANTENNA



NOTES
1. FOR ISOLATOR SIGNALS , REFER TO DRAWING :
KDM-4011-DD-01-01-A3

CLIENT

KWADUKUZA MUNICIPALITY

APPROVED BY	SIGNATURE
DATE	

REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	

PROJECT
VUTHELA SCADA PROJECT

TITLE
IMBONINI 33/11 kV SUBSTATION
SCADA ARCHITECTURE DRAWING

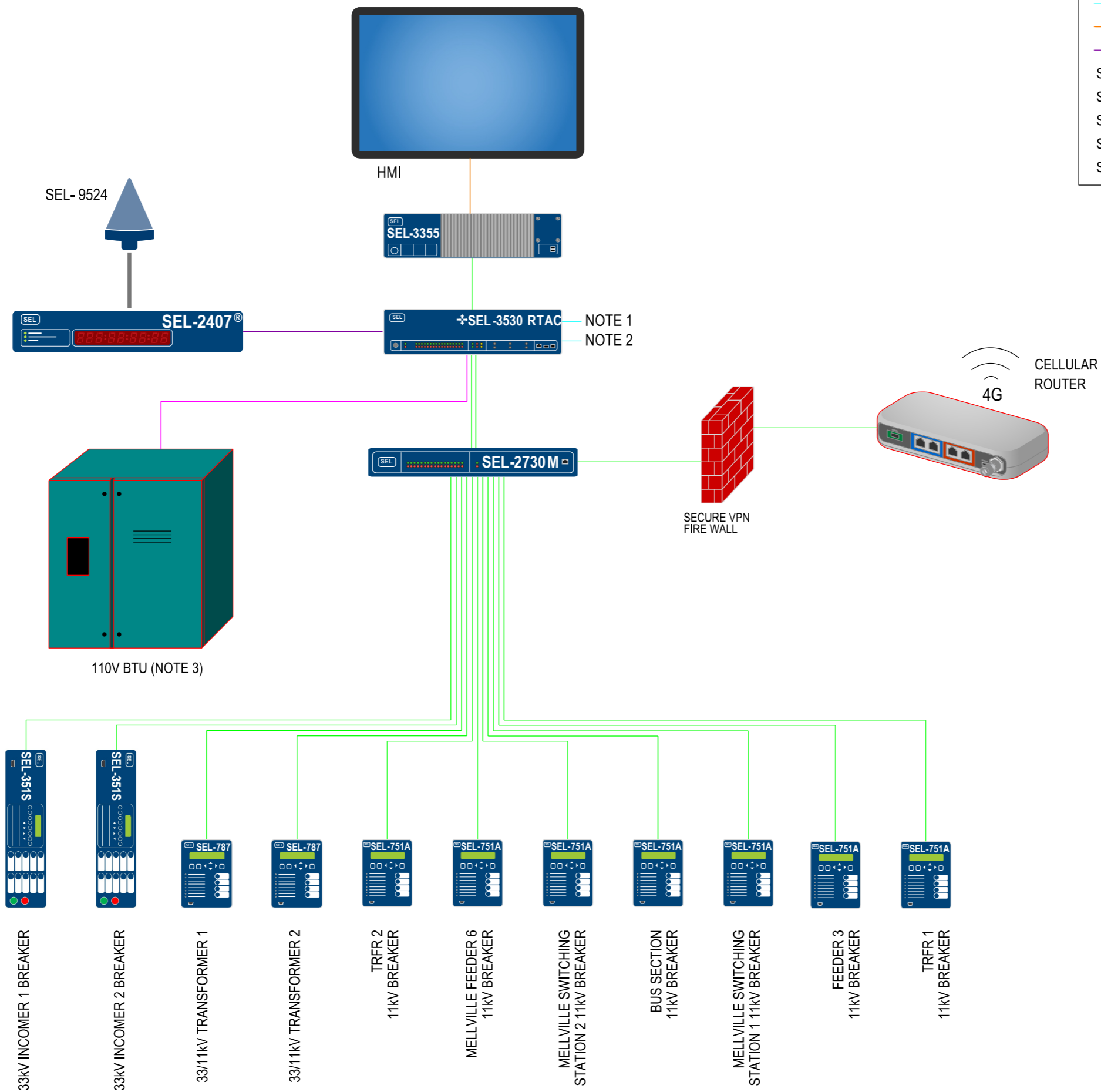
CONSULTANT

aurecon
éThekwini
First Floor, West Building, Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive, Tel: +27 31 575 5500
P.O.Box 335, Umhlanga Rocks, 4320, Fax: +27 86 244 9177

DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION
CHECKED D. NAICKER	APPROVED	PROJECT No. 503986
		SCALE N.T.S.
		SIZE A3L
		DRAWING No. KDM-4011-192-01-01-A3
		REV 01

NOTE 1	NOTE 2
I/O SIGNALS : - AC BOARD - DOOR OPEN	ISOLATOR SIGNALS FROM 33kV CONTROL ROOM PANELS
NOTE 3	
BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL	

LEGEND	
	ETHERNET COMMUNICATION
	SERIAL COMMUNICATION
	HARDWIRED COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA



NOTES
1. FOR ISOLATOR SIGNALS , REFER TO DRAWING :
KDM-4011-51-01-02-A3

CLIENT

KWADUKUZA MUNICIPALITY

APPROVED BY _____ **SIGNATURE** _____
DATE _____

REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	

PROJECT
VUTHELA SCADA PROJECT

TITLE
GROUTVILLE 33/11 KV SUBSTATION
SCADA ARCHITECTURE DRAWING

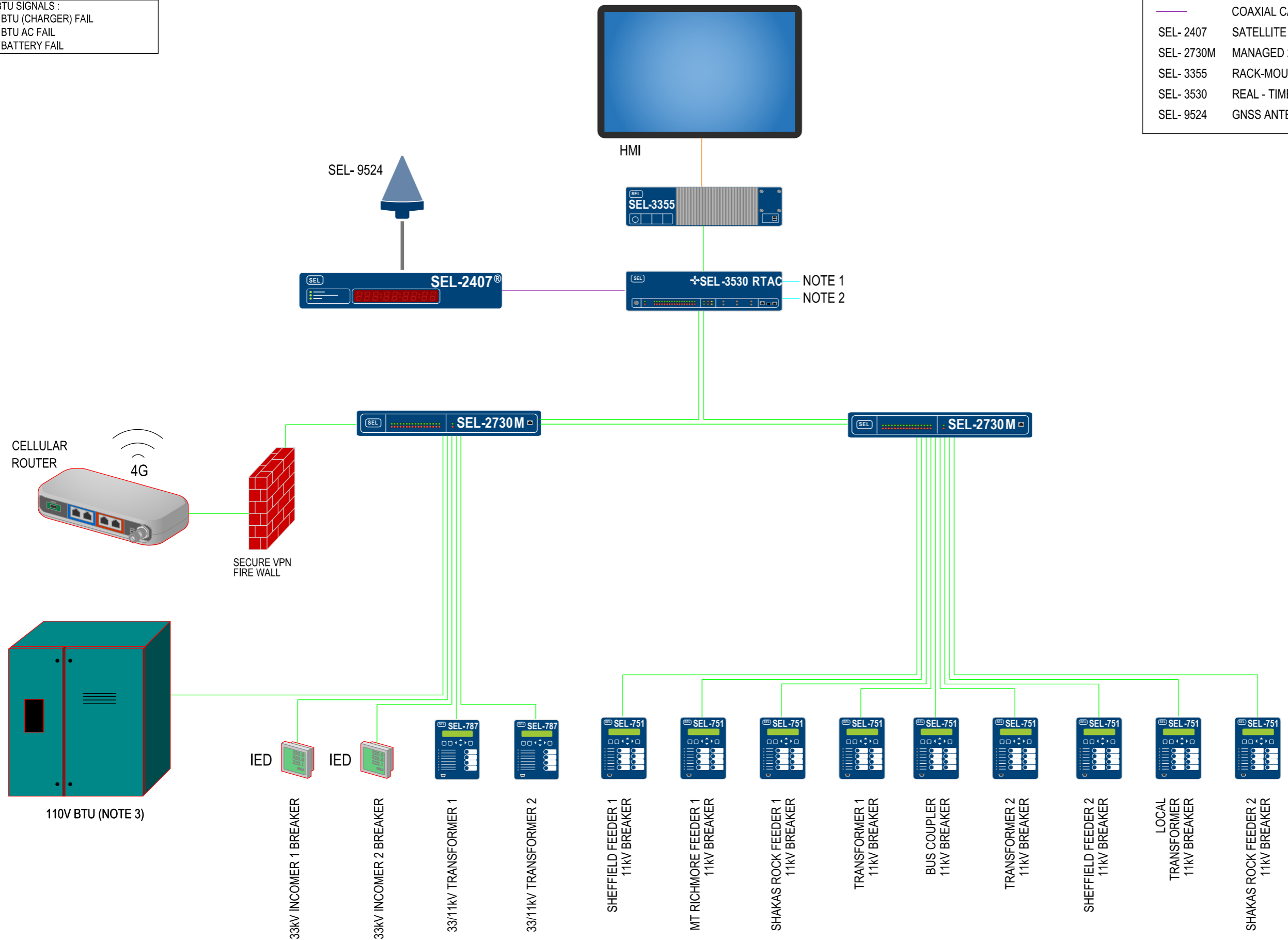
CONSULTANT

aurecon eThekweni
First Floor, West Building, Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive, Tel: +27 31 675 5500
P.O.Box 335, Umhlanga Rocks, 4320, Fax: +27 86 244 9177

DRAWN S. KHAN	DESIGNED S. KHAN	NOT FOR CONSTRUCTION
CHECKED D. NAICKER	PROJECT No. 503986	
APPROVED	SCALE N.T.S.	SIZE A3L
	DRAWING No. KDM-4013-192-01-01-A3	REV 01

NOTE 1	NOTE 2
I/O SIGNALS : - AC BOARD - DOOR OPEN	ISOLATOR SIGNALS FROM 33kV CONTROL ROOM PANELS
NOTE 3	
BTU SIGNALS : - BTU (CHARGER) FAIL - BTU AC FAIL - BATTERY FAIL	

LEGEND	
	ETHERNET COMMUNICATION
	HARDWIRED COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA



NOTES		
1. DRAWING INDICATES CURRENT CONFIGURATION TO BE IMPLEMENTED; REPLACE THE RELAYS WITH RELAYS THAT HAVE COMMS		

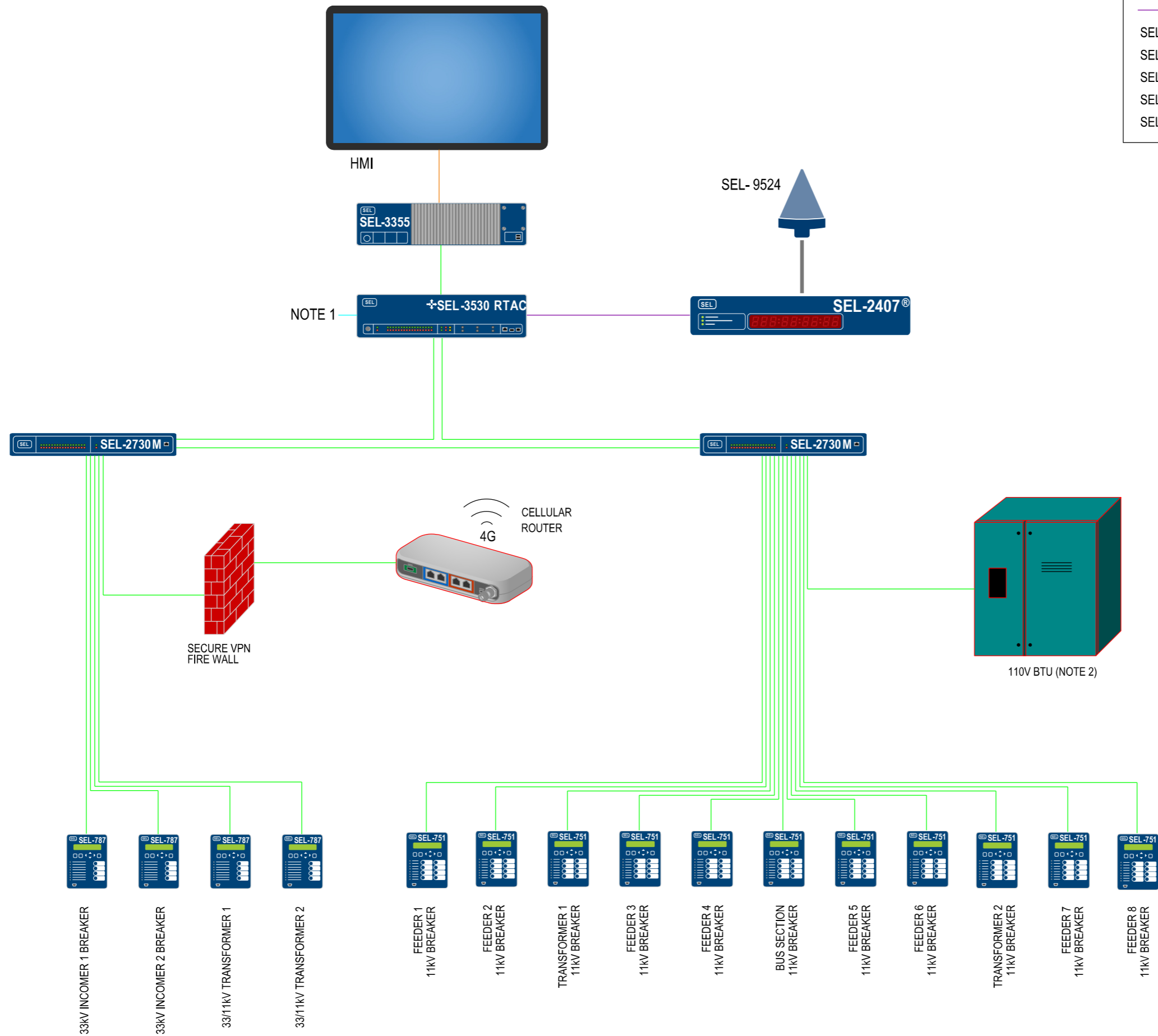
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APPROVED BY	SIGNATURE		
DATE			
REV	DATE	REVISION DETAILS	APPROVED
01	17/04/19	DETAIL DESIGN	

PROJECT	
VUTHELA SCADA PROJECT	
TITLE	
SHEFFIELD 33/11 kV SUBSTATION SCADA ARCHITECTURE DRAWING	

CONSULTANT			
<small>First Floor, West Building Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive Tel: +27 31 575 5500</small>		<small>P.O.Box 335, Umhlanga Rocks, 4320 Fax: +27 86 244 9177</small>	
DRAWN	DESIGNED	NOT FOR CONSTRUCTION	
S. KHAN	S. KHAN		
CHECKED	PROJECT No.		
D. NAICKER	503986		
APPROVED	SCALE	SIZE	
	N.T.S.	A3L	
	DRAWING No.	REV	
	KDM-4014-192-01-01-A3	01	

NOTE 1	NOTE 2
I/O SIGNALS :	BTU SIGNALS :
- AC BOARD	- BTU (CHARGER) FAIL
- DOOR OPEN	- BTU AC FAIL
	- BATTERY FAIL

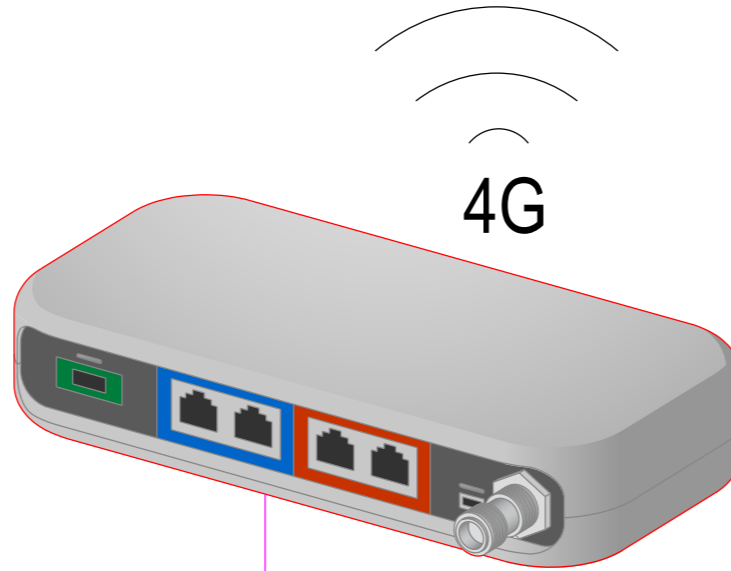
LEGEND	
	ETHERNET COMMUNICATION
	HARDWIRED COMMUNICATION
	VGA / DVI-D COMMUNICATION
	COAXIAL CABLE FOR IRIG-B SIGNAL
SEL- 2407	SATELLITE SYNCHRONISED CLOCK
SEL- 2730M	MANAGED 24-PORT ETHERNET SWITCH
SEL- 3355	RACK-MOUNT COMPUTER
SEL- 3530	REAL - TIME AUTOMATION CONTROLLER (RTAC)
SEL- 9524	GNSS ANTENNA



NOTES			
CLIENT			
APPROVED BY	SIGNATURE		
DATE			
REV	DATE	REVISION DETAILS	APPROVED
01	22/01/19	DETAIL DESIGN	
PROJECT			
VUTHELA SCADA PROJECT			
TITLE			
PROPOSED GIZENGA 33/11 kV SUBSTATION SCADA ARCHITECTURE DRAWING			
CONSULTANT			
First Floor, West Building Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive Tel: +27 31 575 5500		P.O.Box 335, Umhlanga Rocks, 4320 Fax: +27 86 244 9177	
DRAWN	DESIGNED	NOT FOR CONSTRUCTION	
S. KHAN	S. KHAN		
CHECKED	PROJECT No.		
D. NAICKER	503986		
APPROVED	SCALE	SIZE	
	N.T.S.	A3L	
	DRAWING No.	REV	
	Gizenga Sub	01	

LEGEND


- SERIAL COMMUNICATION
- COAXIAL CABLE FOR IRIG-B SIGNAL
- SEL- 2401 SATELLITE SYNCHRONISED CLOCK
- SEL- 9524 GNSS ANTENNA



CELLULAR
ROUTER WITH
GPS CAPABILITY

AUTO RECLOSER

MAIN SUPPLY POINT TO
MANDENI LM

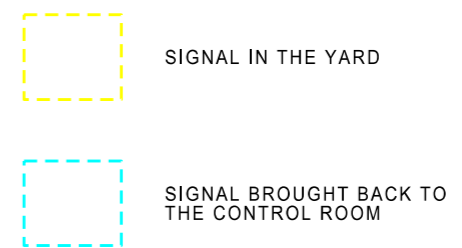
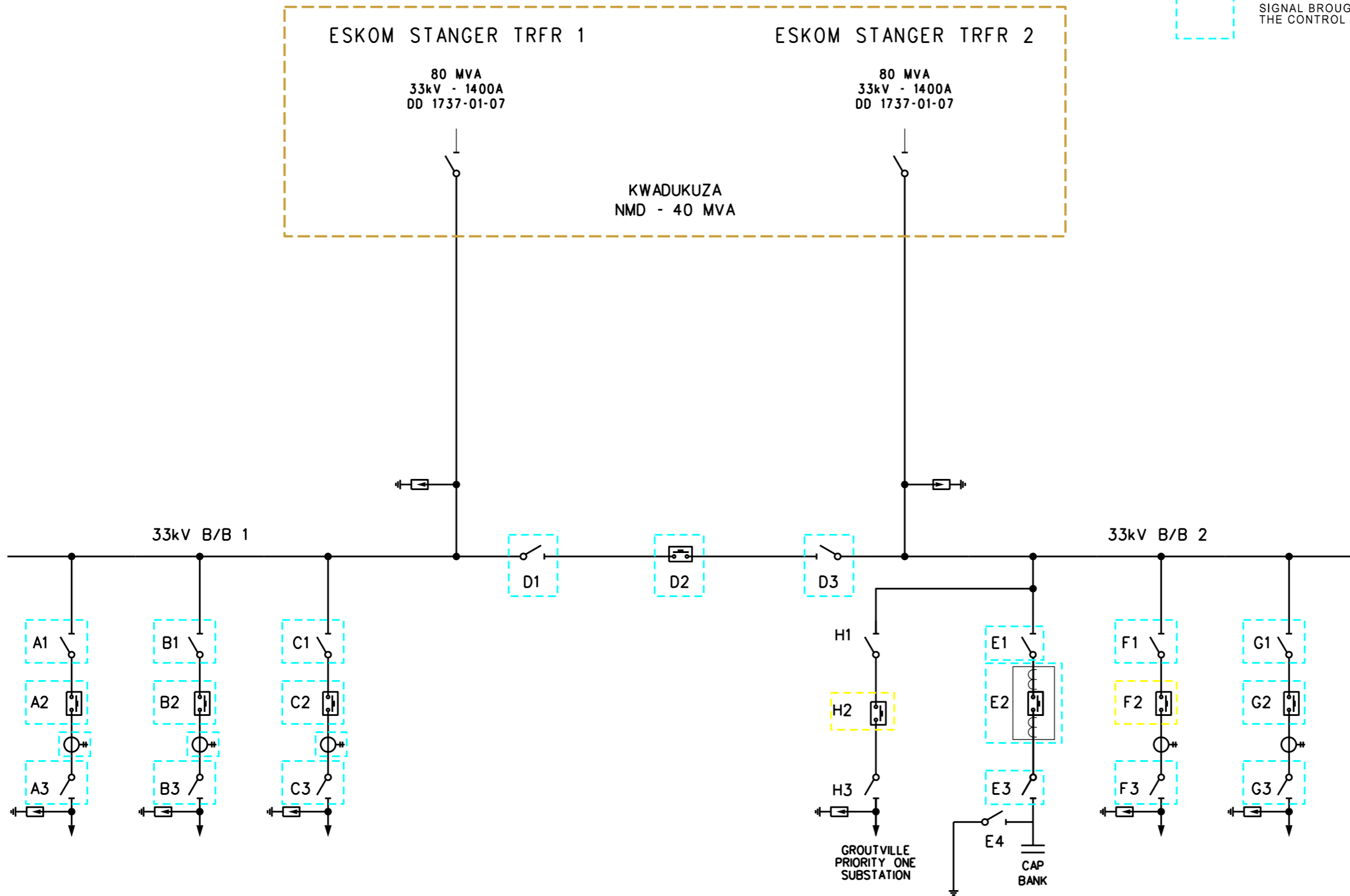
NOTES			
CLIENT			
 <p>KWADUKUZA MUNICIPALITY</p>			
APPROVED BY		SIGNATURE	
DATE			
PROJECT			
VUTHELA SCADA PROJECT			
TITLE			
MANDENI 33/11 KV RECLOSER SCADA ARCHITECTURE DRAWING			
CONSULTANT			
 <p>aurecon eThekweni</p>			
First Floor, West Building Milkwood Office Park, Cnr Umhlanga Rocks & Douglas Saunders Drive Tel: +27 31 575 5500		P.O.Box 335, Umhlanga Rocks, 4320 Fax: +27 86 244 9177	
DRAWN	DESIGNED	NOT FOR CONSTRUCTION	
S. KHAN	S. KHAN		
CHECKED	PROJECT No.		
D. NAICKER	503986		
APPROVED	SCALE	SIZE	
	N.T.S.	A3L	
	DRAWING No.	REV	
	KDM-MAN-192-01-01-A3	01	

Appendix G

Substation Single Line Diagram List

Drawing Number	Size	Drawing Title	Rev
KDM-3001-DD-01-02-A3	A3	Stanger Point of Supply 33kV Distribution Substation - Electrical Operating Diagram	2
KDM-3002-DD-01-04-A3	A3	Shakaskraal 33/11kV Substation - Electrical Operating Diagram	4
KDM-3003-DD-01-01-A3	A3	Proposed 132/33/11kV Dukuza Substation - Single Line Diagram	1
KDM-4001-DD-01-03-A3	A3	Lavoipierre 33/11kV Substation - Existing Substation Operating Diagram	3
KDM-4002-DD-01-02-A3	A3	Sappi 33/11kV Substation - Electrical Operating Diagram	2
KDM-4003-DD-01-04-A3	A3	Glenhills 33/11kV Substation - Electrical Operating Diagram	4
KDM-4004-DD-01-02-A3	A3	Gledhow 33/11kV Substation - Existing Single Line Diagram	2
KDM-4005-DD-01-B-A3	A3	Industrial Park 33/11kV Substation - Electrical Distribution Diagram	B
KDM-4006-DD-01-02-A3	A3	Shakas Rock 33/11kV Substation - Electrical Operating Diagram	2
KDM-4008-DD-01-02-A3	A3	Ballito 33/11kV Substation - Existing Substation Operating Diagram	2
KDM-4009-DD-01-01-A3	A3	Ballito Business Park 33/11kV Substation - Electrical Operating Diagram	1
KDM-4010-DD-01-02-A3	A3	Zimbali 33/11kV Substation - Existing Substation Operating Diagram	2
KDM-4011-DD-01-01-A3	A3	Imbonini 33/11kV Substation - Electrical Operating Diagram	1
(1)G52024-C1011-S052	A3	Sheffield 33/11kV Substation - Single Line Diagram	5
DRG-EE-0-002-00	A3	Proposed Gizenga 33/11kV Substation - Single Line Diagram	0

KWADUKUZA - POINT OF SUPPLY 33kV DISTRIBUTION SUBSTATION



EQUIPMENT LEGEND	
A1	GLEDHOW 33kV BUSBAR 1 ISOLATOR
A2	GLEDHOW 33kV BREAKER
A3	GLEDHOW 33kV LINE ISOLATOR
B1	LAVOPIERRE 33kV BUSBAR 1 ISOLATOR
B2	LAVOPIERRE 33kV BREAKER
B3	LAVOPIERRE 33kV LINE ISOLATOR
C1	SAPPI2 33kV BUSBAR 1 ISOLATOR
C2	SAPPI2 33kV BREAKER
C3	SAPPI2 33kV LINE ISOLATOR
D1	33kV BUS COUPLER ISOLATOR 1
D2	33kV BUS COUPLER BREAKER
D3	33kV BUS COUPLER ISOLATOR 2
E1	CAPACITOR BANK 33kV BUSBAR 2 ISOLATOR
E2	CAPACITOR BANK 33kV BREAKER
E3	CAPACITOR BANK 33kV ISOLATOR 2
E4	CAPACITOR BANK 33kV EARTHING ISOLATOR
F1	GLENHILLS 33kV BUSBAR 2 ISOLATOR
F2	GLENHILLS 33kV AUTORECLOSER
F3	GLENHILLS 33kV LINE ISOLATOR
G1	SAPPI1 33kV BUSBAR 2 ISOLATOR
G2	SAPPI1 33kV BREAKER
G3	SAPPI1 33kV LINE ISOLATOR
H1	GROUVILLE 33kV BUSBAR 2 ISOLATOR
H2	GROUVILLE 33kV BREAKER
H3	GROUVILLE 33kV LINE ISOLATOR



**POINT OF SUPPLY
33kV DIST SUBSTATION**

**ELECTRICAL
OPERATING DIAGRAM**

aurecon
eThekweni

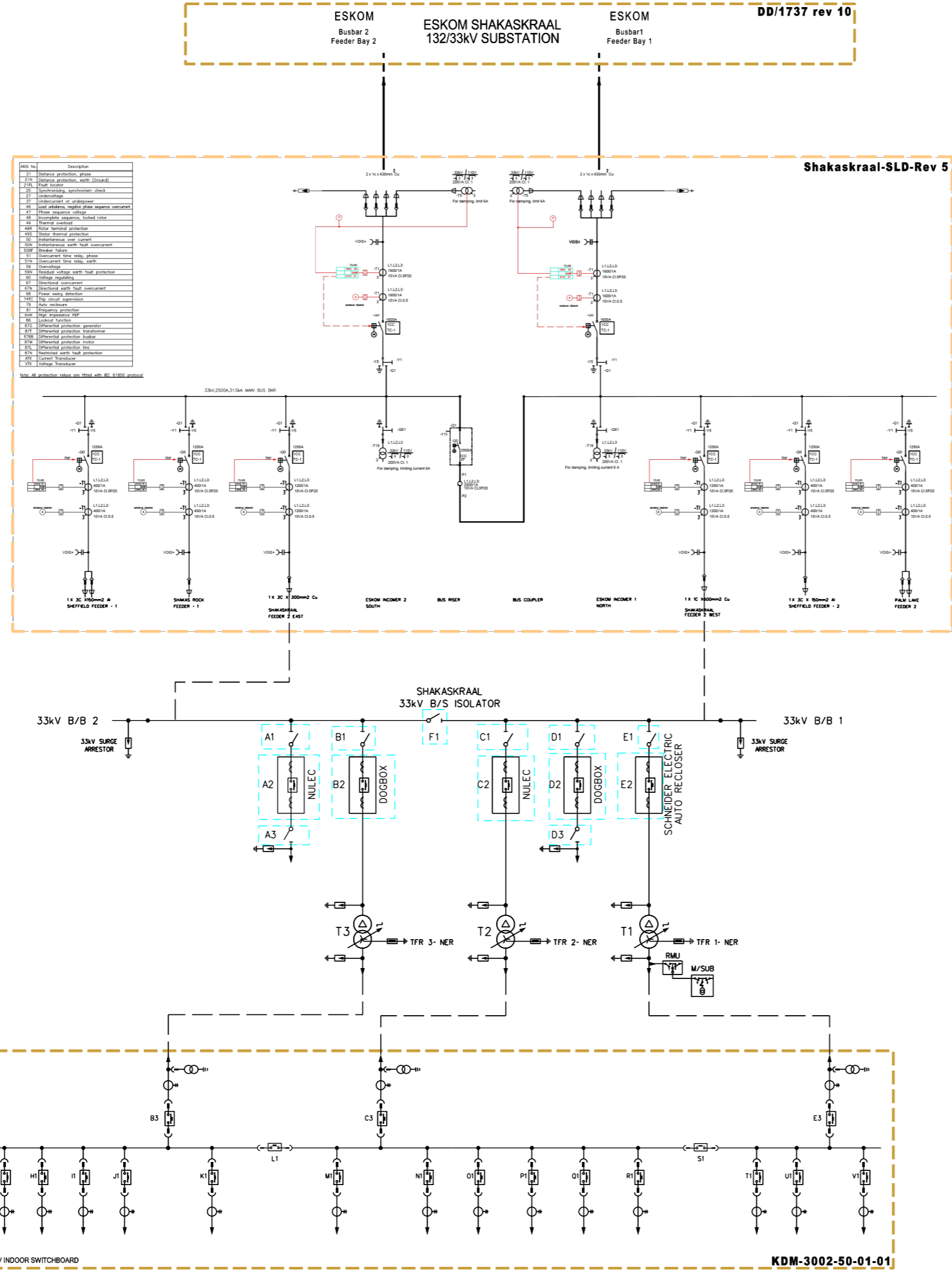
First Floor, West Building, Milkwood Office Park, Chr Rocks & Douglas Saunders Drive, Umhlanga, P.O.Box 335, Umhlanga Rocks, 4320
Tel: +27 31 575 5500 Fax: +27 86 244 9177

Rev.	Drawn	Chkd.	Appr.	Date	Rev. Description
02	SK	-	-	08-11-2018	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS
01	MV	-	-	07-06-2013	DRAWING FOR ISSUE
00	RL	-	-	18-06-2012	FIRST DRAFT ISSUE

Checked	Drawn	Appr.	Date
-	ROB	-	June 2012

Scale	CAD Store No.
N.T.S.	KDM-3001-DD-01-02-A3.dgn

Drawing No.	Set	Sheet	Rev.
KDM-3001	DD	01	02



Ref No	Description
21	Distance protection phase
21A	Distance protection earth (Ground)
21B	Phase monitor
25	Synchronism check
27	Under-voltage
37	Under-voltage with phase sequence monitor
42	Loss of phase sequence, phase sequence monitor
43	Phase sequence voltage
44	Loss of phase sequence, phase sequence monitor
44A	Phase sequence protection
44B	Phase sequence protection
44C	Phase sequence protection
44D	Phase sequence protection
44E	Phase sequence protection
44F	Phase sequence protection
44G	Phase sequence protection
44H	Phase sequence protection
44I	Phase sequence protection
44J	Phase sequence protection
44K	Phase sequence protection
44L	Phase sequence protection
44M	Phase sequence protection
44N	Phase sequence protection
44O	Phase sequence protection
44P	Phase sequence protection
44Q	Phase sequence protection
44R	Phase sequence protection
44S	Phase sequence protection
44T	Phase sequence protection
44U	Phase sequence protection
44V	Phase sequence protection
44W	Phase sequence protection
44X	Phase sequence protection
44Y	Phase sequence protection
44Z	Phase sequence protection
45	Over-current
45A	Over-current
45B	Over-current
45C	Over-current
45D	Over-current
45E	Over-current
45F	Over-current
45G	Over-current
45H	Over-current
45I	Over-current
45J	Over-current
45K	Over-current
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45Q	Over-current
45R	Over-current
45S	Over-current
45T	Over-current
45U	Over-current
45V	Over-current
45W	Over-current
45X	Over-current
45Y	Over-current
45Z	Over-current
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50R	Under-voltage
50S	Under-voltage
50T	Under-voltage
50U	Under-voltage
50V	Under-voltage
50W	Under-voltage
50X	Under-voltage
50Y	Under-voltage
50Z	Under-voltage

33kV EQUIPMENT LEGEND	
A1	BALLITO-DRIEFONTEIN 33kV B/B 2 ISOLATOR
A2	BALLITO-DRIEFONTEIN 33kV BREAKER
A3	BALLITO-DRIEFONTEIN 33kV LINE ISOLATOR
B1	TRANSFORMER 3 33kV B/B 2 ISOLATOR
B2	TRANSFORMER 3 33kV BREAKER
C1	TRANSFORMER 2 33kV B/B 1 ISOLATOR
C2	TRANSFORMER 2 33kV BREAKER
D1	ZIMBALI 33kV B/B 1 ISOLATOR
D2	ZIMBALI 33kV BREAKER
D3	ZIMBALI 33kV LINE ISOLATOR
E1	TRANSFORMER 1 33kV B/B 1 ISOLATOR
E2	TRANSFORMER 1 33kV BREAKER
F1	SHAKASKRAAL 33kV B/S ISOLATOR

11kV EQUIPMENT LEGEND	
B3	TRANSFORMER 3 11kV BREAKER
C3	TRANSFORMER 2 11kV BREAKER
E3	TRANSFORMER 1 11kV BREAKER
G1	WOODMEAD-INDUSTRIAL PARK A 11kV BREAKER
H1	PALM LAKES 2 11kV BREAKER
I1	NKOBONGO SUB FEEDER 1 11kV BREAKER
J1	TINLEY MANOR (4 POLE) 11kV BREAKER
K1	GLENDALE FEEDER 11kV BREAKER
L1	SHAKASKRAAL B/S 2 11kV BREAKER
M1	WOODMEAD-INDUSTRIAL PARK B 11kV BREAKER
N1	JEX-ETETE WEST 11kV BREAKER
O1	OLD ETETE O/H LINE 11kV BREAKER
P1	NKOBONGO SUB FEEDER 2 11kV BREAKER
Q1	WOODMEAD RES MSS 03 11kV BREAKER
R1	PALM LAKES 1 11kV BREAKER
S1	SHAKASKRAAL B/S 1 11kV BREAKER
T1	LOCAL MINI 11kV BREAKER
U1	SHAKASKRAAL VILLAGE FEEDER 11kV BREAKER
V1	STANGER PRIORITY INTERCONNECT 11kV BKR

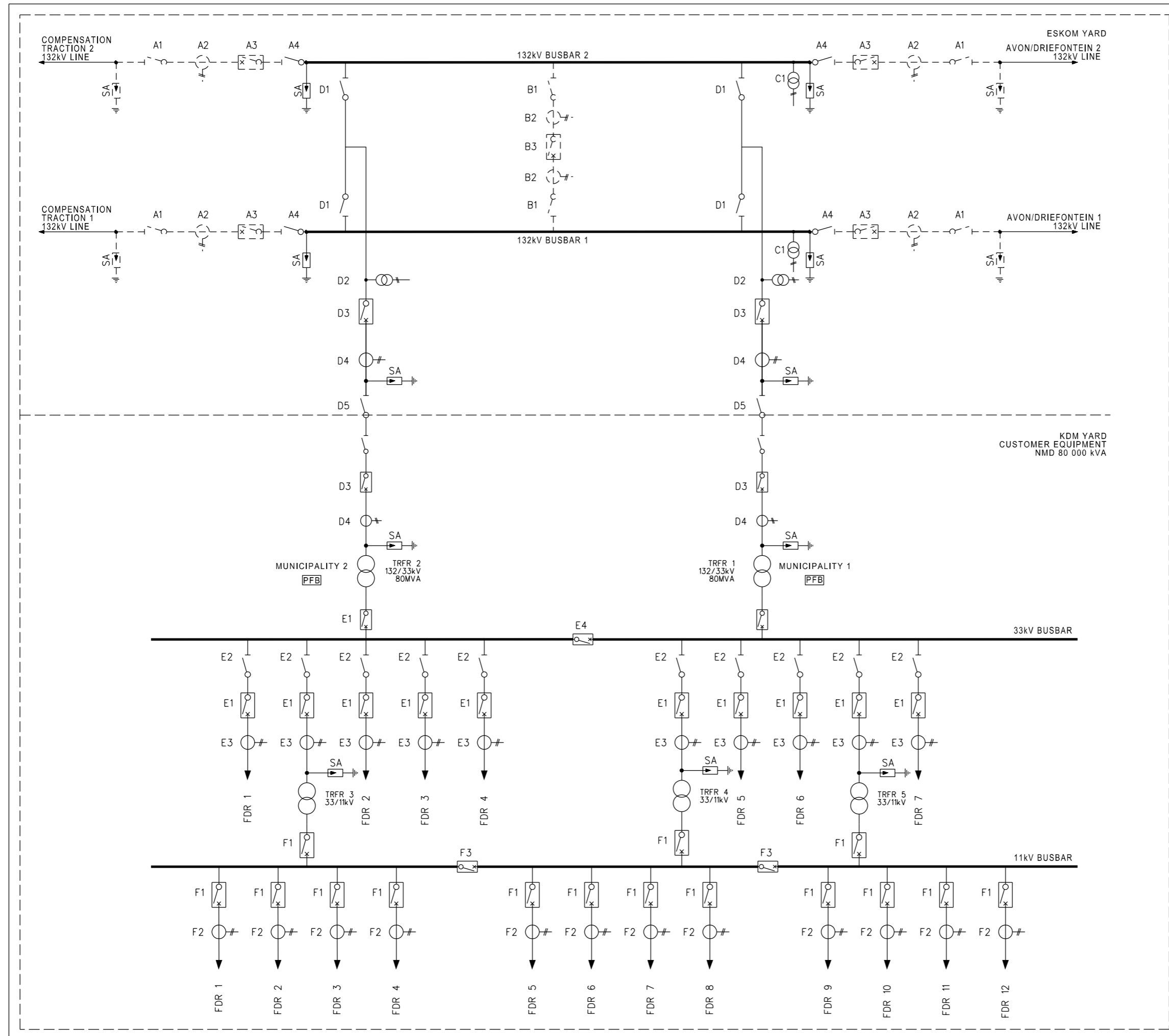


Client
SHAKASKRAAL
33/11kV SUBSTATION
 Description
ELECTRICAL
OPERATING DIAGRAM

aurecon
 eThekweni
 First Floor, West Building, Milkwood Office Park, Chr Umhlanga, Umhlanga Rocks, P.O.Box 335, Umhlanga Rocks, 4320
 Tel: +27 31 575 5500 Fax: +27 86 244 9177

Rev.	Drawn	Chkd.	Appr.	Date	Rev. Description
04	SK	-	-	08-11-2018	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS
03	PS	-	-	27-08-2014	DIAGRAM UPDATED
02	MV	-	-	10-06-2013	DIAGRAM UPDATED
01	RL	-	-	06-2012	Draft Diagram Upgrade
00	RL	-	-	29-05-2012	FIRST DRAFT ISSUE

Checked: - Drawn: ROB Approved: - Date: MAY 2012
 Scale: N.T.S. CAD Store No. KDM-3002-DD-01-04-A3.dgn
 Drawing No. KDM-3002 Set DD Sheet 01 Rev. 04




132 kV EQUIPMENT DESIGNATION			
A1	132 kV LINE ISOL	E1	TRFR FDR 33kV BKR
A2	132 kV CT	E2	TRFR FDR 33 kV ISOL
A3	132 kV BKR	E3	TRFR FDR 33 kV CT
A4	132 kV BUSBAR ISOL	E4	33 kV BUSBAR ISOL
B1	B/CPL 132 kV BUSBAR ISOL	F1	TRFR FDR 11 kV BKR
B2	B/CPL 132 kV CT	F2	TRFR FDR 11 kV CT
B3	B/CPL 132 kV BKR	F3	11 kV BUSBAR ISOL
C1	B/CPL 132 kV POWER VT		
D1	TRFR FDR 132 kV BUSBAR ISOL		
D2	132 kV VT		
D3	TRFR FDR 132 kV BKR		
D4	TRFR FDR 132 kV CT		
D5	TRFR FDR 132 kV MUNIC ISOL		

[PFB] - POSSIBLE FEEDBACK

NOTES

CLIENT



KWADUKUZA
MUNICIPALITY

APPROVED BY	SIGNATURE
DATE	
12/09/18	

REV	DATE	REVISION DETAILS	APPROVED
00	12/09/18	PRELIM DESIGN	


PROJECT

PROPOSED 132/33/11 kV DUKUZA SUBSTATION

TITLE

SINGLE LINE DIAGRAM

CONSULTANT



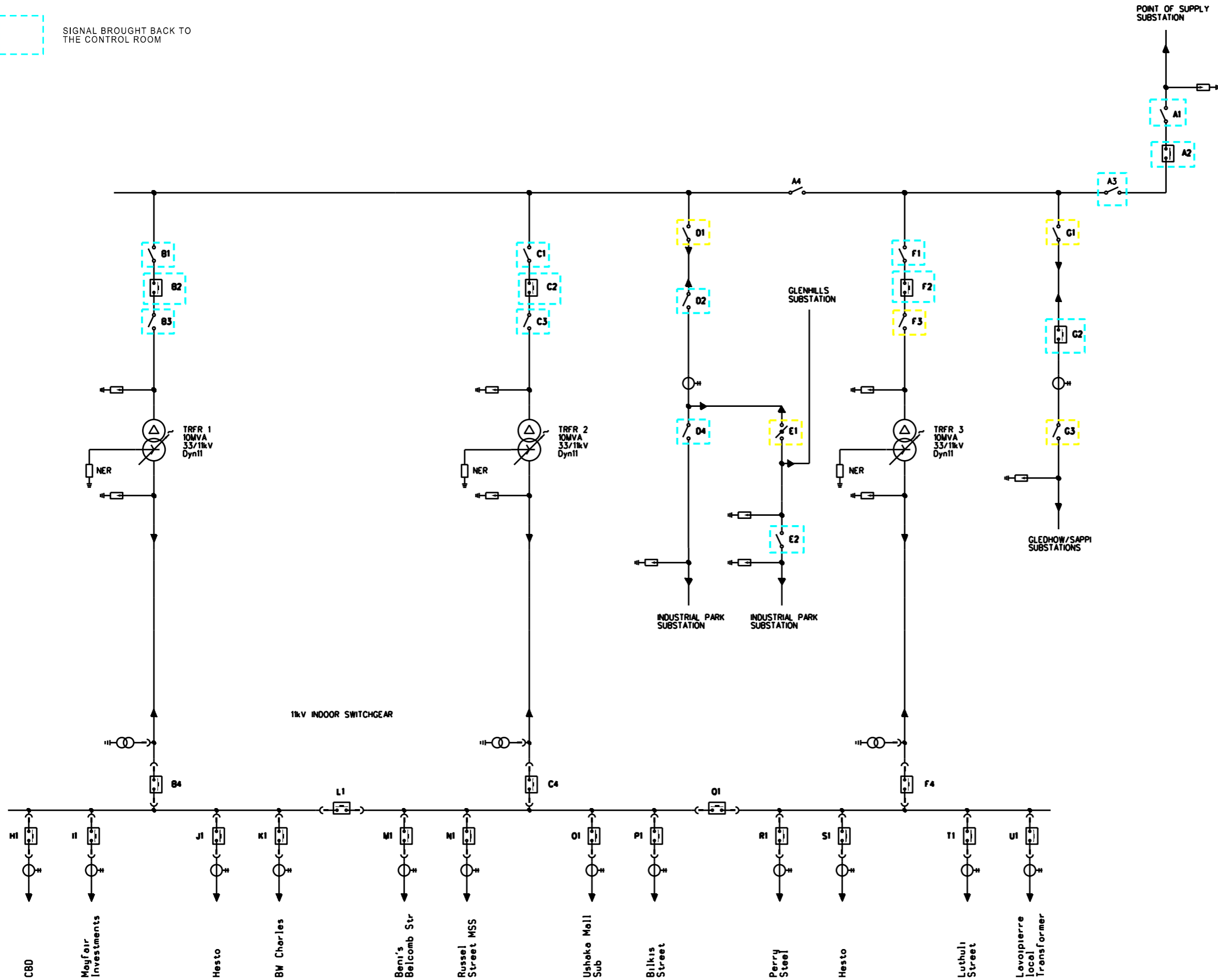
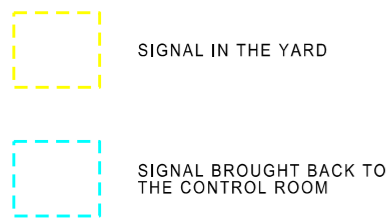
aurecon
éThekwini

First Floor, West Building
Milkwood Office Park, Cnr Umhlanga
Rocks & Douglas Saunders Drive
Tel: +27 31 575 5500

P.O.Box 335,
Umhlanga Rocks,
4320
Fax: +27 86 244 9177

DRAWN	DESIGNED	NFC
S.Khan	S.Khan	
CHECKED		PROJECT No.
I. van Dyk		108012
APPROVED		SCALE
		N.T.S.
		SIZE
		A3L
		DRAWING No.
		KDM-108012-DD-00-A3
		REV
		00

I. van Dyk



EQUIPMENT LEGEND

33kV EQUIPMENT	
A1	POINT OF SUPPLY 33kV LINE ISOLATOR
A2	POINT OF SUPPLY 33kV BREAKER
A3	POINT OF SUPPLY 33kV BUSBAR ISOLATOR
A4	33kV BUSBAR SECTION ISOLATOR
B1	TFR 1 33kV BUSBAR 1 ISOLATOR
B2	TFR 1 33kV BREAKER
B3	TFR 1 33kV ISOLATOR
B4	TFR 1 11kV BREAKER
C1	TFR 2 33kV BUSBAR 1 ISOLATOR
C2	TFR 2 33kV BREAKER
C3	TFR 2 33kV ISOLATOR
C4	TFR 2 11kV BREAKER
D1	INDUSTRIAL AREA 33kV BUSBAR ISOLATOR 1
D2	INDUSTRIAL AREA 33kV BUSBAR ISOLATOR 2
D4	INDUSTRIAL AREA 33kV LINE ISOLATOR 1
E1	GLENHILLS 33kV LINE ISOLATOR
E2	INDUSTRIAL AREA 33kV LINE ISOLATOR 2
F1	TFR 3 33kV BUSBAR 2 ISOLATOR
F2	TFR 3 33kV BREAKER
F3	TFR 3 33kV ISOLATOR
F4	TFR 3 11kV BREAKER
G1	GLEDHOW 33kV BUSBAR 2 ISOLATOR
G2	GLEDHOW 33kV BREAKER
G3	GLEDHOW 33kV LINE ISOLATOR
11kV EQUIPMENT	
H1	CBD 11kV BREAKER
I1	MAYFAIR INVESTMENTS 11kV BREAKER
J1	HESTO 11kV BREAKER
K1	BW CHARLES 11kV BREAKER
L1	11kV BUS SECTION BREAKER 1
M1	BENI'S BALCOMB STR 11kV BREAKER
N1	RUSSEL STREET 11kV BREAKER
O1	USHAKA MALL SUB 11kV BREAKER
P1	BILKIS STREET 11kV BREAKER
Q1	11kV BUS SECTION BREAKER 2
R1	PERRY STEEL 11kV BREAKER
S1	HESTO 11kV BREAKER
T1	LUTHULI STREET 11kV BREAKER
U1	LAVOPIERRE LOCAL TRANSFORMER 11kV BREAKER



LAVOPIERRE 33/11kV SUBSTATION

EXISTING SUBSTATION OPERATING DIAGRAM

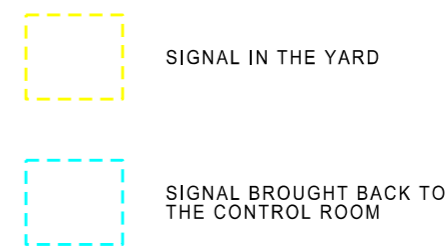
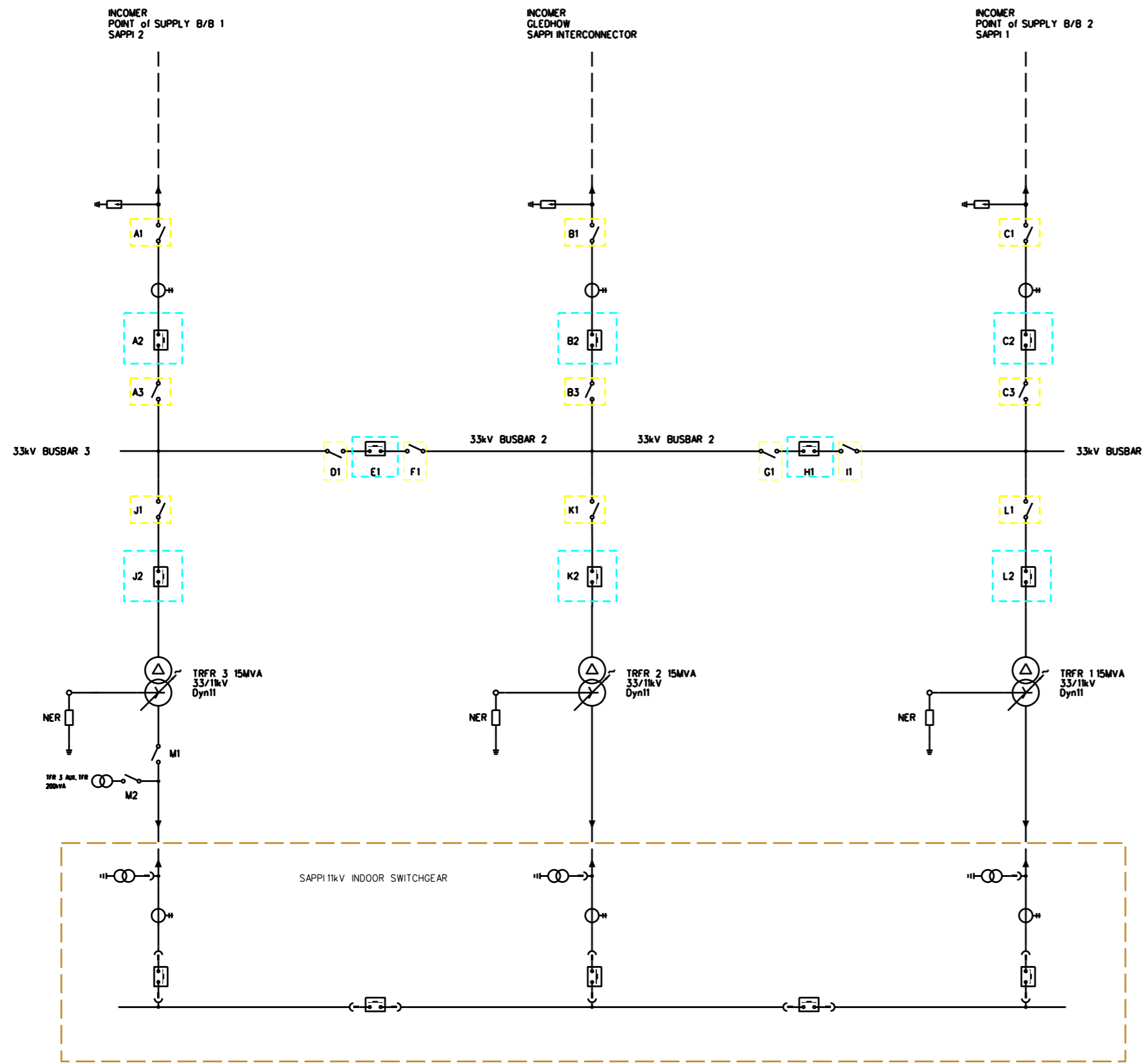
CLIENT APPROVAL			
DISCIPLINE	NAME	SIGN	DATE
CIVIL			
MECH			
ELECT			

First Floor, West Building, Milkwood Office Park, Chr Umhlanga, P.O.Box 335, Umhlanga Rocks, 4320, Richards & Douglas Saunders Drive, 4320
Tel: +27 31 575 5500 Fax: +27 86 244 9177

Rev.	Drawn	Chkd.	Appr.	Date	Rev. Description
03	S.K.	-	-	09-11-18	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS
02	M.V.	-	-	25/06/13	Updated Drawing.
01	J.H.	A.v.E.	-	3/4/2012	33kV Feeder Refit.
00	R.L.	-	-	3/4/2012	Site layout.

Checked:	Drawn:	Approved:	Date:
	J. Human		5 Oct 2012
Scale:	CAD Store No.		
N.T.S.	KDM-4001-DD-01-02-A3.dgn		

Drawing No.	Set	Sheet	Rev.
KDM-4001	DD	01	02



33kV EQUIPMENT LEGEND	
A1	SAPPI2 33kV LINE ISOLATOR
A2	SAPPI2 33kV BREAKER
A3	SAPPI2 33kV BUSBAR ISOLATOR
B1	GLEDHOW 33kV LINE ISOLATOR
B2	GLEDHOW 33kV BREAKER
B3	GLEDHOW 33kV BUSBAR ISOLATOR
C1	SAPPI1 33kV LINE ISOLATOR
C2	SAPPI1 33kV BREAKER
C3	SAPPI1 33kV BUSBAR ISOLATOR
D1	33kV BUS SECTION 2 BUSBAR 3 ISOLATOR
E1	33kV BUSBAR SECTION BREAKER 2
F1	33kV BUS SECTION 2 BUSBAR 2 ISOLATOR
G1	33kV BUS SECTION 1 BUSBAR 2 ISOLATOR
H1	33kV BUSBAR SECTION BREAKER 1
I1	33kV BUS SECTION 1 BUSBAR 1 ISOLATOR
J1	TRANSFORMER 3 33kV BUSBAR ISOLATOR
J2	TRANSFORMER 3 33kV BREAKER
K1	TRANSFORMER 2 33kV BUSBAR ISOLATOR
K2	TRANSFORMER 2 33kV BREAKER
L1	TRANSFORMER 1 33kV BUSBAR ISOLATOR
L2	TRANSFORMER 1 33kV BREAKER
11kV EQUIPMENT LEGEND	
M1	TRANSFORMER 3 11kV ISOLATOR
M2	TRANSFORMER 3 AUX. TFR 11kV ISOLATOR

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 eThekweni
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Rev.	Drawn	Chkd.	Appr.	Date	Rev. Description
02	SK	-	-	08-11-2018	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS
01	MV	-	-	13-06-2013	REVISED DRAWING
00	RL	-	-	23-06-2012	FIRST DRAFT ISSUE



Client: **SAPPI**

Drawing: **33/11kV SUBSTATION**

Description: **ELECTRICAL OPERATING DIAGRAM**

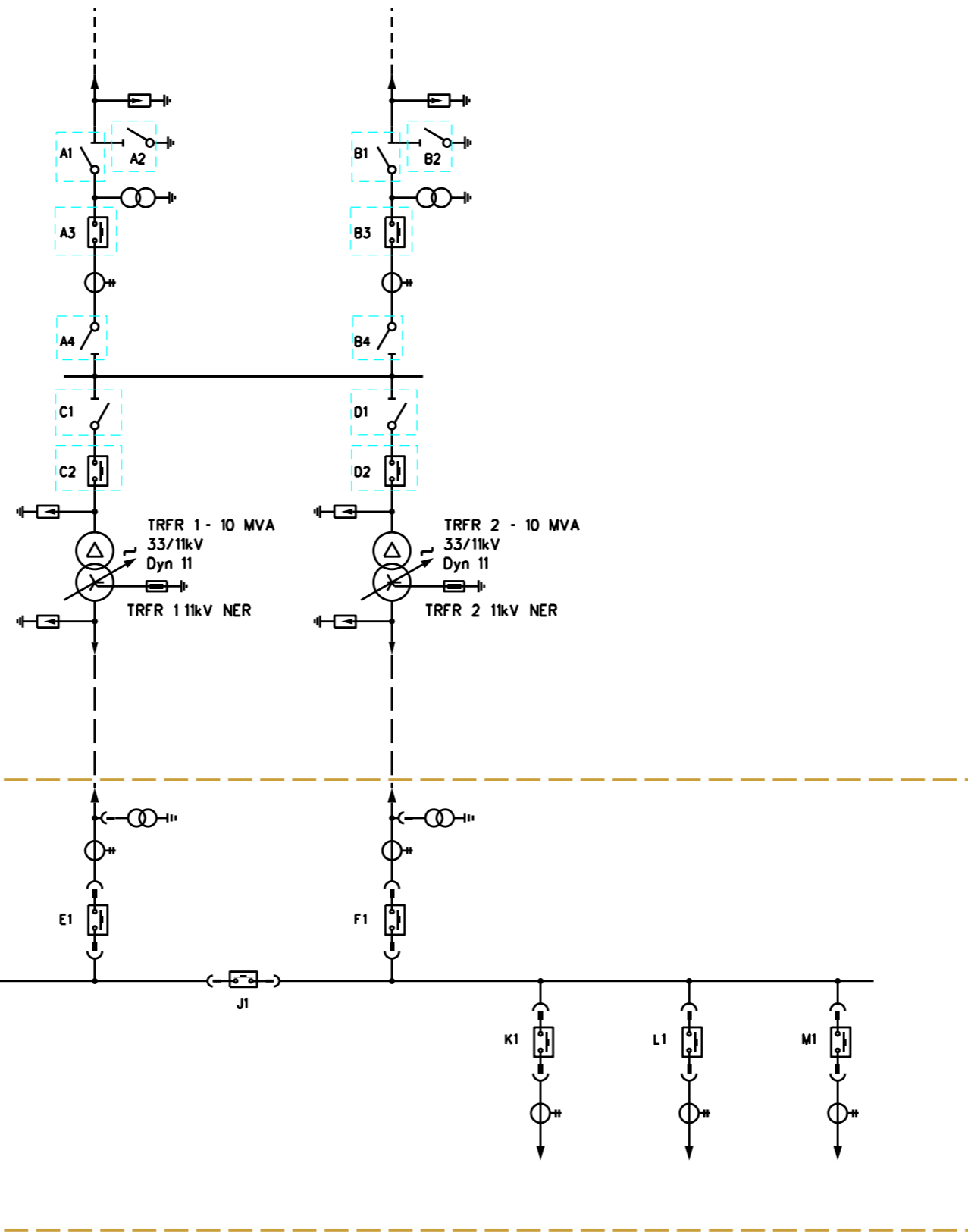
Drawn: R LUCEY	Checked:	Approved:	Date: AUG 2012
Scale: N.T.S.	CAD Store No.:	KDM-4002-DD-01-02-A3.dgn	
Drawing No.:	Set:	Sheet:	Rev.:
KDM-4002	DD	01	02

GLENHILLS 33/11kV SUBSTATION

SIGNAL BROUGHT BACK TO THE CONTROL ROOM

LAVOPIERRE
33kV- 95mm sq
PILC Cable - 240A

POINT OF SUPPLY
33kV- 2 x 95mm sq
PILC Cable - 480A



33kV EQUIPMENT LEGEND	
A1	LAVOPIERRE 33kV CABLE ISOLATOR
A2	LAVOPIERRE 33kV CABLE EARTH SWITCH
A3	LAVOPIERRE 33kV BREAKER
A4	LAVOPIERRE 33kV BUSBAR ISOLATOR
B1	POINT OF SUPPLY 33kV CABLE ISOLATOR
B2	POINT OF SUPPLY 33kV CABLE EARTH SWITCH
B3	POINT OF SUPPLY 33kV BREAKER
B4	POINT OF SUPPLY 33kV BUSBAR ISOLATOR
C1	TRANSFORMER 1 33kV BUSBAR ISOLATOR
C2	TRANSFORMER 1 33kV BREAKER
D1	TRANSFORMER 2 33kV BUSBAR ISOLATOR
D2	TRANSFORMER 2 33kV BREAKER
11kV EQUIPMENT LEGEND	
E1	TRANSFORMER 1 11kV BREAKER
F1	TRANSFORMER 2 11kV BREAKER
G1	TOWNVIEW FLATS 11kV BREAKER
H1	LOCAL 4 WAY RMU 11kV BREAKER
I1	WATERWORKS 11kV BREAKER
J1	11kV BUSBAR COUPLER
K1	TOWNSVIEW 11kV BREAKER
L1	LOT 14 SWITCHROOM 11kV BREAKER
M1	FEEDER TO SAUNDERS STREET SWITCHROOM 11kV BREAKER

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Rev.	Drawn/	Chkd.	Appr.	Date.	Rev. Description.
04	SK	-	-	08-11-2018	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS
03	MV	-	-	13-06-2013	Revised Diagram
02	RL	-	-	08 /2012	Inserted 33kV Cable Earth Switch Removed 33kV B&B Isolator Upgrade Test
01	RL	-	-	06 /2012	Draft Diagram Upgrade
00	JH	-	-	29-05-2012	FIRST DRAFT ISSUE



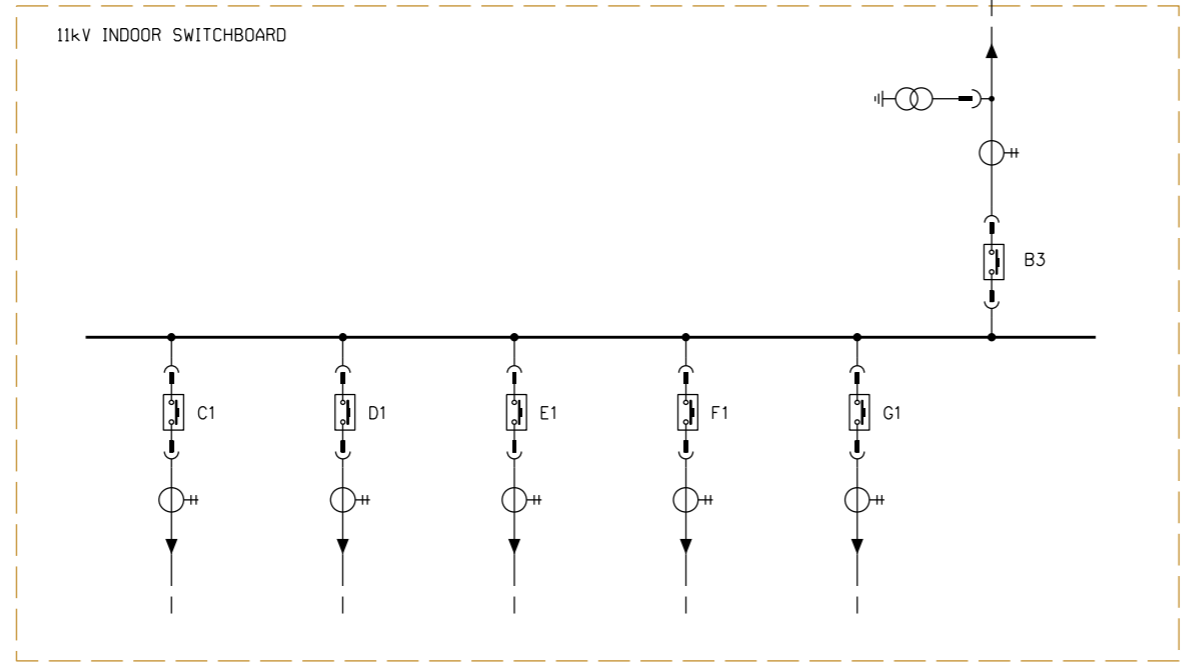
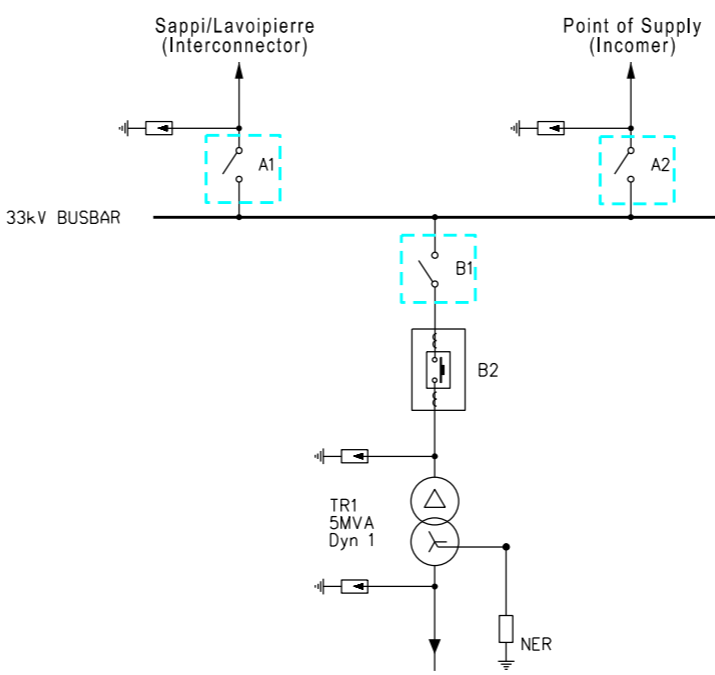
**GLENHILLS
33/11kV SUBSTATION**

**ELECTRICAL
OPERATING DIAGRAM**

Checked:	Drawn:	Approved:	Date:
-	J HUMAN	-	MAY 2012
Scale:	CAD Store No.	KDM-4003-DD-01-04-A3.dgn	
N.T.S.			
Drawing No.	Set	Sheet	Rev.
KDM-4003	DD	01	04



SIGNAL BROUGHT BACK TO THE CONTROL ROOM



EQUIPMENT LEGEND

- 33kV EQUIPMENT**
- A1 SAPP/LAVOPIERRE 33kV LINE ISOLATOR
 - A2 POINT OF SUPPLY 33kV LINE ISOLATOR
 - B1 TFR T303 33kV BUSBAR ISOLATOR
 - B2 TFR T303 33kV BREAKER
- 11kV EQUIPMENT**
- B3 TFR T303 11kV BREAKER
 - C1 GROUTVILLE 11kV BREAKER
 - D1 LOCAL TRANSFORMER 11kV BREAKER
 - E1 GLEDHOW MILL 11kV BREAKER
 - F1 WESTERN ROAD 11kV BREAKER
 - G1 GLEDHOW SOUTH 11kV BREAKER



GLEDHOW 33/11KV SUBSTATION

EXISTING SINGLE LINE DIAGRAM

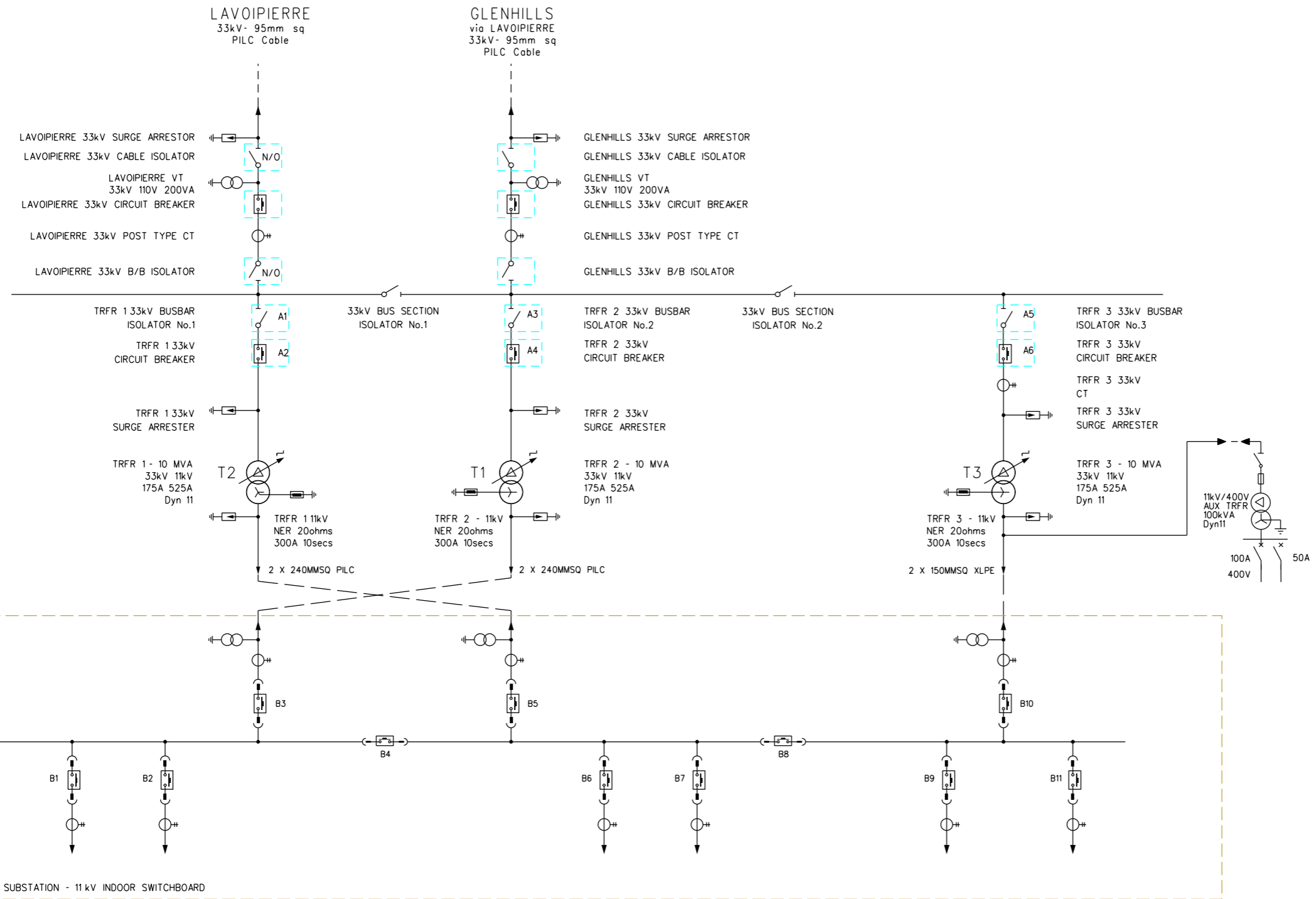
CLIENT APPROVAL			
DISCIPLINE	NAME	SIGN	DATE
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MECH			
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Rev.	Drawn	Chkd.	Appr.	Date	Rev. Description
02	SK	-	-	06-1-2018	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS
01	MV	-	-	18/08/13	REVISED DRAWING
00	RL	-	-	06/2012	REMOVE 22KV EQUIPMENT /11KV CABLE

Checked:	Drawn:	Approved:	Date:
	J.J.Human	-	May 2012
Scale:	CAD Store No:	KDM-4004-DD-01-02-A3.dgn	
N.T.S.			
Drawing No:	Set	Sheet	Rev.
KDM-4004	DD	01	02

SIGNAL BROUGHT BACK TO THE CONTROL ROOM



BAY EQUIPMENT LEGEND	
P	PANEL NUMBER
	FACING PANEL - LEFT TO RIGHT
A1	TRFR 1 33kV BUSBAR ISOLATOR No.1
A2	TRFR 1 33kV CIRCUIT BREAKER
A3	TRFR 2 33kV BUSBAR ISOLATOR No.2
A4	TRFR 2 33kV CIRCUIT BREAKER
A5	TRFR 3 33kV BUSBAR ISOLATOR No.3
A6	TRFR 3 33kV CIRCUIT BREAKER
B1	FLAMBOYANT 11kV SWITCHING STATION 150mm' PILC
B2	NEW GUELDERLAND 11kV OHL 150mm' PILC
B3	TRFR 1 11kV INCOMER 2X240mm' PILC
B4	11kV BUS SECTION CIRCUIT BREAKER No.1
B5	TRFR 2 11kV INCOMER 2X240mm' PILC
B6	KWADUKUZA 11kV SS FEEDER No.1 150mm' PILC
B7	LINDELANI/DOESBERG 11kV OHL 70mm' PILC
B8	11kV BUS SECTION CIRCUIT BREAKER No.2
B9	HYDRANGEA 11kV SWITCHING STATION 150mm' PILC
B10	TRFR 3 11kV INCOMER 2X150mm' XLPE
B11	KWADUKUZA 11kV SS FEEDER No.2 150mm' PILC

NOTES

CLIENT

APPROVED BY _____ **SIGNATURE** _____

DATE _____

REV	DATE	REVISION DETAILS	APPROVED
A	09/07/18	DETAIL DESIGN	
B	08/11/18	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS	

PROJECT

KWADUKUZA MALL BULK SUPPLY

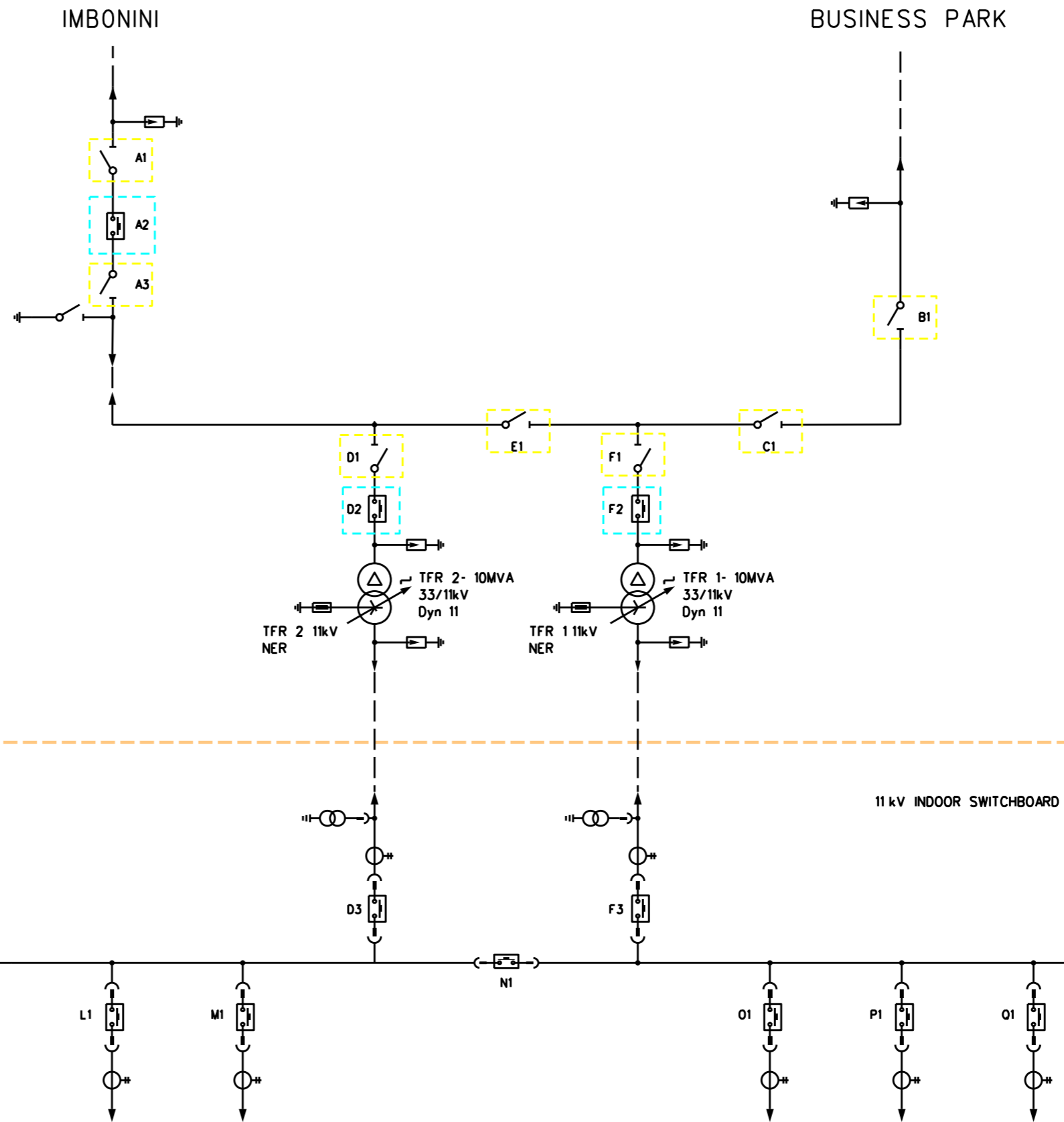
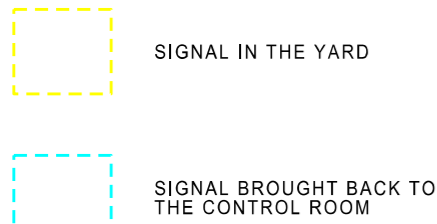
TITLE

ELECTRICAL DISTRIBUTION DIAGRAM

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DRAWN	DESIGNED	TENDER
D.Naicker	D.Naicker	NOT FOR CONSTRUCTION
CHECKED	PROJECT No.	
L.Mudongo	501758	
APPROVED	SCALE	SIZE
I. van Dyk	N.T.S.	A3L
DRAWING No.		REV
KDM-4005-DD-01-B-A3		B



EQUIPMENT LEGEND	
33kV EQUIPMENT	
A1	IMBONINI 33kV LINE ISOLATOR
A2	IMBONINI 33kV BREAKER
A3	IMBONINI 33kV BUSBAR ISOLATOR
A4	IMBONINI 33kV B/B EARTH ISOL.
B1	BUSINESS PARK 33kV LINE ISOL
C1	33kV BUS SECTION 1 ISOLATOR
D1	TFR 2 33kV BUSBAR ISOLATOR
D2	TFR 2 33kV BREAKER
E1	33kV BUS SECTION 2 ISOLATOR
F1	TFR 1 33kV BUSBAR ISOLATOR
F2	TFR 1 33kV BREAKER
11kV EQUIPMENT	
D3	INCOMER 2 11kV BREAKER
F3	INCOMER 1 11kV BREAKER
G1	SIMBITHI T28 11kV BREAKER
H1	SIMBITHI CLUBHOUSE 11kV BREAKER
I1	SPARE 11kV BREAKER
J1	THOMPSONS BAY 11kV BREAKER
K1	MILTONS FOX HILL 11kV BREAKER
L1	SIMBITHI T4.1 11kV BREAKER
M1	OLD LADLAU 11kV BREAKER
N1	11kV BUS SECTION BREAKER
O1	HEWETT ROAD 11kV BREAKER
P1	LOCAL TFR 11kV BREAKER
Q1	MS T3 11kV BREAKER



**SHAKAS ROCK
33/11kV SUBSTATION**

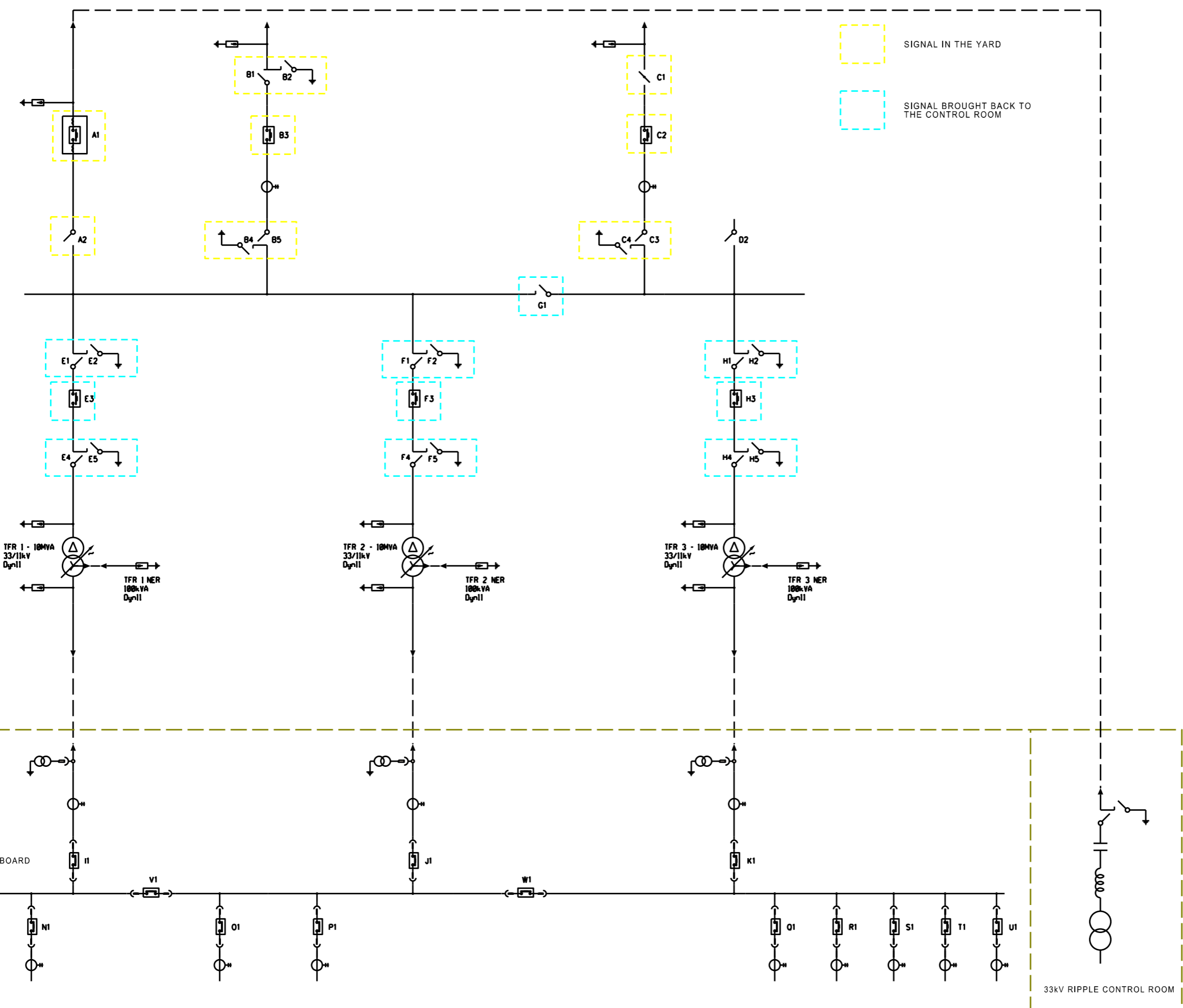
**ELECTRICAL
OPERATING DIAGRAM**

CLIENT APPROVAL			
DISCIPLINE	NAME	SIGN	DATE
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P.O.Box 335, Umhlanga Rocks, 4320
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02	SK	08-01-18	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS
01	MV	14/06/13	Revised Diagram
00	RL	06/20/12	Draft Diagram
Rev.	Drawn	Chkd.	Appr.
Checked:	R Lucey	Approved:	June 2012
Scale:	N.T.S.	CAD Store No.:	KDM-4006-DD-01-02-A3.dgn
Drawing No.:	KDM-4006	Set:	DD 01 02



EQUIPMENT LEGEND

33kV EQUIPMENT	
A1	BALLITO 33kV RIPPLE FEEDER BREAKER
A2	BALLITO 33kV RIPPLE FEEDER BUSBAR ISOLATOR
B1	BUSINESS PARK 33kV LINE ISOLATOR
B2	BUSINESS PARK 33kV EARTHING ISOLATOR
B3	BUSINESS PARK 33kV BREAKER
B4	BUSINESS PARK 33kV BUSBAR EARTHING ISOLATOR
B5	BUSINESS PARK 33kV BUSBAR ISOLATOR
C1	SHAKASKRAAL-DRIEFONTEIN 1 33kV LINE ISOLATOR
C2	SHAKASKRAAL-DRIEFONTEIN 1 33kV AUTORECLOSER
C3	SHAKASKRAAL-DRIEFONTEIN 1 33kV BUSBAR ISOLATOR
C4	SHAKASKRAAL-DRIEFONTEIN 1 33kV BUSBAR EARTHING ISOLATOR
D1	DRIEFONTEIN 33kV RIPPLE FEEDER BREAKER
D2	DRIEFONTEIN 33kV RIPPLE FEEDER BUSBAR ISOLATOR
E1	TRANSFORMER 1 33kV BUSBAR ISOLATOR
E2	TRANSFORMER 1 33kV BUSBAR EARTHING ISOLATOR
E3	TRANSFORMER 1 33kV BREAKER
E4	TRANSFORMER 1 33kV ISOLATOR
E5	TRANSFORMER 1 33kV EARTHING ISOLATOR
F1	TRANSFORMER 2 33kV BUSBAR ISOLATOR
F2	TRANSFORMER 2 33kV BUSBAR EARTHING ISOLATOR
F3	TRANSFORMER 2 33kV BREAKER
F4	TRANSFORMER 2 33kV ISOLATOR
F5	TRANSFORMER 2 33kV EARTHING ISOLATOR
G1	BALLITO 33kV BUS SECTION ISOLATOR
H1	TRANSFORMER 3 33kV BUSBAR ISOLATOR
H2	TRANSFORMER 3 33kV BUSBAR EARTHING ISOLATOR
H3	TRANSFORMER 3 33kV BREAKER
H4	TRANSFORMER 3 33kV ISOLATOR
H5	TRANSFORMER 3 33kV EARTHING ISOLATOR
11kV EQUIPMENT	
I1	TRANSFORMER 1 11kV BREAKER
J1	TRANSFORMER 2 11kV BREAKER
K1	TRANSFORMER 3 11kV BREAKER
L1	PROMENADE 1 11kV BREAKER
M1	EXTENTION 5 SWITCHROOM 11kV BREAKER
N1	ZIMBALI 2 11kV BREAKER
O1	MARION ROAD 11kV BREAKER
P1	ASHLEY ROAD 11kV BREAKER
Q1	ZIMBALI 1 11kV BREAKER
R1	CARAVAN PARK 11kV BREAKER
S1	LOCAL TRANSFORMER 11kV BREAKER
T1	FIRESTATION 11kV BREAKER
U1	PROMENADE 2 11kV BREAKER
V1	BUSSECTION 1 11kV BREAKER
W1	BUSSECTION 2 11kV BREAKER



**BALLITO
33/11kV SUBSTATION**

**EXISTING SUBSTATION
OPERATING DIAGRAM**

CLIENT APPROVAL			
DISCIPLINE	NAME	SIGN	DATE
CIVIL			
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 Tel: +27 31 575 5500

P.O.Box 335,
 Umhlanga Rocks,
 4320
 Fax: +27 86 244 9177

Rev.	Drawn/Chkd.	Appr.	Date	Rev Description
02	SK		08-11-08	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS
01	MV		10-06-13	FIRST ISSUE
00	R.L.		3/4/2012	Site layout.

Checked:	Drawn:	Approved:	Date:
	R. Lucey		May 2012
Scale:	CAD Store No.		
N.T.S.	KDM-4008-DD-01-02-A3.dgn		
Drawing No.	Set	Sheet	Rev.

KDM-4008 DD 01 02

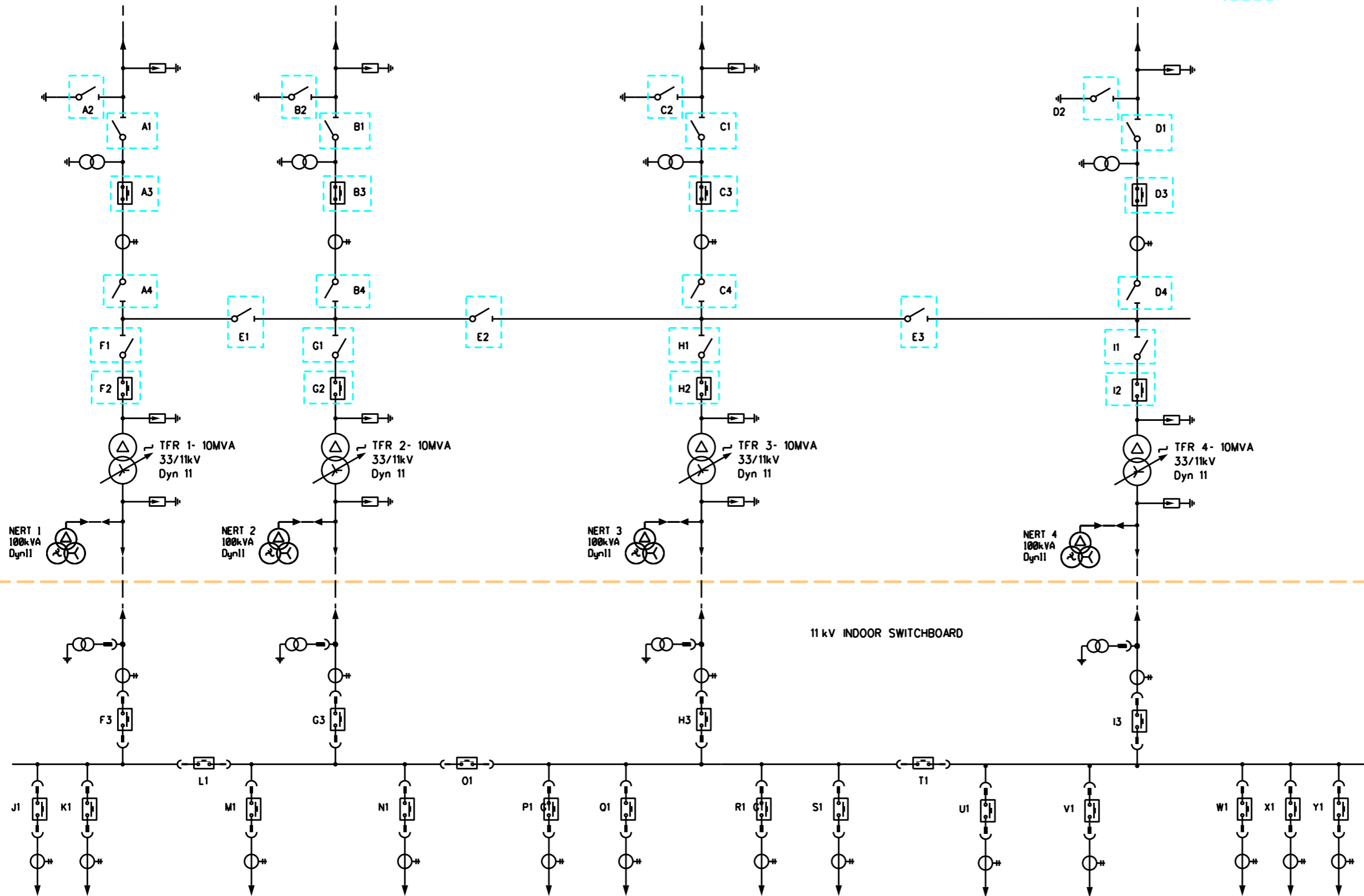
INCIMER 1 (BALLITO)

INCIMER 2 (ZIMBALI)

INCIMER 3 (CHAKA'S ROCK)

INCIMER 4

SIGNAL BROUGHT BACK TO THE CONTROL ROOM



EQUIPMENT LEGEND

33kV EQUIPMENT	
A1	INCIMER 1 33kV LINE ISOLATOR
A2	INCIMER 1 33kV EARTH SWITCH
A3	INCIMER 1 33kV BREAKER
A4	INCIMER 1 33kV BUSBAR ISOL
B1	INCIMER 2 33kV LINE ISOLATOR
B2	INCIMER 2 33kV EARTH SWITCH
B3	INCIMER 2 33kV BREAKER
B4	INCIMER 2 33kV BUSBAR ISOL
C1	INCIMER 3 33kV LINE ISOLATOR
C2	INCIMER 3 33kV EARTH SWITCH
C3	INCIMER 3 33kV BREAKER
C4	INCIMER 3 33kV BUSBAR ISOL
D1	INCIMER 4 33kV LINE ISOLATOR
D2	INCIMER 4 33kV EARTH SWITCH
D3	INCIMER 4 33kV BREAKER
D4	INCIMER 4 33kV BUSBAR ISOL
E1	33kV BUS SECTION ISOL 1
E2	33kV BUS SECTION ISOL 2
E3	33kV BUS SECTION ISOL 3
F1	TFR 1 33kV BUSBAR ISOLATOR
F2	TFR 1 33kV BREAKER
G1	TFR 2 33kV BUSBAR ISOLATOR
G2	TFR 2 33kV BREAKER
H1	TFR 3 33kV BUSBAR ISOLATOR
H2	TFR 3 33kV BREAKER
I1	TFR 4 33kV BUSBAR ISOLATOR
I2	TFR 4 33kV BREAKER
11kV EQUIPMENT	
F3	TFR 1 11kV BREAKER
G3	TFR 2 11kV BREAKER
H3	TFR 3 11kV BREAKER
I3	TFR 4 11kV BREAKER
J1	BALLITO BAY MALL INC 2 11kV BKR
K1	LIFESTYLE CENTRE 11kV BREAKER
L1	BUS SECTION 1 11kV BREAKER
M1	BALLITO JUNCTION NO.2 11kV BREAKER
N1	RICHARDS PARK 11kV BREAKER
O1	BUS SECTION 2 11kV BREAKER
P1	VW MS 11kV BREAKER
Q1	VIRGIN ACTIVE RMU 11kV BREAKER
R1	MONZA M/S 11kV BREAKER
S1	DORADO PARK M/S 11kV BREAKER
T1	BUS SECTION 3 11kV BREAKER
U1	SEAWARD ESTATE 11kV BREAKER
V1	MCCALLS HOUSE 11kV BREAKER
W1	REGAL INN HOTEL 11kV BREAKER
X1	BALLITO JUNCTION NO.1 11kV BKR
Y1	BALLITO BAY MALL INC 1 11kV BKR



**BUSINESS PARK
33/11kV SUBSTATION**

**ELECTRICAL
OPERATING DIAGRAM**

CLIENT APPROVAL			
DISCIPLINE	NAME	SIGN	DATE
CIVIL			
MECH			
ELECT			

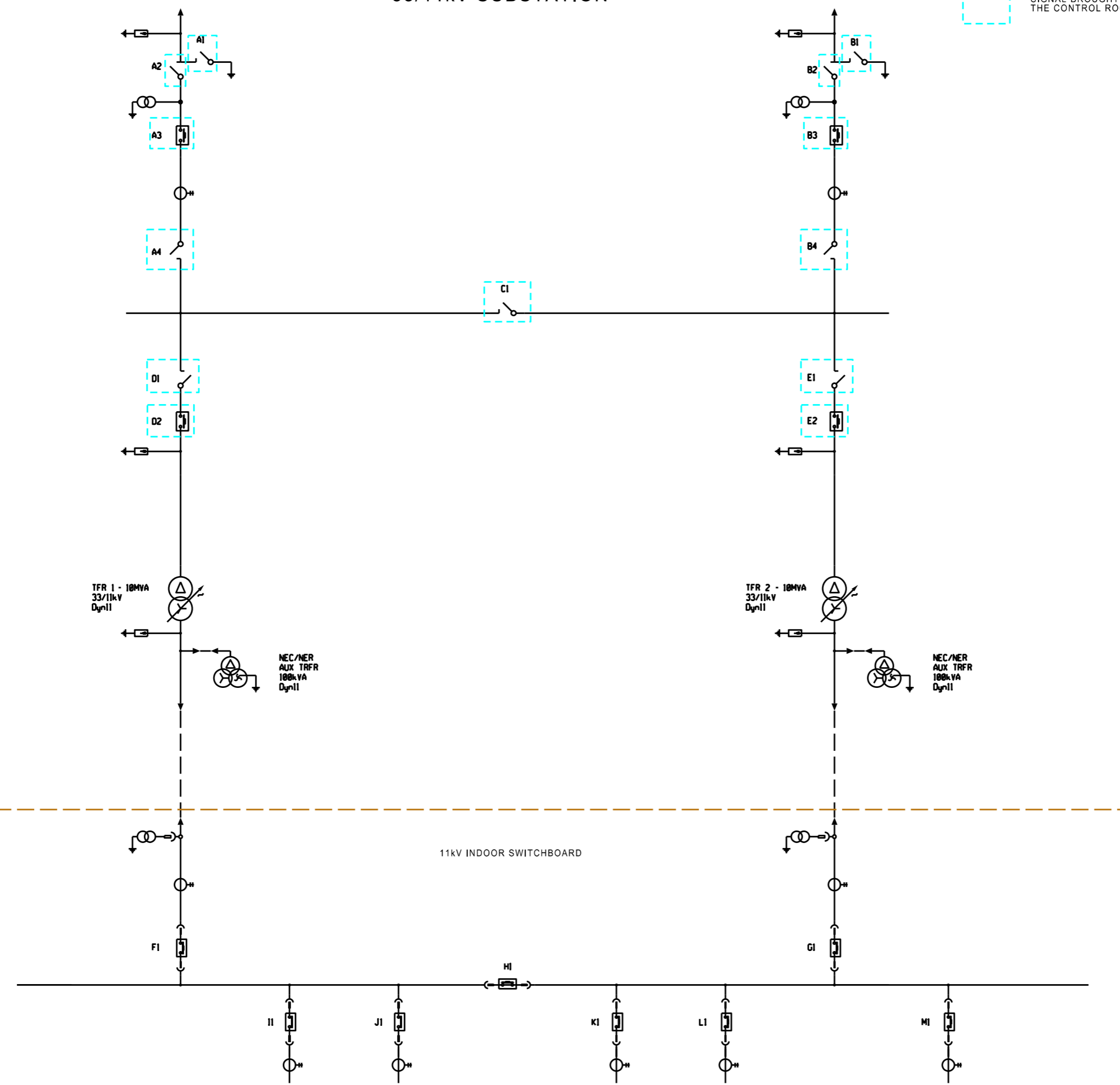
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Rev.	Drawn	Chkd.	Appr.	Date	Rev. Description
01	SK	-	-	26/1/2013	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS
00	MV	-	-	24/06/13	Draft Diagram

Checked: **M. Venter** Approved: **June 2013**
Scale: **N.T.S.** CAD Store No: **KDM-4009-DD-01-01-A3.dgn**
Drawing No: **KDM-4009** Set: **DD** Sheet: **01** Rev: **01**

ZIMBALI 33/11kV SUBSTATION

SIGNAL BROUGHT BACK TO THE CONTROL ROOM



EQUIPMENT LEGEND	
33kV EQUIPMENT	
A1	INCOMER 1 33kV LINE EARTH SWITCH
A2	INCOMER 1 33kV BREAKER
A3	INCOMER 1 33kV BUSBAR ISOLATOR
A4	INCOMER 2 33kV LINE EARTH SWITCH
B1	INCOMER 2 33kV BREAKER
B2	INCOMER 2 33kV BUSBAR ISOLATOR
B3	INCOMER 2 33kV BREAKER
B4	INCOMER 2 33kV BUSBAR ISOLATOR
C1	ZIMBALI 33kV BUSBAR SECTION ISOLATOR
D1	TRANSFORMER 1 33kV BUSBAR ISOLATOR
D2	TRANSFORMER 1 33kV BREAKER
E1	TRANSFORMER 2 33kV BUSBAR ISOLATOR
E2	TRANSFORMER 2 33kV BREAKER
11kV EQUIPMENT	
F1	TRANSFORMER 1 11kV BREAKER
G1	TRANSFORMER 2 11kV BREAKER
H1	11kV BUSBAR SECTION BREAKER
I1	IFA HOTEL 11kV BREAKER
J1	HILLTOP M/S 2 11kV BREAKER
K1	HILLTOP M/S 1 11kV BREAKER
L1	ZIMBALI T4/1 11kV BREAKER
M1	ZIMBALI OFFICE PARK 11kV BREAKER



ZIMBALI 33/11kV SUBSTATION

EXISTING SUBSTATION OPERATING DIAGRAM

CLIENT APPROVAL			
DISCIPLINE	NAME	SIGN	DATE
CIVIL			
MECH			
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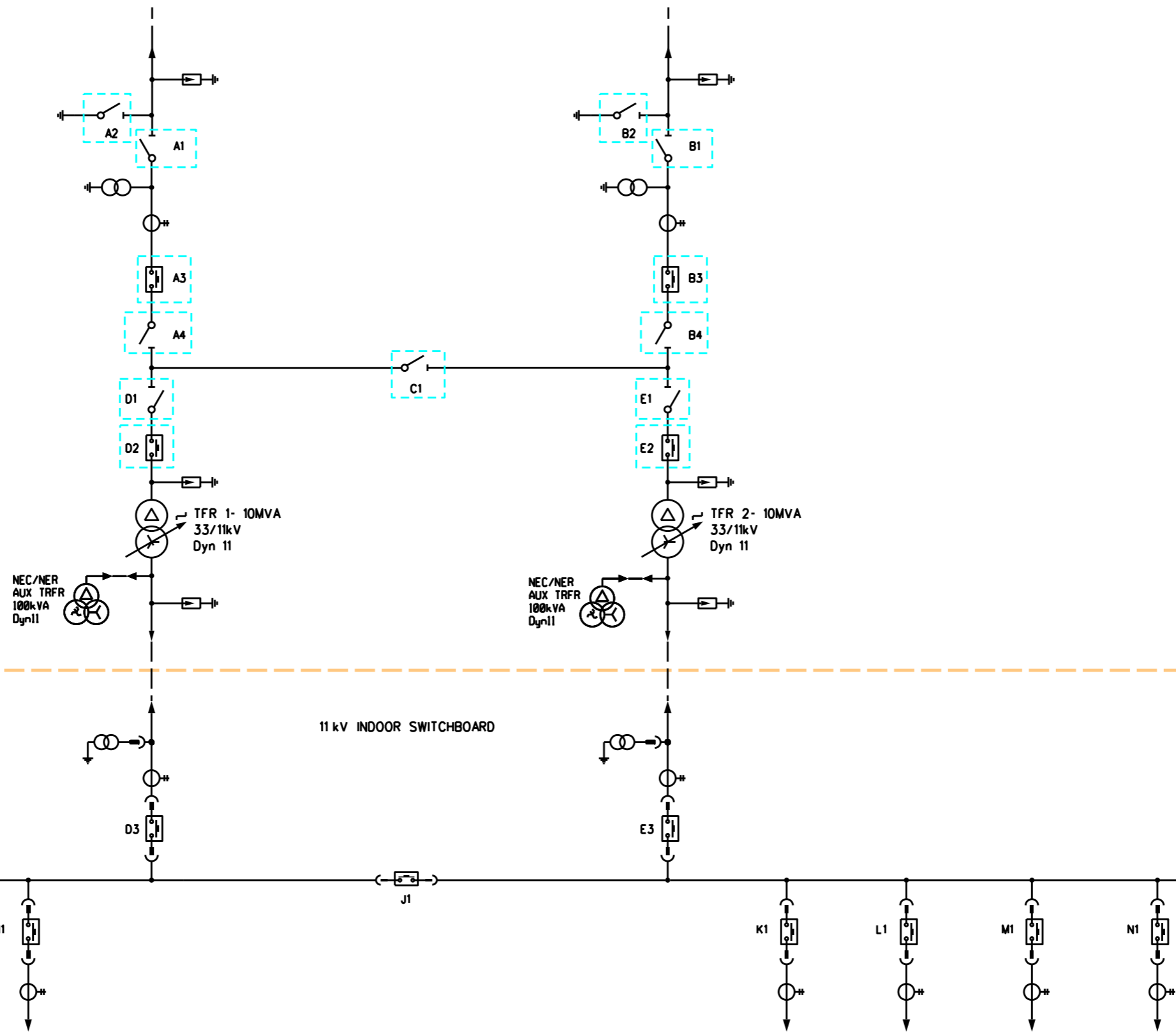
02	S.K.	-	-	08-11-18	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS
01	M.V.	-	-	12/09/13	Revised Diagram
00	R.L.	-	-	30/04/12	Site layout.
Rev.	Drawn	Chkd.	Appr.	Date	Rev Description
Checked.	R. Lucey		Approved.	May 2012	
Scale:	KDM-4010-DD-01-02-A3.dgn		CAD Store No.		
N.T.S.			Set	Sheet	Rev.
Drawing No.	KDM-4010	DD	01	02	



SIGNAL BROUGHT BACK TO THE CONTROL ROOM

INCOMER 1

INCOMER 2



EQUIPMENT LEGEND

33kV EQUIPMENT	
A1	INCOMER 1 33kV LINE ISOLATOR
A2	INCOMER 1 33kV EARTH SWITCH
A3	INCOMER 1 33kV BREAKER
A4	INCOMER 1 33kV BUSBAR ISOL
B1	INCOMER 2 33kV LINE ISOLATOR
B2	INCOMER 2 33kV EARTH SWITCH
B3	INCOMER 2 33kV BREAKER
B4	INCOMER 2 33kV BUSBAR ISOL
C1	33kV BUS SECTION ISOLATOR
D1	TFR 1 33kV BUSBAR ISOLATOR
D2	TFR 1 33kV BREAKER
E1	TFR 2 33kV BUSBAR ISOLATOR
E2	TFR 2 33kV BREAKER
11kV EQUIPMENT	
D3	TFR 1 11kV BREAKER
E3	TFR 2 11kV BREAKER
F1	VMH 1 11kV BREAKER
G1	IMB MSS 0003 11kV BREAKER
H1	BOGMORE 1 11kV BREAKER
I1	IMB MSS 0008 11kV BREAKER
J1	11kV BUS COUPLER BREAKER
K1	IMB MSS 0009 11kV BREAKER
L1	IMB MSS 0010 11kV BREAKER
M1	IMB MSS 0002 11kV BREAKER
N1	VMH 2 11kV BREAKER



**IMBONINI
33/11kV SUBSTATION**

**ELECTRICAL
OPERATING DIAGRAM**

CLIENT APPROVAL			
DISCIPLINE	NAME	SIGN	DATE
CIVIL			
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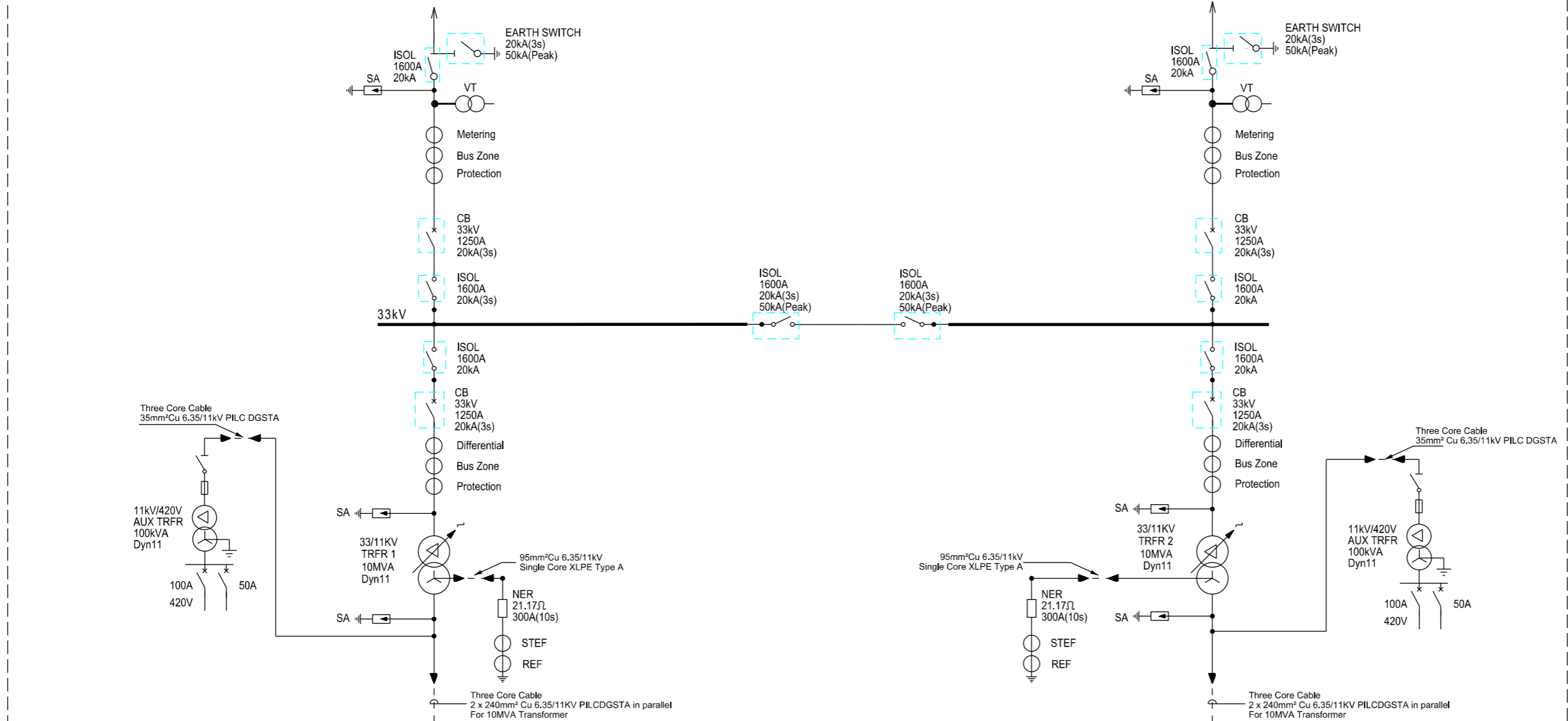
01	SK	08-11-18	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS
00	MV	18/06/13	Draft Diagram
Rev.	Drawn	Chkd.	Appr.
Checked:	M. Venter	Approved:	June 2013
Scale:	N.T.S.	CAD Store No.:	KDM-4011-DD-01-01-A3.dgn
Drawing No.:	KDM-4011	Set:	DD
Sheet:	01	Rev.:	01

OUTDOOR YARD

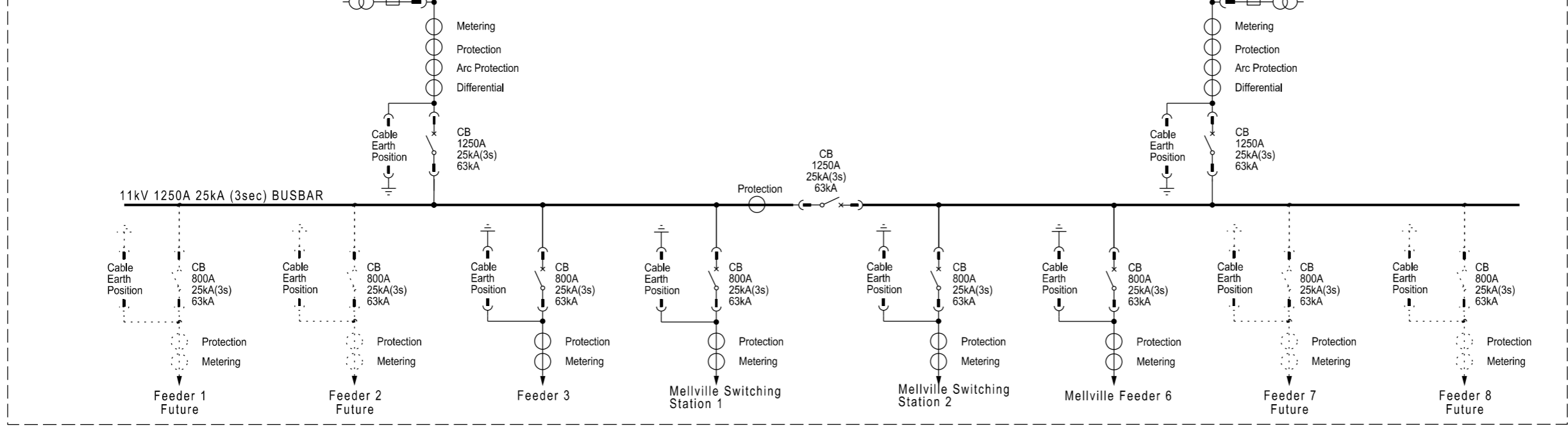
Incomer 1

Incomer 2

SIGNAL BROUGHT BACK TO THE CONTROL ROOM



11kV INDOOR SWITCHBOARD
(Internal cables not indicated)



NOTES

CLIENT

APPROVED BY _____ **SIGNATURE** _____

DATE _____

REV	DATE	REVISION DETAILS	APPROVED
00	09/09/13	DETAILED DESIGN	
01	09/26/13	ADDED BUS SECTION PROTECTION	
02	08/11/18	UPDATE OF EQUIPMENT SIGNAL DESTINATIONS	

PROJECT

GROUTVILLE 33/11kV SUBSTATION

TITLE

MV DISTRIBUTION NETWORK SINGLE LINE DIAGRAM

CONSULTANT

éThekwini

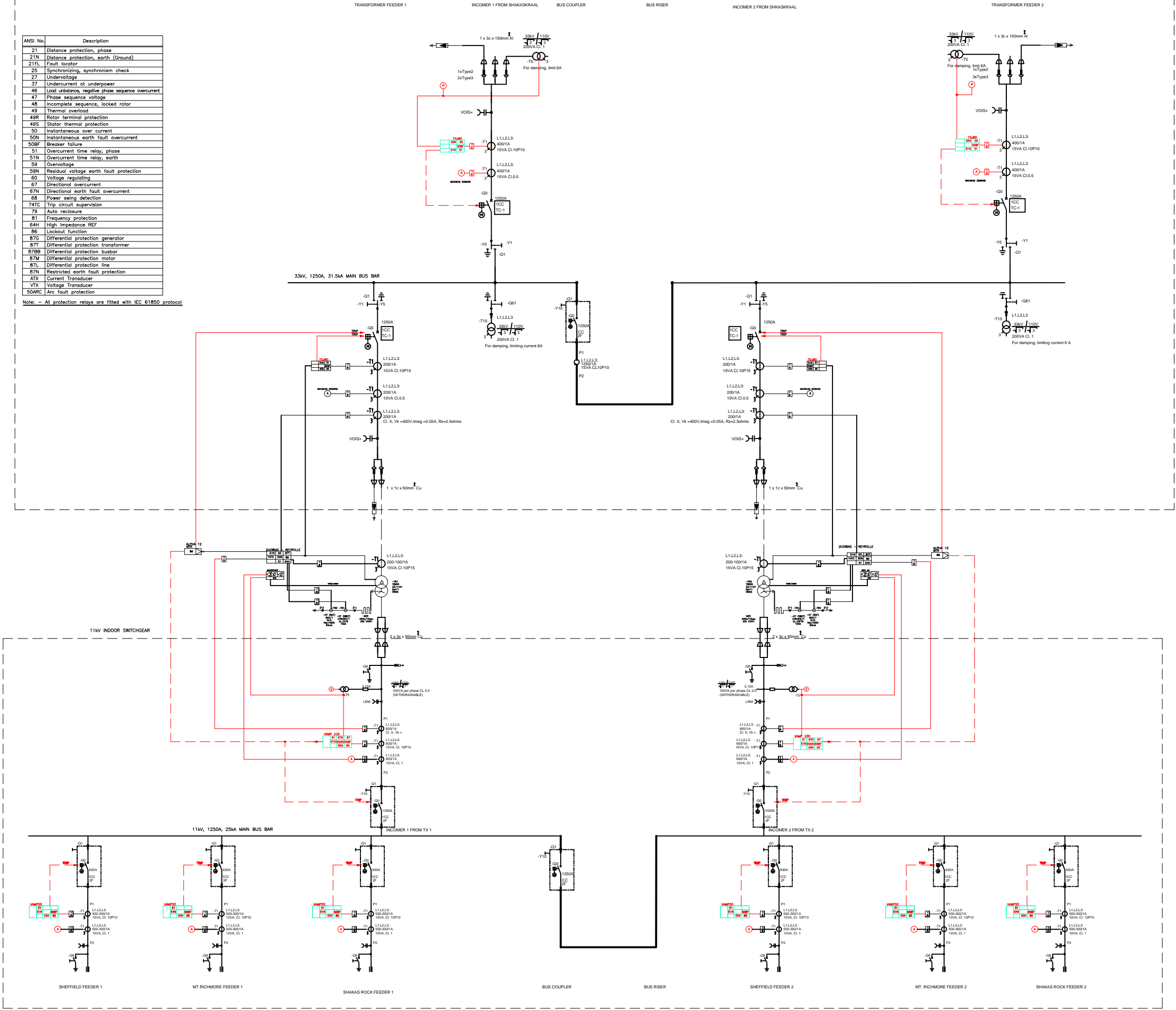
4 - 10 School Road, Park Row Building, Pinetown, 3600
Tel: +27 31 714 2500 Fax: +27 31 702 0287

DRAWN	DESIGNED	PROJECT No.
C. van Dyk	B. Grib	107998
CHECKED	SCALE	SIZE
I. van Dyk	N.T.S.	A3L
APPROVED	DRAWING No.	REV
	KDM-4013-51-02-A3	02

33KV INDOOR SWITCHGEAR

ANSI No.	Description
21	Distance protection, phase
21N	Distance protection, earth (Ground)
21FL	Fault locator
25	Synchronizing, synchronism check
27	Undervoltage
37	Undercurrent at underpower
46	Load unbalance, negative phase sequence overcurrent
47	Phase sequence voltage
48	Incomplete sequence, locked rotor
49	Thermal overload
49R	Rotor terminal protection
49S	Stator thermal protection
50	Instantaneous over current
50N	Instantaneous earth fault overcurrent
50BF	Breaker failure
51	Overcurrent time relay, phase
51N	Overcurrent time relay, earth
59	Overvoltage
59N	Residual voltage earth fault protection
60	Voltage regulating
67	Directional overcurrent
67N	Directional earth fault overcurrent
68	Power swing detection
74TC	Trip circuit supervision
79	Auto reclosure
81	Frequency protection
64H	High impedance REF
86	Lockout function
87G	Differential protection generator
87T	Differential protection transformer
87BB	Differential protection busbar
87M	Differential protection motor
87L	Differential protection line
87N	Restricted earth fault protection
ATX	Current Transducer
VTX	Voltage Transducer
50ARC	Arc fault protection

Note: - All protection relays are fitted with IEC 61850 protocol



REV No.	DATE	DESCRIPTION
5	02/05/14	PANEL NAMES UPDATED AS PER THE COMMENTS FROM SITE
4	31/08/12	REVISED AS PER COMMENTS ON 29.08.12
3	24/08/12	FOR APPROVAL
2	15/08/12	REVISED AS PER COMMENTS
1	30/07/12	FIRST ISSUE

Drawn By:
J. Abraham
Date: 30/07/12

Approved By:

Date: 30/07/12

Designed By:
J. Abraham
Date: 30/07/12

Consultant Engineer Approval:
Name: _____
Date: _____

Signature

Siemens Engineer Signature



SIEMENS
LIMITED
JOHANNESBURG

REG.No. 1923/007514/06

Customer Approval
Name: _____
Date: _____

Signature

Customer Approval

SIEMENS DRAWING No: 1923/007514-06
SHEET No. 1

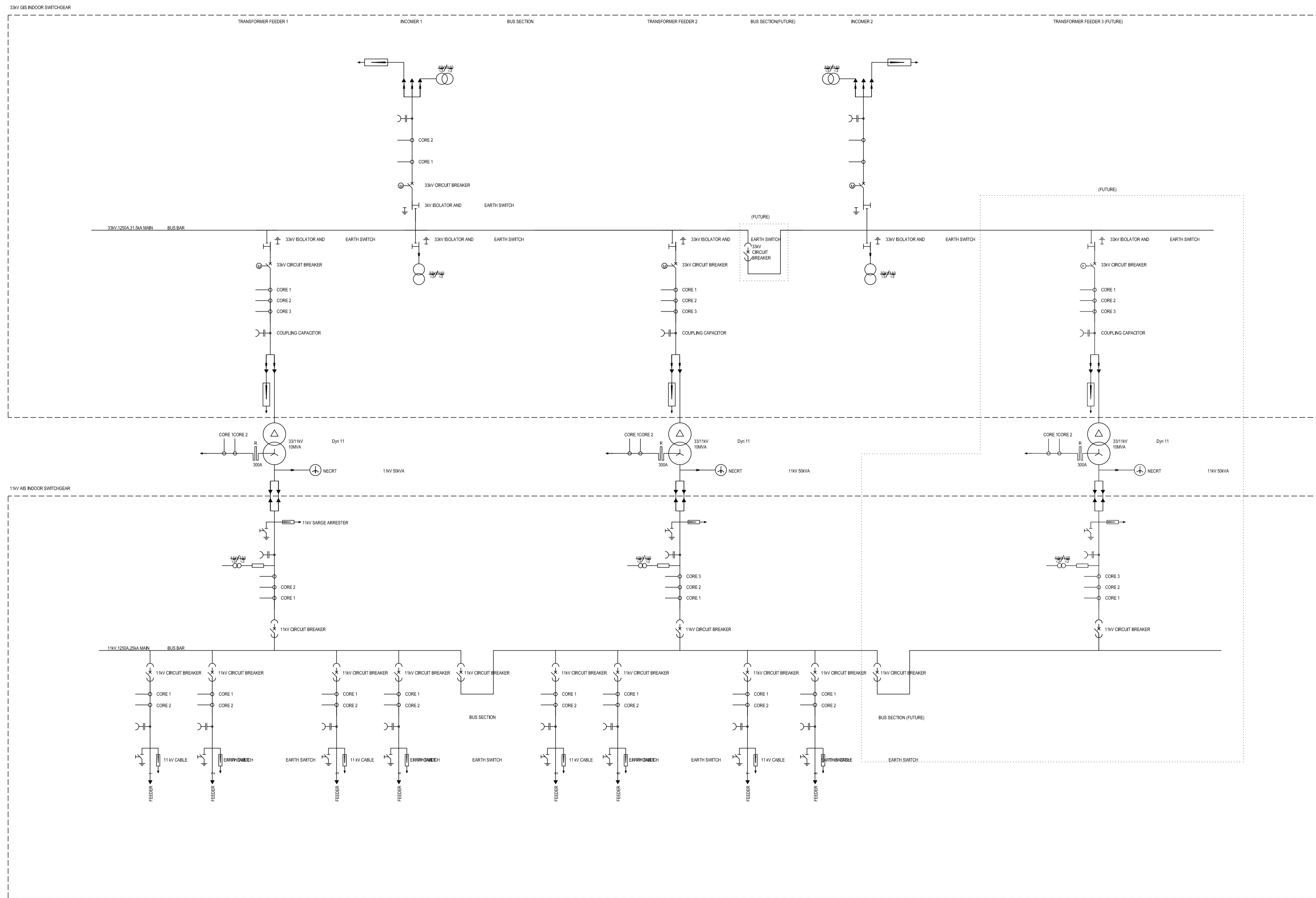
PROJECT NAME:
**SHEFFIELD 33/11KV
SUBSTATION**

DRAWING TITLE:
SINGLE LINE DIAGRAM

DESIGNED: JPA
PROJECT No: 150P-30066
SCALE: N/A

CUSTOMER DRAWING No: _____
REVISION: 3

NOTES:



No.	REVISIONS	DATE
00	ISSUED FOR TENDER	2017-07-26

SABS
ISO 9001

SMEC
Local People. Global Experience

2 The Crescent, Westway Office Park, Westville, 3629
P O Box 1502, Westville, South Africa, 3630
Tel +27(0)31 277-8600 Fax +27(0)31 277-8700
e-mail : durban@smec.co.za Website : www.smec.com

SIGNATURE _____ DATE _____



PROJECT
PROPOSED GIZENGA 33/11kVA SUBSTATION

DRAWING DESCRIPTION
SINGLE LINE DIAGRAM

SCALE:	UNITS:	DATE CREATED:	SIZE:
N/A	N/A	2016-06-29	A1
DRAWN:	DESIGN:	CHECKED:	
C.VDWESTHUIZEN	V.TIEDT	V.TIEDT	

PROJECT NO		PHASE	DISCIPLINE	STAGE
DM	0090	A	EE	T
UNIQUE NUMBER				
DOC TYPE	TYPE	LEVEL	DRAWING NUMBER	REVISION
DRG	EE	0	0002	00

Appendix H

SCADA Project Total Cost Estimate

**SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES
AT THE MANDENI LM & KWADUKUZA LM 33/11kV SUBSTATIONS: COST ESTIMATE**

ALL SUBSTATIONS LISTED

SCADA PROJECT TOTAL COST

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Amount
1	Preliminary and General	Unit	1	R 2,077,333.00
2	Ballito 33/11 kV Substation	Unit	1	R 799,240.00
3	Ballito Business Park 33/11 kV Substation	Unit	1	R 657,500.00
4	Dukuza 132/33/11kV Substation (Future)	Unit	1	R 1,090,728.00
5	Gizenga 33/11 kV Substation (Future)	Unit	1	R 605,468.00
6	Gledhow 33/11 kV Substation	Unit	1	R 597,040.00
7	Glenhills 33/11 kV Substation	Unit	1	R 605,040.00
8	Groutville Priority One 33/11 kV Substation	Unit	1	R 580,640.00
9	Imbonini 33/11 kV Substation	Unit	1	R 601,340.00
10	Industrial Park 33/11 kV Substation	Unit	1	R 702,126.00
11	Lavoipierre 33/11 kV Substation	Unit	1	R 804,718.00
12	Sappi 33/11 kV Substation	Unit	1	R 686,890.00
13	Shakaskraal 33/11 kV Substation	Unit	1	R 2,089,993.00
14	Shakas Rock 33/11 kV Substation	Unit	1	R 743,722.00
15	Sheffield 33/11 kV Substation	Unit	1	R 1,290,743.00
16	Stanger Point of Supply 33kV Substation	Unit	1	R 579,240.00
17	Zimbali 33/11 kV Substation	Unit	1	R 602,840.00
18	Mandeni Local Municipality Intake Point	Unit	1	R 60,900.00
19	Control Room Costs excl. building	Unit	1	R 2,947,137.00
	Sub Total (excl VAT)			R 18,122,638.00

BILL 01: PRELIMINARY AND GENERAL

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Amount
Scheduled Fixed-charge and Value-related Items				
1.1	Fixed preliminary and general charges	Sum	1	R 625,219.00
1.2	Value-related preliminary and general charges	Sum	1	R 294,000.00
Scheduled Time-related Items				
1.3	Time-related preliminary and general	Sum	1	R 347,900.00
Prime Cost Sums				
1.4	Additional tests required by the Engineer	PC Sum	1	R 24,700.00
1.5	Charge required by Contractor on above	%	12	R 2,964.00
Compliance with OHS Act & Regulations (including the Construction Regulations, 2014)				
1.6	Compile a Health and Safety Plan	Sum	1	R 127,800.00
1.7	Comply with Health & Safety Plan, Health & Safety Specification and legislation	Sum	1	R 37,800.00
1.8	Factory Acceptance Tests	Sum	1	R 51,450.00
1.9	SCADA Software Training	Sum	1	R 54,000.00
1.10	Guarantee and Maintenance for a period of 3years	Sum	1	R 473,000.00
1.11	Spare parts inclusive off but not limited by the following: power supplies, DC-DC convertors & modems	Sum	1	R 38,500.00
All Other P&G Items Deemed Necessary to Complete the Works (Specify):				
Sub Total (excl VAT)				R 2,077,333.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT BALLITO SUBSTATION: COST ESTIMATE

BILL 01: BALLITO SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Unit	2	R 29,000.00	R 1,500.00	R 61,000.00
1.1.9	Switch setup and configuration	Unit	2		R 9,528.00	R 19,056.00
1.1.10	Supply and install I/O Module	Unit	1	R 17,472.00	R 1,500.00	R 18,972.00
1.1.11	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.12	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Upgrade the existing protection relays with the IEC61850 Protocol	Unit	14		R 2,900.00	R 40,600.00
1.3	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	19	R 600.00		R 11,400.00
1.4	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.5	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	19		R 300.00	R 5,700.00
1.6	Supply and install 3CR12 epoxy coated marshalling kiosk to house I/O module in the HV Yard including all accessories such as precast concrete plinth, mounting bolts, etc.	Unit	1	R 15,000.00	R 5,000.00	R 20,000.00
1.7	Supply and Install approx. 100m of 12 Core Multimode Fibre cable from I/O module in HV Yard Kiosk to the switch in the control room. This shall be inclusive of HDPE pipe required, trenching, termination kits and accessories required.	Lot	1		R 56,000.00	R 56,000.00
1.8	Supply, install and terminate 2.5mm cable from (1) isolator signals from HV Yard to I/O module, (2) wire control signals from relay in HV CB to I/O module (3) isolator signals from control panel to relevant IED's or RTAC and (4) I/O signals and BTU within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits, etc	Lot	1		R 60,000.00	R 60,000.00
1.9	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 40,000.00	R 40,000.00
1.10	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.11	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 799,240.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT BALLITO BUSINESS PARK: COST ESTIMATE

BILL 01: BALLITO BUSINESS PARK SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Unit	1	R 29,000.00	R 1,500.00	R 30,500.00
1.1.9	Switch setup and configuration	Units	1		R 9,528.00	R 9,528.00
1.1.10	Supply and install serial port server	Unit	1	R 32,760.00	R 1,500.00	R 34,260.00
1.1.11	Serial Port Server setup and configuration	Units	1		R 6,500.00	R 6,500.00
1.1.12	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.13	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Upgrade the existing protection relays with the IEC61850 Protocol	Unit	4		R 2,900.00	R 11,600.00
1.3	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	10	R 600.00		R 6,000.00
1.4	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.5	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	10		R 300.00	R 3,000.00
1.6	Supply, install and terminate 2.5mm cable from (1) isolator signals from control panel to RTAC or relevant IED, (2) Control signals from 11kV breakers and BTU signals to RTAC and (3) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits etc	Lot	1		R 32,000.00	R 32,000.00
1.7	Supply, install and terminate RS232 cables from (1) serial port server to relays and (2) RTAC to relays	Units	21	R 300.00	R 300.00	R 12,600.00
1.8	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 45,000.00	R 45,000.00
1.9	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.10	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 657,500.00

**SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT
DUKUZA SUBSTATION: COST ESTIMATE**

BILL 01: DUKUZA SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	2	R 25,222.00	R 2,000.00	R 54,444.00
1.1.1	Supply and install Real Time Automation Controller	Unit	2	R 117,500.00	R 2,000.00	R 239,000.00
1.1.2	Supply and install Rugged Computer	Unit	2	R 75,000.00	R 2,000.00	R 154,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	2	R 15,000.00	R 2,500.00	R 35,000.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	2	R 5,000.00	R 1,000.00	R 12,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	2		R 26,000.00	R 52,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	2		R 100,000.00	R 200,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Unit	3	R 33,670.00	R 1,500.00	R 105,510.00
1.1.9	Switch setup and configuration	Units	3		R 9,528.00	R 28,584.00
1.1.10	Supply and install Local/Remote Switch	Units	2	R 1,000.00	R 500.00	R 3,000.00
1.1.11	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	42	R 400.00	R 250.00	R 27,300.00
1.3	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	2	R 3,000.00	R 2,500.00	R 11,000.00
1.4	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	42		R 300.00	R 12,600.00
1.5	Supply, install and terminate 2.5mm cable from I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits etc	Lot	1		R 10,000.00	R 10,000.00
1.6	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 60,000.00	R 60,000.00
1.7	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.8	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 1,090,728.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT THE GIZENGA SUBSTATION: COST ESTIMATE

BILL 01: GIZENGA SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Unit	2	R 29,000.00	R 1,500.00	R 61,000.00
1.1.9	Switch setup and configuration	Unit	2		R 9,528.00	R 19,056.00
1.1.10	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.11	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Supply and deliver Cat 6, 500M Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	21	R 600.00		R 12,600.00
1.3	Install conduit and cableway for Ethernet cables to Ethernet switches installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.4	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	21		R 300.00	R 6,300.00
1.5	Supply, install and terminate 2.5mm cable from I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits etc	Lot	1		R 10,000.00	R 10,000.00
1.6	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 30,000.00	R 30,000.00
1.7	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.8	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 605,468.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT GLEDHOW SUBSTATION: COST ESTIMATE

BILL 01: GLEDHOW SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Unit	1	R 29,000.00	R 1,500.00	R 30,500.00
1.1.9	Switch setup and configuration	Units	1		R 9,528.00	R 9,528.00
1.1.10	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.11	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Upgrade the existing protection relays with the IEC61850 Protocol	Unit	5		R 2,900.00	R 14,500.00
1.3	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	10	R 600.00		R 6,000.00
1.4	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.5	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	10		R 300.00	R 3,000.00
1.6	Supply, install and terminate 2.5mm cable from (1) isolator signals from control panel to RTAC or relevant IED, (2) control signals from relays to RTAC and (3) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits etc	Lot	1		R 32,000.00	R 32,000.00
1.7	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 35,000.00	R 35,000.00
1.8	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.90	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 597,040.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT GLENHILLS SUBSTATION: COST ESTIMATE

BILL 01: GLENHILLS SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 Inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Unit	1	R 29,000.00	R 1,500.00	R 30,500.00
1.1.9	Switch setup and configuration	Unit	1		R 9,528.00	R 9,528.00
1.1.10	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.11	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Upgrade the existing protection relays with the IEC61850 Protocol	Unit	5		R 2,900.00	R 14,500.00
1.3	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	10	R 600.00		R 6,000.00
1.4	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.5	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	10		R 300.00	R 3,000.00
1.6	Supply, install and terminate 2.5mm cable from (1) Isolator signals from control panel to RTAC or relevant IED, (2) Control signals from relays to RTAC and (3) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits etc	Lot	1		R 32,000.00	R 32,000.00
1.7	Supply, install and terminate RS485/RS232 cables from RTAC to BTU and relays	Unit	5	R 300.00	R 300.00	R 3,000.00
1.8	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 40,000.00	R 40,000.00
1.9	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.1	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 605,040.00

**SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT
GROUTVILLE SUBSTATION: COST ESTIMATE**

BILL 01: GROUTVILLE SUBSTATION

Rev: 1
Date: 1/10/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Unit	1	R 29,000.00	R 1,500.00	R 30,500.00
1.1.9	Switch setup and configuration	Unit	1		R 9,528.00	R 9,528.00
1.1.10	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.11	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	15	R 600.00		R 9,000.00
1.3	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.4	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	15		R 300.00	R 4,500.00
1.5	Supply, install and terminate 2.5mm cable from (1) isolator signals from control panel to RTAC or relevant IED if not wired and (2) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits etc	Lot	1		R 25,000.00	R 25,000.00
1.6	Supply, install and terminate RS232 cables from RTAC to BTU	Unit	1	R 300.00	R 300.00	R 600.00
1.7	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 35,000.00	R 35,000.00
1.8	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.9	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 580,640.00

**SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT
IMBONINI SUBSTATION: COST ESTIMATE**

BILL 01: IMBONINI SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Unit	1	R 29,000.00	R 1,500.00	R 30,500.00
1.1.9	Switch setup and configuration	Unit	1		R 9,528.00	R 9,528.00
1.1.10	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.11	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Upgrade the existing protection relays with the IEC61850 Protocol	Unit	2		R 2,900.00	R 5,800.00
1.3	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	6	R 600.00		R 3,600.00
1.4	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.5	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	6		R 300.00	R 1,800.00
1.6	Supply, install and terminate 2.5mm cable from (1) isolator signals from control panel to RTAC or relevant IED, (2) Control signals from 11kV breaker to RTAC and (3) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits etc	Lot	1		R 32,000.00	R 32,000.00
1.7	Supply, install and terminate RS232 cables from RTAC to relays	Units	11	R 300.00	R 300.00	R 6,600.00
1.8	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 45,000.00	R 45,000.00
1.9	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.10	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 601,340.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT INDUSTRIAL SUBSTATION: COST ESTIMATE

BILL 01: INDUSTRIAL SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Units	1	R 29,000.00	R 1,500.00	R 30,500.00
1.1.9	Switch setup and configuration	Units	1		R 9,528.00	R 9,528.00
1.1.10	Supply and install SEL751 protection relay	Units	2	R 34,543.00	R 3,500.00	R 76,086.00
1.1.11	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.12	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Upgrade the existing protection relays with the IEC61850 Protocol	Unit	2		R 2,900.00	R 5,800.00
1.3	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	13	R 600.00		R 7,800.00
1.4	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.5	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	13		R 300.00	R 3,900.00
1.6	Supply, install and terminate 2.5mm cable from (1) isolator signals from control panel to RTAC or relevant IED, (2) wire control signals from relays to RTAC and (3) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits etc	Lot	1		R 57,000.00	R 57,000.00
1.7	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 45,000.00	R 45,000.00
1.8	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.9	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 702,126.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT LAVOPIERRE SUBSTATION: COST ESTIMATE

BILL 01: LAVOPIERRE SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 Inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Units	2	R 29,000.00	R 1,500.00	R 61,000.00
1.1.9	Switch setup and configuration	Unit	2		R 9,528.00	R 19,056.00
1.1.10	Supply and install I/O Module	Unit	1	R 20,400.00	R 1,500.00	R 21,900.00
1.1.11	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.12	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Upgrade the existing protection relays with the IEC61850 Protocol	Unit	15		R 2,900.00	R 43,500.00
1.3	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	25	R 600.00		R 15,000.00
1.4	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.5	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	25		R 300.00	R 7,500.00
1.6	Supply and deliver multimode fibre cable complete with LC connectors, and cable numbers on both ends	Lot	1		R 8,000.00	R 8,000.00
1.7	Install and terminate fibre cable from substation ethernet switch to SCADA control room. This shall include conduit and cableways, transievers for ethernet switch and testing	Lot	1		R 9,500.00	R 9,500.00
1.8	Supply and install 3CR12 epoxy coated marshalling kiosk to house I/O module in the HV Yard including all accessories such as precast concrete plinth, mounting bolts, etc.	Unit	1	R 15,000.00	R 5,000.00	R 20,000.00
1.9	Supply and Install approx. 50m of 12 Core Multimode Fibre cable from I/O module in HV Yard Kiosk to the switch in the control room. This shall be inclusive of HDPE pipe required, trenching, termination kits and accessories required.	Lot	1		R 40,750.00	R 40,750.00
1.10	Supply, install and terminate 2.5mm cable from (1) isolator signals from HV Yard to I/O module, (2) isolator status signals in control room to relevant IED's, (3) wire control signals from relay and BTU to RTAC and (4) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits, weatherproof panel etc	Lot	1		R 52,000.00	R 52,000.00
1.11	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 40,000.00	R 40,000.00
1.12	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.13	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 804,718.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT SAPPY SUBSTATION: COST ESTIMATE

BILL 01: SAPPY SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Unit	1	R 29,000.00	R 1,500.00	R 30,500.00
1.1.9	Switch setup and configuration	Unit	1		R 9,528.00	R 9,528.00
1.1.10	Supply and install I/O Module	Units	1	R 20,400.00	R 1,500.00	R 21,900.00
1.1.11	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.12	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Upgrade the existing protection relays with the IEC61850 Protocol	Unit	3		R 2,900.00	R 8,700.00
1.3	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	10	R 600.00		R 6,000.00
1.4	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.5	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	10		R 300.00	R 3,000.00
1.6	Supply and install 3CR12 epoxy coated marshalling kiosk to house I/O module in the HV Yard including all accessories such as precast concrete plinth, mounting bolts, etc.	Unit	1	R 15,000.00	R 5,000.00	R 20,000.00
1.7	Supply and Install approx. 50m of 12 Core Multimode Fibre cable from I/O module in HV Yard Kiosk to the switch in the control room. This shall be inclusive of HDPE pipe required, trenching, termination kits and accessories required.	Lot	1		R 40,750.00	R 40,750.00
1.8	Supply, install and terminate 2.5mm cable from (1) isolator signals from HV Yard to I/O module, (2) Isolator signals on control panel to relevant IED's or RTAC, (3) Control signals of relays to RTAC and (4) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits, weatherproof panel etc	Lot	1		R 50,000.00	R 50,000.00
1.9	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 30,000.00	R 30,000.00
1.10	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.11	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 686,890.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT THE SHAKASKRAAL SUBSTATION: COST ESTIMATE

BILL 01: SHAKASKRAAL SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	2	R 25,222.00	R 2,000.00	R 54,444.00
1.1.1	Supply and install Real Time Automation Controller	Unit	2	R 117,500.00	R 2,000.00	R 239,000.00
1.1.2	Supply and install Rugged Computer	Unit	2	R 75,000.00	R 2,000.00	R 154,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	2	R 15,000.00	R 2,500.00	R 35,000.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	2	R 5,000.00	R 1,000.00	R 12,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	2		R 26,000.00	R 52,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	2		R 100,000.00	R 200,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Units	3	R 29,000.00	R 1,500.00	R 91,500.00
1.1.9	Switch setup and configuration	Units	3		R 9,528.00	R 28,584.00
1.1.10	Supply and install SEL751 protection relay	Units	19	R 38,125.00	R 3,500.00	R 790,875.00
1.1.11	Supply and install com ports for Siemens relays with IEC61850	Units	8	R 15,000.00	R 6,500.00	R 172,000.00
1.1.12	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.13	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	40	R 600.00		R 24,000.00
1.3	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Unit	2	R 3,000.00	R 2,500.00	R 11,000.00
1.4	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	40		R 300.00	R 12,000.00
1.5	Supply, install and terminate RS232 cables from RTAC to relays	Units	3	R 300.00	R 300.00	R 1,800.00
1.6	Supply, install and terminate 2.5mm cable from (1) isolator signals from control panel to RTAC or relevant IED, (2) wire control signals from relay and BTU to RTAC and (3) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits etc	Lot	1		R 40,000.00	R 40,000.00
1.7	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 84,000.00	R 84,000.00
1.8	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.9	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 2,089,993.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT SHAKAS ROCK SUBSTATION: COST ESTIMATE

BILL 01: SHAKAS ROCK SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 Inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Unit	1	R 29,000.00	R 1,500.00	R 30,500.00
1.1.9	Switch setup and configuration	Unit	1		R 9,528.00	R 9,528.00
1.1.10	Supply and install serial port server	Unit	1	R 32,760.00	R 1,500.00	R 34,260.00
1.1.11	Serial Port Server setup and configuration	Unit	1		R 6,500.00	R 6,500.00
1.1.12	Supply and install I/O Module	Unit	1	R 17,472.00	R 1,500.00	R 18,972.00
1.1.13	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.14	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Upgrade the existing protection relays with the IEC61850 Protocol	Unit	2		R 2,900.00	R 5,800.00
1.3	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	11	R 600.00		R 6,600.00
1.4	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.5	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	11		R 300.00	R 3,300.00
1.6	Supply and install 3CR12 epoxy coated marshalling kiosk to house I/O module in the HV Yard including all accessories such as precast concrete plinth, mounting bolts, etc.	Unit	1	R 15,000.00	R 5,000.00	R 20,000.00
1.7	Supply and Install approx. 50m of 12 Core Multimode Fibre cable from I/O module in HV Yard Kiosk to the switch in the control room. This shall be inclusive of HDPE pipe required, trenching, termination kits and accessories required.	Lot	1		R 40,750.00	R 40,750.00
1.8	Supply, install and terminate 2.5mm cable from (1) isolator signals from HV Yard to I/O module, (2) wire control signals from control panel and BTU to RTAC and (3) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits, etc	Lot	1		R 50,000.00	R 50,000.00
1.9	Supply, install and terminate RS232 cables from serial port server to relays	Units	10	R 300.00	R 300.00	R 6,000.00
1.10	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 45,000.00	R 45,000.00
1.11	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.12	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 743,722.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT SHEFFIELD SUBSTATION: COST ESTIMATE

BILL 01: SHEFFIELD SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Units	2	R 29,000.00	R 1,500.00	R 61,000.00
1.1.9	Switch setup and configuration	Units	2		R 9,528.00	R 19,056.00
1.1.10	Supply and install SEL751 relay	Units	9	R 38,125.00	R 3,500.00	R 374,625.00
1.1.11	Supply and install SEL787 relay	Units	2	R 73,225.00	R 25,000.00	R 196,450.00
1.1.12	Supply and install com ports for Siemens relays with IEC61850	Units	4	R 15,000.00	R 6,500.00	R 86,000.00
1.1.13	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.14	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	19	R 600.00		R 11,400.00
1.3	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.4	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	19		R 300.00	R 5,700.00
1.5	Supply, install and terminate 2.5mm cable from (1) isolator signals from control panel to RTAC or relevant IED, (2) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits etc	Lot	1		R 25,000.00	R 25,000.00
1.6	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 45,000.00	R 45,000.00
1.7	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.8	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 1,290,743.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT THE STANGER POS SUBSTATION: COST ESTIMATE

BILL 01: STANGER POS SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI workstation functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Unit	1	R 29,000.00	R 1,500.00	R 30,500.00
1.1.9	Switch setup and configuration	Unit	1		R 9,528.00	R 9,528.00
1.1.10	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.11	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Upgrade the existing protection relays with the IEC61850 Protocol	Unit	4		R 2,900.00	R 11,600.00
1.3	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	14	R 600.00		R 8,400.00
1.4	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.5	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	14		R 300.00	R 4,200.00
1.6	Supply, install and terminate 2.5mm cable from (1) isolator signals from control panel to RTAC or relevant IED and (2) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits etc	Lot	1		R 13,500.00	R 13,500.00
1.7	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 35,000.00	R 35,000.00
1.8	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.9	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
1.10	Sub Total (excl VAT)					R 579,240.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT ZIMBALI SUBSTATION: COST ESTIMATE

BILL 01: ZIMBALI SUBSTATION

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	1	R 25,222.00	R 2,000.00	R 27,222.00
1.1.1	Supply and install Real Time Automation Controller	Unit	1	R 117,500.00	R 2,000.00	R 119,500.00
1.1.2	Supply and install Rugged Computer	Unit	1	R 75,000.00	R 2,000.00	R 77,000.00
1.1.3	Supply and deliver 19 inch screen for SHMI including video cable	Unit	1	R 15,000.00	R 2,500.00	R 17,500.00
1.1.4	Supply and deliver Mouse and keyboard for SHMI	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.1.5	Software installation and designing of SHMI computer	Unit	1		R 26,000.00	R 26,000.00
1.1.6	Testing and verification of SHMI computer functionality	Unit	1		R 100,000.00	R 100,000.00
1.1.7	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.8	Supply and install 24 port managed ethernet switch	Unit	1	R 29,000.00	R 1,500.00	R 30,500.00
1.1.9	Switch setup and configuration	Unit	1		R 9,528.00	R 9,528.00
1.1.10	Supply and install Local/Remote Switch	Unit	1	R 1,000.00	R 500.00	R 1,500.00
1.1.11	Supply and install industrial dual sim modem	Unit	1	R 14,600.00	R 500.00	R 15,100.00
1.2	Upgrade the existing protection relays with the IEC61850 Protocol	Unit	2		R 2,900.00	R 5,800.00
1.3	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	7	R 600.00		R 4,200.00
1.4	Install conduit and cableway for Ethernet cables to Ethernet switch installed inside SHMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.5	Install and terminate Ethernet cables from IED's to Ethernet switches inside the SHMI panel	Units	7		R 300.00	R 2,100.00
1.6	Supply, install and terminate 2.5mm cable from (1) isolator signals from control panel to RTAC or relevant IED, (2) Control signals from 11kV breaker to RTAC and (3) I/O signals within substation to RTAC with cable numbers on both ends. This shall be inclusive of all accessories such as ferrules, limit switches, glands, conduits etc	Lot	1		R 40,000.00	R 40,000.00
1.7	Supply, install and terminate RS232 cables from RTAC to relays	Units	7	R 300.00	R 300.00	R 4,200.00
1.8	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 40,000.00	R 40,000.00
1.9	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.10	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 602,840.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT MANDENI LOCAL MUNICIPALITY INTAKE POINT: COST ESTIMATE

BILL 01: MANDENI LOCAL MUNICIPALITY INTAKE POINT

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply and install industrial dual sim modem with GPS	Unit	1	R 21,800.00	R 500.00	R 22,300.00
1.2	Supply, install and terminate RS232 cables from modem to autorecloser	Unit	1	R 300.00	R 300.00	R 600.00
1.3	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 25,000.00	R 25,000.00
1.4	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.5	End of job documentation	Lot	1		R 5,000.00	R 5,000.00
	Sub Total (excl VAT)					R 60,900.00

SUPPLY, DELIVERY, INSTALLATION AND COMMISSIONING OF SUBSTATION COMMUNICATIONS NETWORK, RELATED MATERIALS AND SERVICES AT KWADUKUZA MUNICIPALITY CONTROL CENTRE: COST ESTIMATE

BILL 01: CONTROL CENTRE

Rev: 1
Date: 4/9/2019

Item	Description	Unit	Qty	Supply	Install	Amount
1.1	Supply delivery and installation of 42U swing frame panel, for the SHMI, rugged computer, RTAC and ethernet switches installation	Unit	2	R 25,222.00	R 2,000.00	R 54,444.00
1.1.1	Supply and install Real Time Automation Controller	Unit	2	R 117,500.00	R 2,000.00	R 239,000.00
1.1.2	Supply and install Rugged Computer	Unit	2	R 75,000.00	R 2,000.00	R 154,000.00
1.1.3	Supply and installation of SCADA Software onto the computer. It shall include: - Unlimited server tags - GIS Editor and Control - Historian SQL Server Interface - Reporting - Message Control (SMS & Email functionality for alarms)	Unit	2	R 205,000.00	R 26,000.00	R 462,000.00
1.1.4	Client Web Server Interface (3 users)	Unit	1	R 110,525.00	R 10,000.00	R 120,525.00
1.1.5	Testing and verification of the computer functionality	Unit	2		R 100,000.00	R 200,000.00
1.1.6	Supply, deliver and install satellite synchronised clock and associated antenna with antenna cable, surge protector, mounting kit and co-axial cable for connection to the RTAC	Unit	1	R 29,190.00	R 2,000.00	R 31,190.00
1.1.7	Supply and install 24 port managed ethernet switch	Unit	2	R 33,670.00	R 1,500.00	R 70,340.00
1.1.8	Switch setup and configuration	Unit	2		R 9,528.00	R 19,056.00
1.1.9	Supply and install industrial dual sim modem	Unit	2	R 14,600.00	R 500.00	R 30,200.00
1.2	Supply and install 23 Inch screen for workstation inclusive of dual screen with single desk mount stand.	Unit	4	R 20,000.00	R 2,500.00	R 90,000.00
1.3	Supply and install 65 Inch screen as SCADA Displays	Unit	2	R 40,000.00	R 2,500.00	R 85,000.00
1.4	Supply and install Mouse and keyboard for workstation	Unit	2	R 950.00	R 200.00	R 2,300.00
1.5	Supply, deliver and Install Printer	Unit	1	R 5,000.00	R 1,000.00	R 6,000.00
1.6	Supply and Install a Data Server	Unit	2	R 250,000.00	R 50,000.00	R 600,000.00
1.7	Supply, delivery and installation of a Swing Panel for the Data Server	Unit	1	R 21,222.00	R 2,000.00	R 23,222.00
1.8	Supply, deliver and Install Single Phase - 10kVA UPS	Unit	1	R 158,360.00	R 8,000.00	R 166,360.00
1.9	Supply, deliver and Install a 22kVA Generator inclusive of transfer switch, cables and cable trays	Unit	1	R 166,500.00	R 20,000.00	R 186,500.00
1.10	Supply, deliver and Install a bundwall with a plinth for the 22kVA Generator inclusive of all labour works, materials and accessories	Unit	1		R 40,000.00	R 40,000.00
1.11	Supply, deliver and Install Office Furniture (Desk and Chairs)	Unit	1	R 226,000.00		R 226,000.00
1.12	Supply and deliver Cat 6, STP Ethernet cables complete with RJ45 connectors, and cable numbers on both ends	Units	15	R 600.00		R 9,000.00
1.13	Install trunking and cableway for Ethernet cables to Ethernet switch installed inside HMI panel	Units	1	R 3,000.00	R 2,500.00	R 5,500.00
1.14	Install and terminate Ethernet cables to SCADA equipment in control room	Units	15		R 300.00	R 4,500.00
1.15	Supply and Install swing frame fibre patch panel inclusive of termination rack, brush panel and patch leads to equipment	Unit	1	15000	R 2,000.00	R 17,000.00
1.16	Testing and commissioning (Including testing and commissioning reports and sign-off's)	Lot	1		R 65,000.00	R 65,000.00
1.17	As Built Network design documentation	Lot	1		R 8,000.00	R 8,000.00
1.18	End of job documentation	Lot	1		R 32,000.00	R 32,000.00
	Sub Total (excl VAT)					R 2,947,137.00

Document prepared by

Aurecon South Africa (Pty) Ltd

Reg No 1977/003711/07

First Floor

West Building

Milkwood Office Park

Cnr Umhlanga Rocks &

Douglas Saunders Drive

La Lucia Ridge 4019

Durban

PO Box 335

Umhlanga Rocks 4320

South Africa

T +27 31 575 5500

F +27 86 244 9177

E ethekwini@aurecongroup.com

W aurecongroup.com

aurecon

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to life*

Aurecon offices are located in:

Angola, Australia, Botswana, China,
Ghana, Hong Kong, Indonesia, Kenya,
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