

**SOUTHERN REGION**

**PROTECTION, TELECONTROL, METERING  
& DC DESIGN**



**KING WILLIAMS TOWN SUBSTATION**

**REFURBISHMENT PROJECT (2 x Distance FDRs)**

**WEF203/C.DS 00068**

**FUNCTIONAL SCOPE OF WORKS**

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# TABLE OF CONTENTS

	Page Numbers
1. PROTECTION DESIGN .....	2
1.1 Protection design (Pembroke 66kV Feeder 1- 4FZD3940) .....	2
1.2 Protection design (Good Hope Textiles 66kV Feeder 2- 4FZD3940) .....	4
1.3 66kV Buszone- 3BT-2301 .....	5
1.4 Sherlog Fault Recorder .....	6
1.5 Batteries & Charger .....	8
1.6 AC/DC Distribution .....	9
2. CONTROL BUILDING .....	10
3. TELECONTROL DESIGN .....	11
3.1 Control Room Layout .....	11
3.2 Supervisory/Telecontrol Design .....	11
3.3 Equipment Requirements .....	11
3.4 Communication Medium .....	11
3.5 Power Requirements .....	11
3.6 Teleprotection .....	11
4. REMOTE ACCESS .....	12
5. STAKEHOLDERS .....	13
6. BILL OF MATERIALS .....	14

# 1. PROTECTION DESIGN

## Executive Summary

The refurbishment of Good Hope Textiles has led to the initiation of a project at King Williams Town Substation- to replace 2x 66kV feeder protection schemes (3FZ3940) for Good Hope Textiles feeder & Pembroke feeder with a new 4FZD3940 Diff/distance schemes. This is to achieve matched protection schemes with communication (i.e. unit protection) over the protected lines. Teleprotection will be achieved through OPGW which will be interconnecting King Williams Town Substation, Good Hope Textiles Substation, Fort Murray Substation, Pembroke, etc. The decommissioned schemes (3FZ3941) will be retained by ED Technology (A .Craib) as spares; they must be sent to Rotran Warehouse.

### 1.1. Pembroke 66kV Feeder 1 – 4FZD3940

The New ABB 4FZD3940 single pole distance scheme has a RED670 main protection relay and the REF615 directional backup protection relay. The scheme offers current differential protection and/or distance protection. **The 66kV line between King Williams Town and Pembroke substation is approximately 16,2km in length.**

This scheme comes standard with the following items:

- DNP3 on RS485 for SCADA
- RED670 internal fibre tele-protection card, 1550nm, 27db (100km)
- Hardwired protection not healthy alarm
- External time synch on REF615

The following ordering options must be ordered with the scheme:

- Communication cable for the RED670 & REF615
- Additional supervisory binary output card
- Additional disturbance output card
- Fibre attenuators (calculations to be done prior to ordering)
- DC/DC (110/48V) tele-protection power supply
- RED670 external time synch module
- IEC61850 remote engineering access via Ethernet
- Busbar voltage selection
- Three phase Actom iSTAT transducer
- Volt meter (66kV)
- Ammeter (ratio 600/1)
- Primary plant bypass with CT shorting relays
- Crating of scheme
- RuggedCom RS900HI-D-MT-MT-MT switch which ABB will fit into the scheme

The following details are important regarding the designs:

1. The scheme will be installed in a separate swing frame cabinet.
2. **An existing 66kV three-pole breaker will be used on this feeder.**
3. A MCB for the supplies on the protection circuits for busbar 1 must be replaced with a 10A triple-pole MCB complete with auxiliary contacts. The auxiliary contacts are to be wired as per the drawings.
4. A Remote Access RASM of type A will be installed in the feeder panel. The Moxa Nport (IA5250) will be connected to a spare Ethernet port on the RuggedCom switch. The transducer will be remotely accessed via it's RS485 through the Moxa N-Port.
5. All isolator's open & closed indication must be wired to the IDF for supervisory indication. Double bit indication must be used; 'M' type contacts should be used for the close indication and 'N' type contacts should be used for the open indication.
6. The SF6 low gas alarm (*not* the low gas *block* alarm) must be wired to the IDF for supervisory indication.
7. The RED670 & REF615 relay use the IRIGB-002 un-modulated time synchronisation protocol. The time synchronisation connection to the relay is made via a single IBTS703R GPS receiver isolation unit which is fitted on the Remote Access RASM. See section 6 for more detail.

8. The CBNH circuit needs to be split into two separate blocking and non-blocking CBNH circuits (in the circuit breaker mechanism box) in order to prevent the circuit breaker from being unnecessarily blocked from closing under certain alarm conditions. The resulting CBNH circuits should be wired as follows:
  - CBNH non-blocking should contain:
    - The ON/OFF switch of the circuit breaker.
    - The motor protective switch.
    - The heater thermal switch.
  - CBNH blocking should contain:
    - The SF6 low gas blocks alarm.
9. The scheme will be ordered with the disturbance recorder option for easy connection to the Sherlog recorder. ED Technology will change the masking on this relay (due to the use of serial SCADA) to free up the binary points previously used for hard-wired distance to fault and allocate them as per the drawings.

#### Scheme Description:

##### 4FZD3940 Production Unit Scheme Single-Pole For 110 Volt DC With 1amp CT Inputs.

Single-Pole/3 pole Tripping (For Triple Mechanism CB's).  
 Distance/Differential Protection. Directional Overcurrent And Earth Fault Protection: - Breaker Fail; Auto-Reclose; Synchro-Check; Measurement Circuit.

Including :-

- 1x RED670 (Version 1.2) Main Protection Dist/Diff Relay, IEC61850 REA Comm.
- 1x REF615 Directional Back-Up Protection Relay With O/C, E/F, 100Base Fx multimode Fx 1300 nanometre for REA Comm.
- DNP3.0 Protocol On RS-485 For SCADA Indication & Control.
- 1550nm 27db OB Internal Teleprotection And Communication Fibre Card (LDCm1).
- Protection Not Healthy Hardwired Supervisory Alarm.
- External Time Synchronisation Input On Back-Up Protection Relay.
- Material, Scheme Assembly And Wiring To Eskom Master Drawings D-DT-15008.

To Specify :-

- Supervisory Hardwired Controls And Alarms Option.
- Disturbance Recorder External Option.
- Voltage Selector Relays For Double Busbar.
- Bypass CT Primary Plant Option.
- 110/48v DC Converter For Power Line Carrier circuit.
- IEC61850 Testing And Remote Engineering Access Option.
- External Time Synchronisation On RED670 Relay Option.
- Ammeter And Voltmeter (0-5ma) Instruments 48mm, 90deg. Blank Scale.
- Pre-Calibrated Volt (Pre-Calibration Of Volt (110/66000. 5mA = 66kV, Full Scale Deflection= 80kV & Amp (600/1. 5Ma = 600A Meters, Full Scale Deflection =600A.
- Istat Transducer Three-Phase. (order separately)
- Crating For Scheme Transport.
- RuggedComm RS900 ethernet switch with 3 x multi-mode F/O ports P7-9 (ST connectors), 110VDC

10. The feeder scheme by-pass facility:-

There is no bypass facility at King Williams Town SS substation on the Pembroke 1 feeder.  
 There is no Bypass facility at Pembroke SS King Williams Town 1 feeder.

## 1.2. Good Hope Textiles 66kV Feeder 2 – 4FZD3940

The New ABB 4FZD3940 single pole distance scheme has a RED670 main protection relay and the REF615 directional backup protection relay. The scheme offers current differential protection and/or distance protection. **The 66kV line between King Williams Town and Good Hope Textile substation is approximately 5,9km in length.**

This scheme comes standard with the following items:

- DNP3 on RS485 for SCADA
- RED670 internal fibre teleprotection card, 1550nm, 27db (100km)
- Hardwired protection not healthy alarm
- External time synch on REF615

The following ordering options must be ordered with the scheme:

- Communication cable for the RED670 & REF615
- Additional supervisory binary output card
- Additional disturbance output card
- Fibre attenuators (calculations to be done prior to ordering)
- DC/DC (110/48V) tele-protection power supply
- RED670 external time synch module
- IEC61850 remote engineering access via Ethernet
- Busbar voltage selection
- Three phase Actom iSTAT transducer
- Volt meter (66kV)
- Ammeter (ratio 600/1)
- Primary plant bypass with CT shorting relays
- Crating of scheme
- RuggedCom RS900HI-D-MT-MT-MT switch which ABB will fit into the scheme

The following details are important regarding the designs:

11. The scheme will be installed in a separate swing frame cabinet.
12. An existing 66kV three-pole breaker will be used on this feeder. Therefore the RED670 settings must select 3pole ARC only. The ARC "1+3P" push button is to have a label stating 'on standby'.
13. A MCB for the supplies on the protection circuits for busbar 1 must be replaced with a 10A triple-pole MCB complete with auxiliary contacts. The auxiliary contacts are to be wired as per the drawings.
14. A Remote Access RASM of type A will be installed in the feeder panel. The Moxa Nport (IA5250) will be connected to a spare Ethernet port on the RuggedCom switch. The transducer will be remotely accessed via it's RS485 through the Moxa N-Port.
15. All isolator's open & closed indication must be wired to the IDF for supervisory indication. Double bit indication must be used; 'M' type contacts should be used for the close indication and 'N' type contacts should be used for the open indication.
16. The SF6 low gas alarm (*not* the low gas *block* alarm) must be wired to the IDF for supervisory indication.
17. The RED670 & REF615 relay use the IIRGB-002 un-modulated time synchronisation protocol. The time synchronisation connection to the relay is made via a single IBTS703R GPS receiver isolation unit which is fitted on the Remote Access RASM. See section 6 for more detail.
18. The feeder scheme by-pass facility:-  
There is no bypass facility at King Williams Town SS substation on the Good Hope Textiles 1 feeder. However there is a Bypass facility at Good Hope Textiles SS King Williams Town 1 feeder. When the feeder is put on bypass, the diff scheme at King Williams Town substation needs to be blocked automatically. The G-type bypass isolator contact input to the RED670 at Good Hope Textiles SS on the King Williams Town 1 feeder will be used to automatically switch the differential state at King Williams Town SS.
  - a. The Good Hope Textiles feeder masking at King William substation must use the output from the remote terminal function within the relay to select 3-pole ARC 'ON' (i.e. if the ARC is set 'ON' prior to receiving the signal).
  - b. At King Williams Town substation on the Good Hope Textiles feeder, the differential block selection must automatically reset to its original state (prior to the bypass), when the bypass is removed at Good Hope Textiles substation on the King Williams Town 1 feeder.

9. The CBNH circuit needs to be split into two separate blocking and non-blocking CBNH circuits (in the circuit breaker mechanism box) in order to prevent the circuit breaker from being unnecessarily blocked from closing under certain alarm conditions. The resulting CBNH circuits should be wired as follows:
  - CBNH non-blocking should contain:
    - The ON/OFF switch of the circuit breaker.
    - The motor protective switch.
    - The heater thermal switch.
  - CBNH blocking should contain:
    - The SF6 low gas block alarm.
10. The scheme will be ordered with the disturbance recorder option for easy connection to the Sherlog recorder. ED Technology will change the masking on this relay (due to the use of serial SCADA) to free up the binary points previously used for hard-wired distance to fault and allocate them as per the drawings.

#### **Scheme Description:**

##### **4FZD3940 Production Unit Scheme Single-Pole For 110 Volt DC With 1amp CT Inputs.**

Single-Pole/3 pole Tripping (For Triple Mechanism CB's).  
 Distance/Differential Protection. Directional Overcurrent And Earth Fault Protection: - Breaker Fail; Auto-Reclose; Synchro-Check; Measurement Circuit.

Including :-

- 1x RED670 (Version 1.2) Main Protection Dist/Diff Relay, IEC61850 REA Comm.
- 1x REF615 Directional Back-Up Protection Relay With O/C, E/F, 100Base Fx multimode Fx 1300 nanometre for REA Comm.
- DNP3.0 Protocol On RS-485 For SCADA Indication & Control.
- 1550nm 27db OB Internal Teleprotection And Communication Fibre Card (LDCm1).
- Protection Not Healthy Hardwired Supervisory Alarm.
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To Specify :-

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- Bypass CT Primary Plant Option.
- 110/48v DC Converter For Power Line Carrier circuit.
- IEC61850 Testing And Remote Engineering Access Option.
- External Time Synchronisation On RED670 Relay Option.
- Ammeter And Voltmeter (0-5ma) Instruments 48mm, 90deg. Blank Scale.
  - Pre-Calibration Of Volt (110/66000. 5mA = 66kV, Full Scale Deflection= 80kV & Amp (600/1. = 600A Meters, Full Scale Deflection =600A.
- Istat Transducer Three-Phase (order separately).
- Crating For Scheme Transport.
- RuggedComm RS900 ethernet switch with 3 x multi-mode F/O ports P7-9 (ST connectors), 110VDC

### 1.3 66kV Buszone – 3BP-2301

The buszone ratio will be 500/1. The Good Hope Textiles and Pembroke feeder forms part of the existing 66kV Buszone.

### 1.4 Sherlog Fault Recorder

The Sherlog fault recorder will be installed in the substation. The recorder is suitably sized to accommodate the selected binary and analogue points for current and future expansions to the substation. The Sherlog fault recorder consists of 2 units interconnected together for complete analysis capability. Recorder panel will be installed between Remote access Panel and BME & Fibre Optic panel. The panel will be equipped with all the terminals for the connection to the actual plant. The panel must be built as per the drawings and standards provided.

Both units will be individually connected to the EDnet switch from its respective port. Each unit will also connect individually to a serial port on the PC. Com ports 3&4 should be used. These connections will ensure fast and reliable access to the units for fault analysis and downloading. EDFS must build a BTP (Bay Terminal Plate) as per the provided designs for each panel to be monitored, except for the 66kV feeders, which come pre-built with an interface terminal strip.

Bay	Current Analogue	Voltage Analogue	Binary
66kV Fdr 1	4	1	16
66kV Fdr 2	4	1	16
66kV Fdr 3	4	1	16
66kV Buszone			9
66kV Bussection 1			2
66kV Bussection 2			2
66kV Busbar 1A		3	
66kV Busbar 1B		3	
66kV Busbar 1C		3	
66kV Busbar 2		3	
66/11kV Trfr 1	8		18
66/11kV Trfr 1 OLTC			8
66/11kV Trfr 2	8		18
66/11kV Trfr 2 OLTC			8

66/11kV Trfr 3	8		18
66/11kV Trfr 3 OLTC			8
11kV Busbar 1		3	1
11kV Busbar 2		3	1
11kV Bus Coupler			2
11kV Fdr 1	2		5
11kV Fdr 2	2		5
UFLS			2
Spare	0	3	101
Total	40	24	256
Recorder Size:	64	Analogues	
	256	Binaries	
Total number of units:	2		

## 1.5 110V Batteries & Charger

An 110V lead acid battery bank with 52 FCP11 cells will be installed. The battery stand will be double row stepped tier. A single phase 25 Amp charger will be installed. The designer must ensure that the supply MCB for the charger is rated high enough to carry the charger supply current. The charger will be supplied with DEHNrail surge protection device with auxiliary contacts and alarm output cards for SCADA alarming.

Cable entries must be installed for each battery bank and they must be sealed after commissioning.

The distance from EDFs (DC) base site to King Williams Town is less than 200km, as per the guideline, a standby time of at least 12hrs is therefore required. The 192AH bank which is to be installed will provide a standby time of 12.1 hours at 80% efficiency with a predicted load of 12.73A.

**Table 1: DC Requirements**

Site Name	Fort Murry Sub Rev 1	
	Description of material	
Battery Charger 110VDC	Battery Charger 110VDC 30A - RV10 - 3Ph/1x63A Charger Isolator/1x63A Battery Isolator/1x63A Load Isolator/4x63A Load MCBs/AC Surge with trip alarm (SimDEHN)/Non-self contained (W 800 x D 600mm)	
Battery Charger 48VDC	None	
	Description of material	
Type of cells 110VDC	Lead Acid	
Type of cells 48VDC	None	
	Description of material	
Number of cells 110VDC		52
Number of cells 48VDC	None	
	Description of material	SAP Nr
Cells for 110VDC	FIRST IAT BATTERY - CELL, WET BATTERY FLAT PLATE 2V 192Ah D9307 (FCP13)	0255533
Cells for 48VDC	None	None
	Description of material	SAP Nr
Battery Stand for 110VDC	STAND Double Row Single Tier Stepped, Laminated Pine 52 Cells AH RANGE 1 (FCP05 (64Ah), FCP07 (96Ah), FCP11 (160Ah) & FCP13 (192Ah)) DRSTS D9211	0014091
Battery Stand for 48VDC	None	None
	Description of material	
Battery Cabinets (NiCad Only)	None	
	Description of material	SAP Nr
Battery Terminating Devices (Pb-Acid)	Terminating device per pair (Pos-Neg) - Type #1 D9306 (FCP05, FCP07, FCP11 & FCP13)	0255484
Battery Terminating Devices (Pb-Acid)	None	None
	Description of material	SAP Nr
Inter-row connectors	CONNECTOR CELL INTER-ROW TYPE 1 D9306 (FCP05, FCP07, FCP11 & FCP13) DRST Stand	0255491
Inter-row connectors	None	None
	Description of material	SAP Nr
Spares & Safety Equipment	Jug	0014404
Spares & Safety Equipment	Funnel	0014405
Spares & Safety Equipment	Anti-corrosion lubricant (at least 250ml)	None
Spares & Safety Equipment	Hydrometer	0014402
Spares & Safety Equipment	Thermometer	0014403
Spares & Safety Equipment	Maintenance & safety equipment board / rack (Excludes Maintenance equipment and PPE)	0256065
Spares & Safety Equipment	Lead acid battery 54 cell logbook	0209843
Spares & Safety Equipment	Rubber gloves (Re-usable)	0016896
Spares & Safety Equipment	Battery stand touch-up paint (1000ml)	0256067
Spares & Safety Equipment	Paint brush - 50mm wide	0250068
Spares & Safety Equipment	Battery room safety sign, DCSS1	0186195
Spares & Safety Equipment	Eyewash bottle - sealed	0256069
Spares & Safety Equipment	Faceshield	0016897
Spares & Safety Equipment	Rubber gloves (Re-usable)	0016896

## 1.6 AC & DC Distribution Design

A DC distribution panel and AC distribution panel will be installed in the building. The substation AC auxiliary supply will be obtained from the 100A MCB of the 66/11kV TRFR1 NEC and 66/11kV TRFR2 NEC.

The new DC panel will be fitted with the following modules:

DC Modules				
QTY	SCHEME (MANUF)	MODULE DESCRIPTION	OPTIONS (MODULE) DESCRIP	ENC
2	Various	DC panel	2AD1500 [Main DC supply (1*D/P 60A isol, 10*D/P 32A MCB)]	1 None
1			2AD1900 [Backup DC supply (1*D/P 60A isol, 10*D/P 32A MCB)]	
1			2AD1700 110VDC Spring Rewind module (8*32A double pole MCB's with aux. contacts & 60A isolator)	
1			Swing frame cabinet bottom entry	

The AC panel will be fitted with the following modules:

AC Modules				
QTY	SCHEME (MANUF)	MODULE DESCRIPTION	OPTIONS (MODULE) DESCRIP	ENC
1	Various	AC panel	2AD1100 AC control module (Voltmeter, Control circuit MCB's and AC Fail detection)	2 None
1			2AD1400 Chop over module	
1			2AD1400 contactor	
2			2AD1300 3Ø 400V AC Distribution module (5 x 32 amp 3 pole MCB's )	
2			2AD1200 220V 1Ø AC distribution module (10 X 10 amp 1 pole MCB's)	
1			Yard lighting module 2AD2100	
1			2AD1800 AC supply module	
1			Swing frame cabinet bottom entry	

Three DEHNblock Maxi surge protection units (Part: 900026) must be fitted after the MCB on each phase of the NECRT. A bridge piece (Part: 900611) must be ordered for the NECRT as this simplifies the connection of the DEHN devices. Note the neutral must not be taken through a surge arrester and must be earthed directly.

AC and DC light will be installed in the control room. All the emergency lights must be switched via the 60-min mechanical timer situated at the relay room door. The cabling contractor must cable the emergency lights DC supply to an enclosure in the cable trench from where the building contractor will wire the supply to the emergency lights via the 60 min timer.

The yard light switch must be mounted outside the relay room door; this will operate a contactor on the yard lighting module fitted in the AC distribution panel, from where the yard light power distribution will be done. The yard lighting module will be fitted with a supply selection switch which will facilitate the connection of a generator via the generator supply box to supply the two strategically positioned yard light fittings in emergency conditions. The yard lights can be remotely

The generator supply box would be connected via a 10m length of captyre with a 15A plug at the end. The captyre would be stored inside the stainless steel box positioned outside the building in the substation yard to supply selected AC yard lights via the AC panel. A lockable handle must be fitted on this enclosure and it must be kept locked (this generator is existing it does not need to ordered).

A new brick similar to type A control room will be built and split into two separate rooms, one being the relay room and the other being the battery room. The relay and battery room should be constructed in such a way so as to cater for expansion of the substation at a later stage. The battery room need to comply with specification for Battery Room (DSP 34-479) and standards for a lead acid battery room this includes an extractor fan, correct basin and taps, safety board and light fittings. The relay room must be fitted with a suitably sized air conditioner. Emergency lights will be fitted in both relay and battery rooms. All these lights will be switched by the new 60min timer located at the relay room door.

COC wiring certificate needs to be issued for the battery room and relay room

Architectural floor plan of the first floor of the 'Korona' building. The plan shows a large central hall with a staircase, surrounded by various rooms and corridors. Rooms are labeled with numbers and names in Russian. The plan is color-coded: green for rooms 1-10, yellow for rooms 11-20, and red for rooms 21-30. The building has a complex layout with multiple entrances and exits.

### **3 TELECONTROL DESIGN**

#### **3.1 Control Room Layout**

Refer to substation floor plan.

#### **3.2 Supervisory/Telecontrol design**

A GE D20 RTU and Krone IDF will be installed in the control room to accommodate all the I/O requirements of the new sub-station. The RTU will communicate via a BME managed X21 link to SMART. The communication protocol will be NDP3. Krone free standing 2 x 80 way IDF will be mounted.

#### **3.3 Equipment Requirements**

A GE D20 RTU will be installed as per the floor plan.

#### **3.3 Equipment Requirements**

- 1 x GE D20 RTU (512DI, 96AI & 128SCO), built into a PB8 SFC, complete with PSU and all IDF cabling.
- Krone IDF equipment
- Temperature sensor which will be monitored by smart via the RTU. Temperature sensor to be mounted in control room.

#### **3.4 Communication Medium**

The RTU will communicate with SMART on a BME managed X21 circuit @ 9600 Bd.

#### **3.5 Power Requirements**

The RTU will be powered from the station 110VDC supply.

#### **3.6 Teleprotection**

Teleprotection on the [Pembroke](#) 66kV feeder and [Good Hope Textiles](#) 66kV feeder will be via OPGW.

## 4 REMOTE ENGINEERING ACCESS & TIME SYNCHRONISATION

### 4.1 Remote Access

1. A remote access computer will be installed in the combined remote access and recorder panel and will be connected directly to the 8 port switch. A Juniper router with 4x X.21 interfaces and 2x Ethernet interfaces with the 110 VDC option 19" rack mountable and installed in a remote access. the recorder/remote access panel will be connected to the 8 port switch and will provide access to the substation network through an X21 circuit.
2. Both the switch and router will be powered by a separate 110/12Vdc Meanwell MDR-40-12 power supply. (Input: 85-264VAC or 110-370VDC, Output: 12VDC Max 3.33A).
3. All the schemes which have remote access capabilities will be multi-dropped via a Remote Access BTP to the 8 port switch. For better redundancy the multi-drop link will be closed to the switch. Two cables must therefore be connected from the plant to form a closed loop. Screened Ethernet cable will be used and must be placed in suitable conduit (SZ09 kaprisouple) specified by EDNS to prevent any damage in trenches and cabling ducts.
4. Each panel requiring remote access will be fitted with an application specific Remote Access BTP. There are three types of Remote Access & Time Synch Modules (RASM); the various components they consist of are as follows:
  - Remote Access & Time Synch Module (RASM) Type A (Standard):
    - 5U blanking pate.
    - 2A double pole C-curve MCB
    - Meanwell MDR-20-12 power supply.
    - Moxa Nport (IA5250) 2 port serial to Ethernet converter.
    - IBTS703R GPS receiver isolation unit.
  - Remote Access & Time Synch Module (RASM) Type A (Standard):
    - 5U blanking pate.
    - 2A double pole C-curve MCB
    - Meanwell MDR-20-12 power supply.
    - Moxa Nport (IA5250) 2 port serial to Ethernet converter.
    - IBTS703R GPS receiver isolation unit.
  - Remote Access & Time Synch Module (RASM) Type B (Transformer):
    - 5U blanking pate.
    - 2A double pole C-curve MCB.
    - Meanwell MDR-20-12 power supply.
    - 2 x Moxa Nport (IA5250) 2 port serial to Ethernet converter.
    - IBTS703R GPS receiver isolation unit.
5. The RASM will be powered from the schemes' 110V back-up DC supply (where available). The supply must be taken before the DC isolating switch and the scheme MCB. The Remote Access BTP will be supplied by EDNS.

There will be two Sherlog recorder units, each with 32 analogue inputs and 128 binary inputs. Each unit must be connected directly to the the Moxa PT 7728-R-HV switch on the PM-7200 8TX module ports via their own Ethernet cable which is supplied with the unit.

6. The recorder and remote access will require two double entry panels with glass front doors; Adlerac Gold (1R-19-843) 43U panels will be used.

## 5 STAKEHOLDERS

The following stakeholders were involved:

- M. Hloma - Design Engineer (Protection)
- W van Heerden - Design Engineer (Telecontrol)
- R McLaren - Control Plant Maintenance Ducats (Protection & DC)
- P Hobson - Control Plant Maintenance Ducats (Metering)
- A Craib - PTM&C/Group Technology & Commercial
- G Geddie - Network Operations & Support
- J Enslin - Group Technology - Eastern Cape
- N Ntsunguzi - NS Project Engineering
- B Mutangadura - NS Project Engineering

## 6 BILL OF MATERIALS

- 2 \* 132kV single pole impedance schemes (4FZD3940)
- 2 \* Perano 3CR12 VTJB for synch check
- 8 \* Swing-frame cabinets
- 2 \* Double entry cabinets for recorder & remote access
- 2 \* Sherlog Recorder Units
- 1 \* Substation PC
- 1 \* D20 RTU & IDF
- 4 \* Metering modules
- 2 \* Measuretronics Voltage Transducers
- 1 \* ABB Transducers
- 6 \* Landis & Ger meters class 0.5
- 1 \* Vectograph
- 1 \* 110Vdc 1ph 25A charger with battery bank
- 1 \* AC Distribution panel with modules
- 1 \* DC Distribution panel with modules
- 5 \* Allen Bradley Contactors
- 3 \* 110V Schrack relays & 11-pin bases
- 1 \* 50V Schrack relay & 11-pin base
- 1 \* N PROTECT BHEAD MA FEM 230V inline surge protection device

### 6.1 STAKEHOLDERS SIGNATURES

Name	Signature	Comments