EASTERN CAPE OPERATING UNIT

EDNS PROJECT ENGINEERING

PROTECTION, TELECONTROL, METERING & DC DESIGN

GOOD HOPE TEXTILES SUBSTATION PROJECTS

REFURBISHMENT PROJECT (WEF116)
C.DS00074

FUNCTIONAL SCOPE OF WORKS

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Rev 1: 03/10/2011	S.C. Myeza	EDNS Project Engineering
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Executive Summary

Background

Good Hope Textiles needs refurbishment due to equipment ageing problems and the lack of spares thereof. An estimated budget of about R12.3 M rand is allocated to undertake this project. This substation is situated in the KWT TSA, and is interconnected with Fort Murray and King William Town. There are S1 type customers connected and the Da Gama Textiles factory supplied by the substation. The substation consists of two 7.5MVA and 6 MVA transformers.

Problem Statement

Equipment (Isolators, Breakers and CTs) at these substations are obsolete with no spare parts should there be a failure.

- LINEGEAR isolators manufactured in 1959 are problematic and do not support SCADA. TSG make use of second hand spares to repair and repairs cannot be guaranteed.
- EIB, Delle and OSM10 breakers are no longer manufactured. TSG makes use of second hand spares to repair and repairs require more than eight hours with no guarantees. TSG confirms that no matter how good maintenance is performed on these breakers they are bound to fail.
- Problems experienced on these breakers range from burnt trip and closing coils, spring rewind motors burning out, contactor failures, ceased rollers and linkages.
- Maintenance of these breakers requires scarce specialized skills.
  Breakers do not comply to Coastal conditions

Solution

Good Hope Textiles will be upgraded to have two new 66kV feeder bays which are 4FZD3940 schemes, a new 66 kV buscoupler scheme and new 3TM5110 protection schemes for the transformers.
Some existing primary plant will be replaced such as the HV breakers, isolators, etc.

Teleprotection will be achieved through OPGW which will be interconnecting King Williams Town Substation, Good Hope Textiles Substation, Fort Murray Substation, Pembroke, etc.

1 PROTECTION DESIGN

1.1 King Williams Town 1 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 Good Hope Textile and King Williams Town substation is approximately 5,9km 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 400/1)
- 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. A 132kV single-pole breaker will be installed on this feeder.
3. The CTs need to be outboard and the by-pass needs to be inboard.
4. The sync check function on this scheme will not be used.
5. Differential protection and fibre teleprotection will be used on this scheme.
6. The scheme must be ordered with VT selection relays for the double busbar scenario. Use "M" type contacts for the set condition and 'F" type for the reset condition.
7. A MCB for the supplies on the protection circuits for busbar 1 & 2 must be replaced with a 10A triple-pole MCB complete with auxiliary contacts. The auxiliary contacts are to be wired as per the drawings. A CTJB will be installed on the white phase CT steelwork.
8. 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.
9. An isolator junction box will be installed in an appropriate place in the 66kV feeder 1 bay area in the yard to accommodate the CT wiring for the double busbar arrangement and the by-pass control circuitry.
10. All isolator's, including the bypass isolator, 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.
11. The scheme SCADA I/O will be telemetered via the hardwired IDF.
12. The SF6 low gas alarm (*not* the low gas *block* alarm) must be wired to the IDF for supervisory indication.

13. 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.
14. 66kV feeder 1 scheme by-pass facility: On busbar 1. (The default masking on the RED670 includes the bypass logic)
    a. The feeder will be bypassed on busbar 1. The feeder must be locked onto busbar 1 in normal operation. The Busbar 2 isolator must be locked in the open position.
    b. The feeder will be able to be by-passed using the bus-coupler breaker and its protection by automatically selecting the correct settings groups for the feeder on bypass.
    c. The 66kV bypass isolators supplied by Actom needs to have the following contacts: 2F, 2GS, 10G, 5M & 5N.
    d. The bypass link (feeder bypass) must be used to do a settings change on the 66kV bus coupler scheme. The bypass isolator aux. 'G' contact must be used for this settings change. Use settings group 1 for this feeder by-pass on the bus coupler protection relays.
    e. When the bypass isolator is closed, a 'GS' contact must operate two Arteche BJ8 relays and short the main and back-up CT circuits for this feeder. A normally closed "N" contact can be used for the reset state of the shorting relays.
    f. To ensure stability in the bus zone circuits during a bypass selection a set of "G" contacts (two in parallel) in the by-pass isolator must be used in parallel with the a set of "G" contacts of busbar 1 isolator (two in parallel). See bus zone drawings for clarity.
    g. When the feeder is put on bypass, the distance/diff scheme at King Williams Town substation needs to switch to three-pole tripping 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 select the ARC state at King Williams Town SS.
    h. 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).
    i. At Good Hope Textiles substation on the King Williams Town 1 feeder, a bypass isolator contact (type N) must be wired to reset the selection. This function will not be used as the set/reset masking logic only requires one input, but might be necessary in the future; it is therefore necessary to include this function in the design.
    j. At King Williams Town substation on the Good Hope Textiles feeder, the ARC bypass 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.
    k. The feeder protection at Good Hope Textiles substation must match the protection specified for King Williams Town substation and thus will have the same ARC selection/de-selection logic since the Good Hope Textile feeder at King Williams Town substation will also have bypass capabilities.
    l. All isolator statuses must be wired to the RED670 Relay for indication and HMI SLD purposes. 'M' type contacts should be used for the close indication and 'N' type contacts should be used for the open indication. For the bypass isolator, which is wired to the RED670 Relay for indication, HMI SLD and bypass sequence purposes, G & N contacts must be used.
15. 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 heater thermal switch.
    - CBNH blocking should contain:
        - The SF6 low gas block alarm.
        - The ON/OFF switch of the circuit breaker.
        - The motor protective switch.
16. Busbar 1, 2 and bypass isolator closed status M-type contacts must be wired to the disturbance recorder panel for recording purposes.
17. 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. The binary points in Table 1 below will be monitored.

Table 1: FEEDER TYPE 4FZD3940 Recorder Points

ALARM	Equipment	WIRE No -	SHEET No
Red Phase Trip	Disturbance recorder module	K302	16
White Phase Trip	Disturbance recorder module	K302	16
Blue Phase Trip	Disturbance recorder module	K302	16
Zone Instantaneous Trip	Disturbance recorder module	K302	16
Zone Time Delayed Trip	Disturbance recorder module	K302	16
DIFF Trip	Disturbance recorder module	K302	16
SOTF Trip	Disturbance recorder module	K302	16
Tele-protection Comms Fail or Isolated	Disturbance recorder module	K302	16
Bkr Fail; Bus Trip; DTTS	Disturbance recorder module	K302	16
Permissive Inter-trip Receive	Disturbance recorder module	K302	16
Supervisory or External Trip	Disturbance recorder module	K302	16
Circuit Breaker Open	Disturbance recorder module	K302	16
Circuit Breaker Not Healthy	Disturbance recorder module	K302	16
Synch Check Inhibit Close	Disturbance recorder module additionally)	K302	16
BU Trip	Disturbance recorder module additionally)	K302	12
Direct Transfer Trip Receive	Disturbance recorder module additionally	K302	18
Auto-reclose Lockout / OFF	Disturbance recorder module additionally	K302	18
ARC 1 + 3 Pole Only Selected	Disturbance recorder module additionally	K302	18
Pole Disagreement Trip	Disturbance recorder module additionally	K302	18
UV/OV/Overload trip	Disturbance recorder module additionally	K302	18
Broken conductor Alarm/Trip	Disturbance recorder module additionally	K302	18
Remote Bypass (Rx)	Disturbance recorder module additionally	K302	18
Protection Not Healthy	Disturbance recorder module additionally	K302	18
GPS Fail	Disturbance recorder module additionally	K302	18

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, Multimode Fibre port (LC connectors) 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 Convertor For Power Line Carrier circuit.
- IEC61850 Testing And Remote Engineering Access Option.
- External Time Synchronisation On RED670 Relay Option.
- Ammeter (0-5ma) Instruments 48mm, 90deg. Calibration required: 5mA = 400/1.
- Voltmeter Ratio = 110/66kV, Calibration required: 5mA=66kV
- Pre-Calibrated Volt & Amp Meters Values Via Sap Options.
- 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

1.2 Fort Murray 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 Good Hope Textile and Fort Murray substation is approximately 6,9km 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 400/1)
- 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. A 132kV single-pole breaker will be installed on this feeder.
3. The CTs need to be outboard and the by-pass needs to be inboard.
4. The sync check function on this scheme will not be used.
5. Differential protection and fibre teleprotection will be used on this scheme.
6. The scheme must be ordered with VT selection relays for the double busbar scenario. Use "M" type contacts for the set condition and 'F" type for the reset condition.
7. A MCB for the supplies on the protection circuits for busbar 1 & 2 must be replaced with a 10A triple-pole MCB complete with auxiliary contacts. The auxiliary contacts are to be wired as per the drawings. A CTJB will be installed on the white phase CT steelwork.
8. 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.
9. An isolator junction box will be installed in an appropriate place in the 66kV feeder 2 bay area in the yard to accommodate the CT wiring for the double busbar arrangement and the by-pass control circuitry. Even though there is no 66kV bus coupler, I have decided to install an isolator JB.
10. All isolator's, including the bypass isolator, 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.
11. The scheme SCADA I/O will be telemetered via the hardwired IDF.
12. The SF6 low gas alarm (*not* the low gas *block* alarm) must be wired to the IDF for supervisory indication.
13. 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.

14. 66kV feeder 2 scheme by-pass facility: On busbar 1. (The default masking on the RED670 includes the bypass logic)
    a. The feeder will be bypassed on busbar 1. The feeder must be locked onto busbar 1 in normal operation. The Busbar 2 isolator must be locked in the open position.
    b. The feeder will be able to be by-passed using the bus-coupler breaker and its protection by automatically selecting the correct settings groups for the feeder on bypass.
    c. The 66kV bypass isolators supplied by Actom needs to have the following contacts: 2F, 2GS, 10G, 5M & 5N.
    d. The bypass link (feeder bypass) must be used to do a settings change on the 66kV bus coupler scheme. The bypass isolator aux. 'G' contact must be used for this settings change. Use settings group 2 for this feeder by-pass on the bus coupler protection relays.
    e. When the bypass isolator is closed, a 'GS' contact must operate two Arteche BJ8 relays and short the main and back-up CT circuits for this feeder. A normally closed "N" contact can be used for the reset state of the shorting relays.
    f. To ensure stability in the bus zone circuits during a bypass selection a set of "G" contacts (two in parallel) in the by-pass isolator must be used in parallel with the a set of "G" contacts of busbar 1 isolator (two in parallel). See bus zone drawings for clarity.
    g. When the feeder is put on bypass, the distance scheme at Fort Murray substation needs to switch to three-pole tripping automatically. The G-type bypass isolator contact input to the RED670 at Good Hope Textiles SS on the Fort Murray feeder will be used to automatically select the ARC state at Fort Murray SS.
    h. The Good Hope Textiles feeder masking at Fort Murray 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).
    i. At Good Hope Textiles substation on the Fort Murray feeder, a bypass isolator contact (type N) must be wired to reset the selection. This function will not be used as the set/reset masking logic only requires one input, but might be necessary in the future; it is therefore necessary to include this function in the design.
    j. At Fort Murray substation on the Good Hope Textiles feeder, the ARC bypass selection must automatically reset to its original state (prior to the bypass), when the bypass is removed at Good Hope Textiles substation on the Fort Murray feeder.
    k. The feeder protection at Good Hope Textiles substation must match the protection specified for Fort Murray substation and thus will have the same ARC selection/de-selection logic since the Good Hope Textiles feeder at Fort Murray substation will also have bypass capabilities.
    l. All isolator statuses must be wired to the RED670 Relay for indication and HMI SLD purposes. 'M' type contacts should be used for the close indication and 'N' type contacts should be used for the open indication. For the bypass isolator, which is wired to the RED670 Relay for indication, HMI SLD and bypass sequence purposes, G & N contacts must be used.
15. 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.
    - CBNH blocking should contain:
        - The SF6 low gas block alarm.
        - The motor protective switch.
        - The heater thermal switch.
16. Busbar 1, 2 and bypass isolator closed status M-type contacts must be wired to the disturbance recorder panel for recording purposes.
17. 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. The binary points in Table 2 below will be monitored.

Table 2: FEEDER TYPE 4FZD3940 Recorder Points

ALARM	Equipment	WIRE No -	SHEET No
Red Phase Trip	Disturbance recorder module	K302	16
White Phase Trip	Disturbance recorder module	K302	16
Blue Phase Trip	Disturbance recorder module	K302	16
Zone Instantaneous Trip	Disturbance recorder module	K302	16
Zone Time Delayed Trip	Disturbance recorder module	K302	16
DIFF Trip	Disturbance recorder module	K302	16
SOTF Trip	Disturbance recorder module	K302	16
Tele-protection Comms Fail or Isolated	Disturbance recorder module	K302	16
Bkr Fail; Bus Trip; DTTS	Disturbance recorder module	K302	16
Permissive Intertrip Receive	Disturbance recorder module	K302	16
Supervisory or External Trip	Disturbance recorder module	K302	16
Circuit Breaker Open	Disturbance recorder module	K302	16
Circuit Breaker Not Healthy	Disturbance recorder module	K302	16
Synch Check Inhibit Close	Disturbance recorder module additionally)	K302	16
BU Trip	Disturbance recorder module additionally)	K302	12
Direct Transfer Trip Receive	Disturbance recorder module additionally	K302	18
Auto-reclose Lockout OFF	Disturbance recorder module additionally	K302	18
ARC 1 + 3 Pole Only Selected	Disturbance recorder module additionally	K302	18
Pole Disagreement Trip	Disturbance recorder module additionally	K302	18
UV/OV/Overload trip	Disturbance recorder module additionally	K302	18
Broken conductor Alarm/Trip	Disturbance recorder module additionally	K302	18
Remote Bypass (Rx)	Disturbance recorder module additionally	K302	18
Protection Not Healthy	Disturbance recorder module additionally	K302	18
GPS Fail	Disturbance recorder module additionally	K302	18

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, Multimode Fibre port (LC connectors) 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 Convertor For Power Line Carrier circuit.
- IEC61850 Testing And Remote Engineering Access Option.
- External Time Synchronisation On RED670 Relay Option.
- Ammeter (0-5ma) Instruments 48mm, 90deg. Calibration required: 5mA = 400/1.
- Voltmeter Ratio = 110/66kV, Calibration required: 5mA=66kV
- Pre-Calibrated Volt & Amp Meters Values Via Sap Options.
- 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 Buscoupler – 3FZ0902 (MOD)

The 3FZ0902 (MOD) bus coupler is a non-ENC scheme; the modifications (including the recorder point modifications) are done by IST in accordance with Southern Regions drawings. It comprises of the SEL 321 and SEL 351 protection relays. The SEL 321 relay will be used to facilitate the main distance protection and the SEL 351 relay, the back-up over-current and earth fault protection, whilst the bus-coupler is used during the bypass of any of the 66kV feeders. The SEL351 relay will further be used for protection during busbar coupling. Directional over-current, earth fault and sensitive earth fault, synchronism check, under/over frequency and under/over voltage functions are also available if needed.

The following notes are important regarding the scheme:

1. The scheme will be installed in a separate swing frame cabinet.

2. An ABB 66kV three-pole breaker will be installed for the coupler.

3. 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.

4. When any of the 66kV feeders are bypassed they must initiate a setting change on the bus coupler via their respective bypass isolator G-contacts (two in parallel). This setting change then enables the buscoupler to protect the relevant feeder.

5. GS-contacts are also required on the bypass isolators, these are used to short out the main & backup protection CT's on the specific feeder being bypassed. Two Arteche BJ8 flip-flop relays are required by each feeder to short the CT's. EDFS must install the Arteche BJ8 relays in each of the feeder schemes on a 5U B/P. An N-contact on the bypass isolator is used to reset the shorting relays (BJ8).
   The reasons for shorting the CT's of the feeder on bypass are that:
   - The feeder scheme can mal-operate when busbar isolators are opened and the VT supply is removed.
   - If there is a fault on the line while the bypass isolator is being closed the feeder could trip resulting in the bypass isolator being closed onto a fault, which could be detrimental to the isolator and the operator.
   - Breaker fail maloperation

6. Two voltage transducers and one current transducer will be installed in the scheme. The voltage transducers will be wired to the voltmeters and the IDF to enable control to monitor the voltage status of both the 66kV busbars and the current transducer will be used to drive the ammeter. The scheme suppliers are to calibrate the meters with the following ranges:
   - Voltmeter scale 0 to 90kV. Calibration required: 5mA=66kV.
   - Ammeter scale 0 to 600A. Calibration required: 5mA = 600A.

7. The protection relay will have automatic settings selection and needs to be designed as follows:

SEL 321

INPUT	IN12	IN11	IN10	
SETTING	SS3	SS2	SS1	
DEFAULT - BC OFF	0	0	0	GROUP COM (G6)
132kV FDR 1 BYPASS	0	0	1	G1
132kV FDR 2 BYPASS	0	1	0	G2
NOT USED	-	-	-	G3
NOT USED	-	-	-	G4
NOT USED	-	-	-	G5
BC OFF/ON	1	1	0	G6
DEFAULT	1	1	1	GROUP COM (G6)

SEL 351

INPUT	SETTING	Description – marshal to a settings group
IN201	SS1	KING WILLIAMS TOWN 1 66kV FDR BYPASS
IN202	SS2	FORT MURRAY 66kV FDR BYPASS
IN203	SS3	SPARE
IN204	SS4	SPARE
IN205	SS5	BC ON
IN206	SS6	BC OFF

8. A Remote Access RASM of type A will be installed in the buscoupler panel. Refer to section 6 for details.

9. The SEL 321 relay must be fitted with a SEL2885 converter (RS232 to RS485-4W).

10. The RS485-4W ports on the SEL321 (via the SEL2885) and the SEL351 are multi-dropped to the Remote Access RASM. See section 6 for further details.

11. The SEL relays use the IRIGB-002 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.

12. The scheme must also cater for a Sherlog fault recorder and all the necessary modification must be done by IST. A BTP (bay terminal plate) with suitable fused terminals for all digitals circuits must be built by IST using a 3U blanking plate. The BTP must be mounted in an appropriate place in the panel to facilitate the connection to the recorder. See drawing for details.

    The following binary points must be monitored and in cases where circuits need to be separated, suitable tripping diodes (25FR120) must be used:

BUSCOUPLER TYPE 3FZ0902 (MOD)			
ALARM	**WIRE No (+)**	**WIRE No (-)**	**SHEET No**
CB Closed	K103	K102	8
Main Trip	K113	K102	8
Earth-fault Trip	K323	K302	9
Over-current Trip	K325	K302	9
Back-up Trip	K305	K302	9
CB Close coil	K307	K302	10
CB Fail	K321	K302	9
Remote & ARC Close	K351	K302	9
BRKR Fail Re-trip	K305 (insert diode)	K302	9
PNH	K335	K302	9
CBNH	L113 (insert diode)	L104	12
ARC Off/Lockout	L107 (insert diode)	L104	12
Out of Synch Close Attempt	L117 (insert diode)	L104	12

Scheme Description:

Bus Coupler protection scheme				
QTY	**SCHEME (MANUF)**	**PROT AVAILABLE (MODULE) DESCRIPTION**	**OPTIONS (MODULE) DESCRIP**	**ENC**
1	3FZ0902(MOD) (IST)	SEL351 & SEL321 relay - R173 709	1. 2 * Voltmeters 2. 2 * Voltage transducers 3. 1 * Current transducer	

1.4 66kV Buszone – 4BZ5700

The scheme comprises of the GE Multilin F35 over-current relay with IRIG-B inputs. The scheme is wired and equipped for 8 bays and a bus-coupler bay. The scheme caters for a double zone, with checkzone high impedance protection.

Commissioning Notes:

1. The stabilizing resistor size specified by EDNS must be 2000Ω. The options are a 2000Ω, 800Ω OR 200Ω 200W resistor.

2. The buszone CT circuits will utilise a 500/1 ratio core on all the bays CT's. Four bays and the buscoupler bay will be wired to the scheme leaving four spare bays for future expansion.

3. Both 66kV feeder schemes and both transformer schemes are equipped with breaker fail functionality, which must be included in the buszone tripping input for a bay breaker failure condition.

4. The checkzone CT circuits must be wired directly from the CT junction boxes of the different bays. Note the buscoupler does not form part of the checkzone circuit. The second core on the CT's will be used for the different zones depending on the busbar isolator selection and must be wired from the CT junction box to the isolator mechanism box of both isolators. The circuit will be fed through two "G" contacts in parallel for each phase in both the busbar 1 and busbar 2 isolator mechanism boxes and back to the isolator junction box. The circuit will then be taken from the isolator junction box back to the buszone panel for the respective zone 1 and zone 2 circuits. Note: The neutral will not be taken through any contacts.

5. A Remote Access & Time Synch Module (RASM) of type A will be installed in the buszone panel. Refer to section 6 for details.

6. The GE Multilin F35 includes a 2nd RS485 port for remote access. This port must be wired to the Remote Access RASM. See section 6 for details.

7. The GE Multilin F35 has various IRIG-B input. The connection is of the BNC type or terminals 4B (IRIGB+) & 4A (IRIGB-) can be used. The unit is compatible with the amplitude modulated (B121* or B122) signal (the single modulated output on the Meinberg unit) for synchronization purposes and does not support DC shift (B021* or B022) method. The IRIGB-002 must be used.

8. The Scheme will be supplied with blanking plates in a swing frame cabinet.

9. The buszone scheme must also cater for the connection to the Sherlog fault recorder. A RASM (bay terminal plate) must be built by EDFS using a 3U blanking plate and mounted in the panel. Suitable terminals as per recorder standard must be used. Note that for the last two binary points, schrack relays must be installed to multiply the contacts. See drawings for details.

10. EDFS must install a schrack relay on strip X6 for supervisory DC Fail indication. See sheet 14 for details.

The following binary points must be monitored:

BUSZONE TYPE 4BZ5700 (MOD)			
ALARM	**WIRE No (+)**	**WIRE No (-)**	**SHEET No**
Buszone Isolated	P39	P2	13
Buszone (Expansion panel) Isolated	P41	P2	13
CT Bus wires Shorted (Z1)	P45 (diode)	P2	13
CT Bus wires Shorted (Z2)	P45 (diode)	P2	13
CT Bus wires Shorted (Check Zone)	P45 (diode)	P2	13
Zone 1 Trip	P3	P2	12
Zone 2 Trip	P5	P2	12
Zone Discrepancy	X109 (use Schrack)		14
PNH	X117 (use Schrack)		14

Scheme description:

QTY	SCHEME (MANUF)	**PROT AVAILABLE (MODULE) DESCRIPTION**	OPTION (MODULE) DESCRIP	ENC
1	**IST Energy**	**4BZ-5700 High Impedance Bus Zone Protection Scheme (110Vdc).** Two zone differential protection with a check zone. ***Suitable for application in substations with double busbars with up to eight bays and a bus coupler bay.*** INCLUDES: - Interface for 4BZ-5750 expansion panel to extend application by an additional 8 bays. (4BZ-5750 panel NOT included). - GE Multilin F35 protection relay with IRIG-B time synchronisation input. - 2000 Ohm, 200 Watt variable stabilizing resistors and metrosils. (May be changed to 200 Ohm or 800 Ohm resistors on request – see Options). - Separate hand-reset trip repeat relays per bay. - Electrically-reset CT buswire shorting relays per zone. - Test blocks, isolation switches, indication lamps, terminal back plate. - Provision for hardwired and/or serial communication (RS-485/DNP3) to SCADA. - F35 equipped with second rear RS-485 comms port for remote engineering access. - Dual entry swing frame panel of dimensions: 2400mm high x 800mm wide x 600mm deep. Requisite blanking plates. - Packaging for transport. Scheme suitable for **110 V DC** voltage supply. Wired for **1 Amp** Current Transformer rating. (May be modified on site for 5A). Scheme Master drawings: D-DT-15600.	200 Ohm, 200 Watt	SAP 0224967

1.5 66/11kV Transformer 1 – 3TM5110

The 3TM5110 scheme designed for protection of distribution transformers larger than 20MVA will be used to protect this transformer. The scheme is suitable to protect transformers of all vector groups over a wide voltage range.
The scheme has a SEL-387A integrated relay comprising the following protection: Two winding differential, HV over current & earth fault, MV earth fault, MV SEF, HV & MV breaker fail and sustained fault timer.
The HV & MV High Impedance REF option will be ordered,

- The scheme will be placed in a separate swing frame panel.
- The existing 3 pole 66kV Alstom breaker will be used on the HV side of the breaker and the existing Dogbox breaker on the MV side.
- New 66kV post CT's will be installed. A CTJB will be installed on the white phase CT steelwork. 500/1 Buszone CT ratio CT's must be ordered for future application.
- The HV REF will utilise the HV post CT's. The HV side of the transformer is a delta configuration and has no neutral CT's.
- The MV REF will utilise the second set of protection CT's on the MV dogbox breaker and the second neutral CT on the NECRT.
- The HV & MV REF trip must initiate an input into the SEL387A relay for event recording purposes, use IN205 & IN206 respectively. IN205 & IN 206 must be configured to trip the same outputs as the low impedance REF function.
- The ratio of the SEF current transformer must be 100/1 so that this protection can be set to 10A on the primary. The 10A value is important so as to protect the NEC for long duration neutral currents as the NEC neutral is only rated at 10Amps continuous. The timing delay must be set long enough to allow operating on the MV network and to prevent unnecessary tripping of the transformer. The SEF will trip the transformer MV breaker and initiate the sustained fault timer. This protection must also provide a display point on the SEL387A relay.
- A Remote Access RASM of type B will be installed in the transformer panel. Refer to section 9 for details.
- The RS485-4W ports on the SEL387A will be connected to port 1 on the Remote Access RASM. See section 9 for further details.
- The Type B Remote Access RASM has a second Nport device to facilitate the RS485 connection to the ABB transducer in the panel.
- The SEL relay uses the IRIGB-002 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.
- All isolators in this bay will be new. 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.
- EDFS must install trip auxiliary contactors and free-wheeling diodes in both the main and backup trip circuits of the MV breaker. (Exposed wiring to be covered with heat shrink). See drawings for details.
- A Shrack relay must be built into the scheme by EDFS to serve as a Anti pump timer auxiliary relay on the HV & MV closing circuit, all three contacts of this relay must be wired in series. This relay will act as a sacrificial relay to safeguard the SEL387A output contact.
- The transformer MV Breaker fail function must be marshalled to trip the HV breaker and the MV breaker of Transformer 2 & via the 11kV section isolator Transformer 3. The MV Breaker fail output contact must be used to trip Transformer 1 MV breaker by energising IN106 utilising Transformer 1 DC supply.
- The 11kV Feeder's breaker fail must be used to trip the Transformer 1, 2 and 3 MV breakers.

- The trip input from the respective feeders must be wired to IN106 on the SEL387A. IN106 must be marshalled to trip the MV breaker and energise Display Point (DP) 16 via a latch. DP 16 must be labelled accordingly. A spare LCD display point must be used to display this trip and the text must read as follows: EXT BKR FAIL
  DP 16 will be reset by pushing the reset button on the SEL387A.
  Setting for DP 16:
  S3 SLT4 = IN106
  S3RLT4 = TRGTR
  DP16 = S3LT4

- The supervisory indication for HV and MV trip coil supervision must be made to share a common output from the SEL387A (OUT211), thus freeing an output (OUT212) which will be used as a common external breaker fail alarm. Note: EDNS and EDFS to make sure the settings accommodate this change.
  The output logics should look as follows: **OUT211 = S3V1T+S3V3T+S3V2T+S3V4T**
  OUT212 = IN106
- One of the SF6 block alarms in the breaker must be used in the breaker not healthy circuit.
- The other SF6 alarm contact must be used for an alarm to Scada. See drgs. For details.
- The scheme will be supplied with all necessary wiring to accommodate the ABB transducer. EDFS must fit the transducer in the scheme. The ABB transducer provides remote analogue Watts, VAR's, Frequency and current indication.
- The scheme will be connected to the Sherlog recorder as per the drawings. The binary points in Table 3 below will be monitored.

TABLE 3: TRANSFORMER TYPE- 3TM5110

Diff HV E/F; HV O/C (Hi-set) Trip; HV/MV REF Trip	Pin A02 of SEL-387A (insert diode between SEL output and HV CB Main trip) and number wire K103A	K102	8
Sustained Fault Trip	K109	K102	8
Fault Master Trip	K113	K102	8
Trfr Buch Trip	K115	K102	8
Trfr PRV Trip	K119	K102	8
Trfr Oil Temp Trip	K123	K102	8
OLTC Buch	K127	K102	8
TRFR Winding Temp	K135	K102	8
NECRT Buch/Oil Temp	K131	K102	8
Trfr/OLTC Oil Level Alarm	K165	K102	9
Diff/Hiset HV O/C (HI-SET); HV/MV REF	K143A (insert diode)	K102	10
HV REF Trip	K147	K102	10
MV REF Trip	K147A	K102	10
External Bkr Fail	K303B (insert diode)	K302	11
Diff/REF/HV E/F; HV O/C (Hi-set) Trip	K303A (insert diode)	K302	11
MV O/C&E/F; HV O/C Trip	K325A (insert diode)	K302	12
HV Bkr Open	L111	L104	14
MV Bkr Open	L117	L104	14

Scheme Description:

QTY	SCHEME (MANUFACTURER)	PROT AVAILABLE (MODULE) DESCRIPTION	OPTIONS SELECTED	SAP
1	3TM5110 (IST)	SEL-387A relay with –2 Wdg DIFF, HV O/C, HV E/F, MV O/C & E/F, MV SEF, HV & MV BF, and SFT. External high impedance HV & MV REF R150 000	Communication cable for use with SEL relays and computer	4600010558

The detail of the new equipment is as follows:

- 1 x 66kV, 1600A Busbar 1 isolator, 31mm/kV creapage.
- 1 x 66kV, 1600A Busbar 2 isolator, 31mm/kV creapage.
- 3 x 1600A, 20kA, 6-core current transformers (2 prot, 2 meas, 2 Buszone 500/1)
- 1 x 1600A, 20kA, 66kV three pole circuit breaker, 31mm/kV creapage.
- 1 x 11kV NEC/NER/Aux TRFR, 360A, 31mm/kV creapage.
- 1 x 11kV, SF6 dog box breaker, 31mm/kV creapage.
- 1 x 11kV busbar isolator, 31mm/kV creapage. (standard DT auxiliary contact configuration)

1.6 66/11 kV Transformer 1 OLTC – 4TC5100

The Tap Change protection and control module consists of a multifunctional voltage regulator, integrated transducer and recorder functions, integrated statistical functions to measure and evaluate operation data, several programs for parallel operation of transformers.

1. The tap changer scheme will be mounted in a separate relay panel with the new Transformer 2 OLTC control scheme.

2. EDFS must install an 11-pin Schrack relay (TCDT-X) across the tap change drive tripped lamp; this is to multiply the tap change motor drive tripped auxiliary contacts. A contact from this relay must be wired to the IDF for supervisory indication. A diode must be installed in this circuit to prevent the lamp check switch from energising the TCDT-X relay. A spare diode is available on the diode board supplied with the scheme.

3. The Reg.-D relay requires a phase-phase VT input and a single-phase current input from the transformer bushing protection CT cores on the MV side. The current input is essential, as the relay will block all tapping when on auto if there is no load current flowing.

4. A Remote Access RASM of type A will be installed in the OLTC control panel for the Eberle relay which has an RS232 port; an RS232 inline surge protection device must be installed between the Eberle relay and the Nport.
An RS232 DB9 Clearline surge protection device (12-00768) must be included to protect the serial port.

5. The AC supply from the 4TC5100 scheme must be used to supply the tap position encoder and not the motor supply. A separate supply cable must therefore be installed to the drive.

6. EDFS is to install a 48V schrack relay in the scheme which is to serve as a supervisory reset for a tap change lockout. See the drawings for further details.

7. The scheme will run in Master/Follower mode.

8. The scheme will be connected to the Sherlog recorder as per the drawings. The binary points in Table 4 below will be monitored.

TABLE 4: OLTC TYPE - 4TC5100

ALARM	WIRE NUMBER +	WIRE No -	SHEET No	REV (DT)
Motor Runing Auxiliary	N113	N102	4	2
TC O/C Block	N159	N102	5	2
Lock-out Reset	N163	N102	5	2
TC Voltage Abnormal	N167	N102	5	2
Tap Change not Healthy	N165	N102	5	2
TC Lockout	N171A	N102	6	2
TC on Manual	N173A	N102	6	2
TC Drive Tripped	N175A	N102	6	2

8. Additional supervisory points need to be wired for SCADA. See drawings for point names.

Scheme Description:

1.6.1.1 Cost Effective, Minimum Functionality Tap Change Control Scheme				
QTY	**SCHEME (MANUF)**	**PROT AVAILABLE (MODULE) DESCRIPTION**	**OPTIONS (MODULE) DESCRIP**	**ENC**
1	4TC5100 (IST)	1. Eberle REG-D voltage regulator	.	**4600010558 1.6.1.1.1.1.1**

1.7 66/11kV Transformer 2 – 3TM5110

The 3TM5110 scheme designed for protection of distribution transformers larger than 20MVA will be used to protect this transformer. The scheme is suitable to protect transformers of all vector groups over a wide voltage range.
The scheme has a SEL-387A integrated relay comprising the following protection: Two winding differential, HV over current & earth fault, MV earth fault, MV SEF, HV & MV breaker fail and sustained fault timer.
The HV & MV High Impedance REF option will be ordered,

- The scheme will be placed in a separate swing frame panel.
- The existing 3 pole 66kV Alstom breaker will be used on the HV side of the breaker and the existing Dogbox breaker on the MV side.
- New 66kV post CT's will be installed. A CTJB will be installed on the white phase CT steelwork. 500/1 Buszone CT ratio CT's must be ordered for future application.
- The HV REF will utilise the HV post CT's. The HV side of the transformer is a delta configuration and has no neutral CT's.
- The MV REF will utilise the second set of protection CT's on the MV dogbox breaker and the second neutral CT on the NECRT.
- The HV & MV REF trip must initiate an input into the SEL387A relay for event recording purposes, use IN205 & IN206 respectively. IN205 & IN 206 must be configured to trip the same outputs as the low impedance REF function.
- The ratio of the SEF current transformer must be 100/1 so that this protection can be set to 10A on the primary. The 10A value is important so as to protect the NEC for long duration neutral currents as the NEC neutral is only rated at 10Amps continuous. The timing delay must be set long enough to allow operating on the MV network and to prevent unnecessary tripping of the transformer. The SEF will trip the transformer MV breaker and initiate the sustained fault timer. This protection must also provide a display point on the SEL387A relay.
- A Remote Access RASM of type B will be installed in the transformer panel. Refer to section 9 for details.
- The RS485-4W ports on the SEL387A will be connected to port 1 on the Remote Access RASM. See section 9 for further details.
- The Type B Remote Access RASM has a second Nport device to facilitate the RS485 connection to the ABB transducer in the panel.
- The SEL relay uses the IRIGB-002 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.
- All isolators in this bay will be new. 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.
- EDFS must install trip auxiliary contactors and free-wheeling diodes in both the main and backup trip circuits of the MV breaker. (Exposed wiring to be covered with heat shrink). See drawings for details.
- A Shrack relay must be built into the scheme by EDFS to serve as a Anti pump timer auxiliary relay on the HV & MV closing circuit, all three contacts of this relay must be wired in series. This relay will act as a sacrificial relay to safeguard the SEL387A output contact.
- The transformer MV Breaker fail function must be marshalled to trip the HV breaker and the MV breaker of Transformer 1 & via the 11kV section isolator Transformer 3. The MV Breaker fail output contact must be used to trip Transformer 1 MV breaker by energising IN106 utilising Transformer 1 DC supply.
- The 11kV Feeder's breaker fail must be used to trip the Transformer 1, 2 and 3 MV breakers.

- The trip input from the respective feeders must be wired to IN106 on the SEL387A. IN106 must be marshalled to trip the MV breaker and energise Display Point (DP) 16 via a latch. DP 16 must be labelled accordingly. A spare LCD display point must be used to display this trip and the text must read as follows: EXT BKR FAIL
  DP 16 will be reset by pushing the reset button on the SEL387A.
  Setting for DP 16:
  S3 SLT4 = IN106
  S3RLT4 = TRGTR
  DP16 = S3LT4

- The supervisory indication for HV and MV trip coil supervision must be made to share a common output from the SEL387A (OUT211), thus freeing an output (OUT212) which will be used as a common external breaker fail alarm. Note: EDNS and EDFS to make sure the settings accommodate this change.
  The output logics should look as follows: **OUT211 = S3V1T+S3V3T+S3V2T+S3V4T**
  OUT212 = IN106
- One of the SF6 block alarms in the breaker must be used in the breaker not healthy circuit.
- The other SF6 alarm contact must be used for an alarm to Scada. See drgs. For details.
- The scheme will be supplied with all necessary wiring to accommodate the ABB transducer. EDFS must fit the transducer in the scheme. The ABB transducer provides remote analogue Watts, VAR's, Frequency and current indication.
- The scheme will be connected to the Sherlog recorder as per the drawings. The binary points in Table 3 below will be monitored.

TABLE 5: TRANSFORMER TYPE- 3TM5110

Diff HV E/F; HV O/C (Hi-set) Trip; HV/MV REF Trip	Pin A02 of SEL-387A (insert diode between SEL output and HV CB Main trip) and number wire K103A	K102	8
Sustained Fault Trip	K109	K102	8
Fault Master Trip	K113	K102	8
Trfr Buch Trip	K115	K102	8
Trfr PRV Trip	K119	K102	8
Trfr Oil Temp Trip	K123	K102	8
OLTC Buch	K127	K102	8
TRFR Winding Temp	K135	K102	8
NECRT Buch/Oil Temp	K131	K102	8
Trfr/OLTC Oil Level Alarm	K165	K102	9
Diff/Hiset HV O/C (HI-SET); HV/MV REF	K143A (insert diode)	K102	10
HV REF Trip	K147	K102	10
MV REF Trip	K147A	K102	10
External Bkr Fail	K303B (insert diode)	K302	11
Diff/REF/HV E/F; HV O/C (Hi-set) Trip	K303A (insert diode)	K302	11
MV O/C&E/F; HV O/C Trip	K325A (insert diode)	K302	12
HV Bkr Open	L111	L104	14
MV Bkr Open	L117	L104	14

Scheme Description:

QTY	SCHEME (MANUFACTURER)	PROT AVAILABLE (MODULE) DESCRIPTION	OPTIONS SELECTED	SAP
1	3TM5110 (IST)	SEL-387A relay with –2 Wdg DIFF, HV O/C, HV E/F, MV O/C & E/F, MV SEF, HV & MV BF, and SFT. External high impedance HV & MV REF R150 000	Communication cable for use with SEL relays and computer	4600010558

The detail of the new equipment is as follows:

- 1 x 66kV, 1600A Busbar 1 isolator, 31mm/kV creapage.
- 1 x 66kV, 1600A Busbar 2 isolator, 31mm/kV creapage.
- 3 x 1600A, 20kA, 6-core current transformers (2 prot, 2 meas, 2 Buszone 500/1)
- 1 x 1600A, 20kA, 66kV three pole circuit breaker, 31mm/kV creapage.
- 1 x 11kV NEC/NER/Aux TRFR, 360A, 31mm/kV creapage.
- 1 x 11kV, SF6 dog box breaker, 31mm/kV creapage.
- 1 x 11kV busbar isolator, 31mm/kV creapage. (standard DT auxiliary contact configuration)

1.8 66/11 kV Transformer 2 OLTC – 4TC5100

The Tap Change protection and control module consists of a multifunctional voltage regulator, integrated transducer and recorder functions, integrated statistical functions to measure and evaluate operation data, several programs for parallel operation of transformers.

1. The tap changer scheme will be mounted in a separate relay panel with the new Transformer 1 OLTC control scheme.

2. EDFS must install an 11-pin Schrack relay (TCDT-X) across the tap change drive tripped lamp; this is to multiply the tap change motor drive tripped auxiliary contacts. A contact from this relay must be wired to the IDF for supervisory indication. A diode must be installed in this circuit to prevent the lamp check switch from energising the TCDT-X relay. A spare diode is available on the diode board supplied with the scheme.

3. The Reg.-D relay requires a phase-phase VT input and a single-phase current input from the transformer bushing protection CT cores on the MV side. The current input is essential, as the relay will block all tapping when on auto if there is no load current flowing.

4. A Remote Access rasm of type A will be installed in the OLTC control panel for the Eberle relay which has an RS232 port; an RS232 inline surge protection device must be installed between the Eberle relay and the Nport.
   An RS232 DB9 Clearline surge protection device (12-00768) must be included to protect the serial port.

5. The AC supply from the 4TC5100 scheme must be used to supply the tap position encoder and not the motor supply. A separate supply cable must therefore be installed to the drive.

6. EDFS is to install a 48V schrack relay in the scheme which is to serve as a supervisory reset for a tap change lockout. See the drawings for further details.

7. The scheme will run in Follower mode.

8. The scheme will be connected to the Sherlog recorder as per the drawings. The following binary points in Table 6 below will be monitored.

TABLE 6: OLTC TYPE - 4TC5100

ALARM	WIRE NUMBER +	WIRE No -	SHEET No	REV (DT)
Motor Runing Auxiliary	N113	N102	4	2
TC O/C Block	N159	N102	5	2
Lock-out Reset	N163	N102	5	2
TC Voltage Abnormal	N167	N102	5	2
Tap Change not Healthy	N165	N102	5	2
TC Lockout	N171A	N102	6	2
TC on Manual	N173A	N102	6	2
TC Drive Tripped	N175A	N102	6	2

9. Additional supervisory points need to be wired for SCADA. See drawings for point names.

Scheme Description:

1.8.1.1 *Cost Effective, Minimum Functionality Tap Change Control Scheme*

QTY	SCHEME (MANUF)	PROT AVAILABLE (MODULE) DESCRIPTION	OPTIONS (MODULE) DESCRIP	ENC
1	4TC5100 (IST)	1. Eberle REG-D voltage regulator	.	**4600010558 1.8.1.1.1.1.1**

1.9 66/11kV Transformer 3 – 3TM5110

The 3TM5110 scheme designed for protection of distribution transformers larger than 20MVA will be used to protect this transformer. The scheme is suitable to protect transformers of all vector groups over a wide voltage range.
The scheme has a SEL-387A integrated relay comprising the following protection: Two winding differential, HV over current & earth fault, MV earth fault, MV SEF, HV & MV breaker fail and sustained fault timer.
The HV & MV High Impedance REF option will be ordered,

1. The scheme will be placed in a separate swing frame panel.

2. An ABB 66kV 3 pole breaker will be installed on the HV side of the breaker and the existing Dogbox breaker on the MV side.

3. New 66kV CT's will be installed. A CTJB will be installed on the white phase CT steelwork. 500/1 Buszone CT ratio CT's must be ordered for future application.

4. The HV REF will utilise the HV post CT's. The HV side of the transformer is a delta configuration and has no neutral CT's.

5. The MV REF will utilise the second set of protection CT's on the MV dogbox breaker and the second neutral CT on the NECRT.

6. The HV & MV REF trip must initiate an input into the SEL387A relay for event recording purposes, use IN205 & IN206 respectively. IN205 & IN 206 must be configured to trip the same outputs as the low impedance REF function.

7. The ratio of the SEF current transformer must be 100/1 so that this protection can be set to 10A on the primary. The 10A value is important so as to protect the NEC for long duration neutral currents as the NEC neutral is only rated at 10Amps continuous. The timing delay must be set long enough to allow operating on the MV network and to prevent unnecessary tripping of the transformer. The SEF will trip the transformer MV breaker and initiate the sustained fault timer. This protection must also provide a display point on the SEL387A relay.

8. A Remote Access RASM of type B will be installed in the transformer panel. Refer to section 9 for details.

9. The RS485-4W ports on the SEL387A will be connected to port 1 on the Remote Access RASM. See section 9 for further details.

10. The Type B Remote Access RASM has a second Nport device to facilitate the RS485 connection to the ABB transducer in the panel.

11. The SEL relay uses the IRIGB-002 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.

12. All isolators in this bay will be new. 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.

13. EDFS must install trip auxiliary contactors and free-wheeling diodes in both the main and backup trip circuits of the MV breaker. (Exposed wiring to be covered with heat shrink). See drawings for details.

14. A Shrack relay must be built into the scheme by EDFS to serve as a Anti pump timer auxiliary relay on the HV & MV closing circuit, all three contacts of this relay must be wired in series. This relay will act as a sacrificial relay to safeguard the SEL387A output contact.

15. The transformer MV Breaker fail function must be marshalled to trip the HV breaker and the MV breaker of Transformer 1 & 2. The MV Breaker fail output contact must be used to trip Transformer 1 MV breaker by energising IN106 utilising Transformer 1 DC supply.

16. The 11kV Feeder's breaker fail must be used to trip the Transformer 1, 2 and 3 MV breakers.

17. The trip input from the respective feeders must be wired to IN106 on the SEL387A. IN106 must be marshalled to trip the MV breaker and energise Display Point (DP) 16 via a latch. DP 16 must be labelled accordingly. A spare LCD display point must be used to display this trip and the text must read as follows: EXT BKR FAIL
DP 16 will be reset by pushing the reset button on the SEL387A.
Setting for DP 16:
S3 SLT4 = IN106
S3RLT4 = TRGTR
DP16 = S3LT4

18. The supervisory indication for HV and MV trip coil supervision must be made to share a common output from the SEL387A (OUT211), thus freeing an output (OUT212) which will be used as a common external breaker fail alarm. Note: EDNS and EDFS to make sure the settings accommodate this change.
The output logics should look as follows: **OUT211 = S3V1T+S3V3T+S3V2T+S3V4T**
OUT212 = IN106

19. One of the SF6 block alarms in the HV and MV breaker must be used in the breaker not healthy circuits.

20. The other SF6 block contact must be used for an alarm to Scada. See drgs. For details
21. The thermal contact in the breakers must be taken back to scada for alarming purposes.

22. The scheme will be supplied with all necessary wiring to accommodate the ABB transducer. EDFS must fit the transducer in the scheme. The ABB transducer provides remote analogue Watts, VAR's, Frequency and current indication.

23. The scheme will be connected to the Sherlog recorder as per the drawings. The binary points in Table 7 below will be monitored.

TABLE 7: TRANSFORMER TYPE- 3TM5110

Diff HV E/F; HV O/C (Hi-set) Trip; HV/MV REF Trip	Pin A02 of SEL-387A (insert diode between SEL output and HV CB Main trip) and number wire K103A	K102	8
Sustained Fault Trip	K109	K102	8
Fault Master Trip	K113	K102	8
Trfr Buch Trip	K115	K102	8
Trfr PRV Trip	K119	K102	8
Trfr Oil Temp Trip	K123	K102	8
OLTC Buch	K127	K102	8
TRFR Winding Temp	K135	K102	8
NECRT Buch/Oil Temp	K131	K102	8
Trfr/OLTC Oil Level Alarm	K165	K102	9
Diff/Hiset HV O/C (HI-SET); HV/MV REF	K143A (insert diode)	K102	10
HV REF Trip	K147	K102	10
MV REF Trip	K147A	K102	10
External Bkr Fail	K303B (insert diode)	K302	11
Diff/REF/HV E/F; HV O/C (Hi-set) Trip	K303A (insert diode)	K302	11
MV O/C&E/F; HV O/C Trip	K325A (insert diode)	K302	12
HV Bkr Open	L111	L104	14
MV Bkr Open	L117	L104	14

Scheme Description:

QTY	SCHEME (MANUFACTURER)	PROT AVAILABLE (MODULE) DESCRIPTION	OPTIONS SELECTED	SAP
1	3TM5110 (IST)	SEL-387A relay with –2 Wdg DIFF, HV O/C, HV E/F, MV O/C & E/F, MV SEF, HV & MV BF, and SFT. External high impedance HV & MV REF R150 000	Communication cable for use with SEL relays and computer	4600010558

The detail of the new equipment is as follows:

- 1 x 66kV, 1600A Busbar 1 isolator, 31mm/kV creapage.
- 1 x 66kV, 1600A Busbar 2 isolator, 31mm/kV creapage.
- 3 x 1600A, 20kA, 6-core current transformers (2 prot, 2 meas, 2 Buszone 500/1)
- 1 x 1600A, 20kA, 66kV three pole circuit breaker, 31mm/kV creapage.
- 1 x 11kV NEC/NER/Aux TRFR, 360A, 31mm/kV creapage.
- 1 x 11kV, SF6 dog box breaker, 31mm/kV creapage.
- 1 x 11kV busbar isolator, 31mm/kV creapage. (standard DT auxiliary contact configuration)

1.10 66/11 kV Transformer 3 OLTC – 4TC5100

The Tap Change protection and control module consists of a multifunctional voltage regulator, integrated transducer and recorder functions, integrated statistical functions to measure and evaluate operation data, several programs for parallel operation of transformers.

1. The tap changer scheme will be mounted in a separate relay panel.

2. EDFS must install an 11-pin Schrack relay (TCDT-X) across the tap change drive tripped lamp; this is to multiply the tap change motor drive tripped auxiliary contacts. A contact from this relay must be wired to the IDF for supervisory indication. A diode must be installed in this circuit to prevent the lamp check switch from energising the TCDT-X relay. A spare diode is available on the diode board supplied with the scheme.

3. The Reg.-D relay requires a phase-phase VT input and a single-phase current input from the transformer bushing protection CT cores on the MV side. The current input is essential, as the relay will block all tapping when on auto if there is no load current flowing.

4. A Remote Access RASM of type A will be installed in the OLTC control panel for the Eberle relay which has an RS232 port; an RS232 inline surge protection device must be installed between the Eberle relay and the Nport.
An RS232 DB9 Clearline surge protection device (12-00768) must be included to protect the serial port.

5. The AC supply from the 4TC5100 scheme must be used to supply the tap position encoder and not the motor supply. A separate supply cable must therefore be installed to the drive.

6. EDFS is to install a 48V schrack relay in the scheme which is to serve as a supervisory reset for a tap change lockout. See the drawings for further details.

7. The scheme will run in Isolated mode. It must be noted that as Tfrf 3 is unmatched with Trfr 1 and 2, then the 11kV section isolator should be run open as the default norm. A note stating this (11kV section isolator to remain open) must be placed on the scheme. Should the 11kV section isolator be closed for any (emergency) condition, all tap changer schemes must run in manual operation and all tap changers to be monitored and run on fixed nominal tap.

8. The scheme will be connected to the Sherlog recorder as per the drawings. The binary points in Table 8 below will be monitored.

TABLE 8: OLTC TYPE - 4TC5100

ALARM	WIRE NUMBER +	WIRE No -	SHEET No	REV (DT)
Motor Runing Auxiliary	N113	N102	4	2
TC O/C Block	N159	N102	5	2
Lock-out Reset	N163	N102	5	2
TC Voltage Abnormal	N167	N102	5	2
Tap Change not Healthy	N165	N102	5	2
TC Lockout	N171A	N102	6	2
TC on Manual	N173A	N102	6	2
TC Drive Tripped	N175A	N102	6	2

9. Additional supervisory points need to be wired for SCADA. See drawings for point names.

Scheme Description:

1.10.1.1 Cost Effective, Minimum Functionality Tap Change Control Scheme

QTY	SCHEME (MANUF)	PROT AVAILABLE (MODULE) DESCRIPTION	OPTIONS (MODULE) DESCRIP	ENC
1	4TC5100 (IST)	1. Eberle REG-D voltage regulator	.	**4600010558 1.10.1.1.1.1.1**

1.11 11kV Rural Feeder Schemes – 3RF-3100

The 3RF3100 schemes will remain.

- EDFS must install trip auxiliary contactors and free-wheeling diodes in the main trip circuit of the feeder breaker. (Exposed wiring to be covered with heat shrink). See drawings for details.
- These are vacuum breakers, so no mods. are required for SF6 gas.
- A breaker fail isolator must be installed in each of the schemes by EDFS. An output (shown on existing drgs. As "start") will be marshalled as a breaker fail. The breaker fail output must be wired to energise the breaker fail auxiliary relay (Arteche RF4 relay installed by Eskom) used to multiply the contacts of the breaker fail output. A breaker fail contact from each feeder must be wired to trip the Transformer MV breakers on each transformer scheme utilising the respective DC supply. The breaker fail outputs must have a breaker fail isolator contact wired in on both sides of the output. A contact on the Breaker Fail auxiliary relay must be wired to supervisory to indicate the breaker fail condition. The BFI off position must be wired to the IDF for supervisory indication and another contact must be wired into the protection not healthy circuit.
- A Remote Access RASM of type A will be installed in each of the 11kV feeder panels.
- The BTP's will have sufficient connection to connect to the DPU2000R relays.
- The existing communication cards in the DPU2000R relays do not support time synchronisation and are not going to be replaced on this project.
- New AC & DC supplies will be obtained from the new AC & DC panels being installed.

1.12 Under Frequency Load Shedding - 3LM3400

The UFLS scheme consists of under/over frequency with four stages but only two stages are used. This is a non ENC scheme which utilises the SPAF-140C relay provides under & over frequency, and it was used by Eskom Distribution when it was on ENC a few years ago. Each frequency stage can be set for definite time and can also be given separate operate times. It has four output relays, i.e. two for tripping, one for signalling and one for the self-supervision system. The UFLS scheme is required in this substation to ensure that during under frequency conditions the necessary outgoing feeders are tripped. This is essential because the under frequency conditions are generally caused by overloading or loss of capacity of the network.

The following notes are important regarding the scheme:

1. The loads shed are carefully selected to ensure that the minimum load is shed.
2. The 11kV VT supplies must be monitored for UFLS purposes
3. The AC & DC supplies will be obtained from the new AC & DC panels being installed.
4. A Remote Access & Time Synch Module (RASM) of type A will be installed in the UFLS panel. The scheme will be ordered with a SPAZA15 RS485/TTL converter module to be used to connect the SPAF140C relay to the Remote Access RASM. The SPAZA15 needs to be powered from the 12V DC supply on the Remote Access RASM. EDFS is required to wire the 12V DC supply to the SPAZA15 converter.
5. All the Tripping Output terminals must be replaced with Entrelec Sliding Link Terminals as per drawings.
6. The Setting Group 1 Control will be replaced by the UFLS On Control and the Settings Group 2 Control with UFLS Off Control. The Settings Group 2 Selected Indication will be replaced by the UFLS Off Indication and the Settings Group 1 Selected Indication by the UFLS On Indication.

The UFLS scheme must also facilitate connection to the Sherlog recorder. EDFS must modify the scheme and the following points need to be monitored:

UFLS TYPE 3LM3400			
ALARM	**WIRE NUMBER +**	**WIRE No -**	**SHEET No**
Stage 1 Trip	K104	K102	2
Stage 2 Trip	K106	K102	2

Scheme Description:

QTY	SCHEME (MANUF)	PROT AVAILABLE (MODULE) DESCRIPTION	ENC
1	3LM3400 (ABB)	**3LM3400** UNDERFREQUENCY LOAD SHEDDING Protection Module. Dual stage, equipped for **4 circuits** per stage for **110V** DC operation	**Non ENC**

1.13 Fault Recorder

Two Sherlog fault recorders 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 recorders will be mounted in the remote access panel and will consist of 2 units interconnected together for complete analysis capability. A second panel will be installed next to the first panel. The panel will be equipped with all the terminals for the connection to the actual plant. Both these panels must be built as per the drawings and standards provided.

Both units will be individually connected to the EDnet switch from its respective port. This connection 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.

Future schemes requiring analogue current channels will use some existing 11kV feeder's analogue current channels.

Bypass indication for both the 66kV feeders needs to be wired to the recorder.
The GPS antennae for the recorder shall be mounted and connected by the cabling contractor. EDNS will supply an inline surge protection device that is to be installed between the antennae and the recorder.
See each panel in Table 9 for the points which are to be monitored by the recorder.

TABLE 9: Number of Analogues and binaries to be monitored per equipment

Bay	Current Analogue	Voltage Analogue	Binary
66kV Fdr 1	4		16
66kV Fdr 2	4		16
66kV Buszone			9
66kV Bus Coupler			13
66kV Busbar 1		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 1A		3	1
11kV Busbar 1B		3	1
11kV Bussection			2
11kV Fdr 1	4		5
11kV Fdr 2	4		5
11kV Fdr 3	4		5
11kV Fdr 4	4		5
UFLS			2
Spare	0	4	98
Total	**48**	**16**	**256**
Recorder Size:	64 Analogues 256 Binaries		
Total number of units:	2		

1.14 Swing Frame Cabinets and Blanking Plates

Five new swing frame cabinets complete with earthing, trunking and pre-punched chassis plates are required for the installation of the schemes.
The recorder and remote access will require two double entry panels with glass front doors.
One BME panel and one RTU panel will be provided with its equipment mounted and provision should be made for the installation of a second panel in the future. The 66kV buszone, AC and DC distribution panels will be provided with all schemes fitted.
The panels must be positioned in the building as per the drawings.

2 AC & DC SYSTEMS

2.1 110V Batteries and Charger

The existing Ni-cads are inadequately sized for this extension and must be upgraded. New Ni-Cad batteries and a new battery cabinet will be installed. The old batteries and cabinet must be send back to Ducats and can be used as spares.
The distance form EDFS (DC) base site to Good Hope Textiles is less than 200km, as per the guideline, a standby time of at least 12hrs is therefore required. The 185AH bank which is to be installed will provide a standby time of 19.89 hours at 80% efficiency with a predicted load of 9.3A.

Table 10 : DC Requirements

Alkaline Batteries contract no 4600041171			
QTY	**TYPE (MANUF)**	**DESCRIPTION**	**Sap No**
85	(ALCAD)	CELL, NICD 1.2V 185AH VTX1 L185 D9308	0256094
1	Cabinet	CABINET, BATT NICD 1250x650x1850 D9218 Standalone Cabinet with fixed steps Suitable for 88 of the following cells: VTX1 L: 95 - 185Ah VTX1 M: 75 - 170Ah Safety sign DCSS 2 (0186196) included	256354

Alkaline Batteries contract no 4600041171			
QTY	**TYPE (MANUF)**	**DESCRIPTION**	**Sap No**
1	Link set	CONNECTORS, VTX BATT LINK SET 4 D9310 Suitable for connecting 85 - 88 of the following cells in a Standalone Battery Cabinet: VTX1 L: 140 - 185Ah VTX1 M: 125 - 170Ah	0256349

2.2 AC & DC Distribution Design

A new 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 and 3 NEC's.

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

DC Modules				
QTY	**SCHEME (MANUF)**	**MODULE DESCRIPTION**	**OPTIONS (MODULE) DESCRIP**	**ENC**
1	Various	DC panel	2AD1500 (1st Module) 110VDC Main Distribution module 1 (10*32A double pole MCB's with 60A isolator) for 10 protection output circuits (CIRCUIT: A-B-C-D-E-F-G-H-J-K) 2AD1500 (2nd Module) 110VDC Main Distribution module 2 (10*32A double pole MCB's with 60A isolator) for 10 protection output circuits (CIRCUIT: L-M-N-P-R-S-T-U-V-W) 2AD1900 (1st Module) 110VDC Backup	**2.2.1.1.1.1.1**

			Distribution module 1 (10*32A double pole MCB's with 60A isolator) for 10 protection output circuits (CIRCUIT: A-B-C-D-E-F-G-H-J-K) 2AD1900 (2nd Module) 110VDC Backup Distribution module 2 (10*32A double pole MCB's with 60A isolator) for 10 protection output circuits (CIRCUIT: L-M-N-P-R-S-T-U-V-W) 2AD1700 (1st Module) 110VDC Spring Rewind module 1 (8*32A double pole MCB'swith aux contacts & 60A isolator) for 8 spring rewind circuits (CIRCUIT: A-B-C-D-E-F-G-H) 2AD1700 (2nd Module) 110VDC Spring Rewind module 2 (8*32A double pole MCB'swith aux contacts & 60A isolator) for 8 spring rewind circuits (CIRCUIT: K-L-M-N-P-R-S-T) 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) Order if using chop over 2AD1400 3Ph chop over module (400VAC, 100A with two 4pole 100A isolators, 2 * Dehnguard TT surge protection units [900550]) 2AD1300 (1st Module) 3Ph AC distribution module 1 (5*32A three pole MCB's) (CIRCUIT: A-B-C-D-E) 2AD1300 (2nd Module) 3Ph AC distribution module 2 (5*32A three pole MCB's) (CIRCUIT: F-G-H-J-K) 2AD1200 (1st Module) 1Ph AC Distribution module (10*10A single pole MCB's) (CIRCUIT: A-B-C-D-E-F-G-H-J-K) 2AD1200 (2nd Module) 1Ph AC Distribution module (10*10A single pole MCB's) (CIRCUIT: L-M-N-P--R-S-T-U-V-W) 2AD1800 400VAC & 240VAC Supply module (5-pin, 20A, 3Ph socket & 2*16A plug sockets with 20A MCB & earth leakage) 2AD2100 Yard Light Module 1 * Swing frame cabinet bottom entry	**2.2.1.1.1.1.2**

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 arrestor 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 switched via the SCADA system and they can also be triggered by the security beams. See drawings for wiring details.

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.

3 MEASUREMENTS DESIGN

3.1 Statistical Measurements

Transducers

1. An iSTAT I5MT transducer will be installed on the each of the two 66kV feeder schemes.

2. ABB digital transducers will be installed on the transformer scheme; EDFS will fit the transducer in each scheme. The ABB transducers on the two 66kV feeders and the transformer schemes must be connected via the RS-485 bus to the Nport devices on the Remote Access Modules.

3. Since there will be no 11kV bus-section, a transducer module will be installed in 11kV tariff metering panel1 in order to monitor bus bar pressures.

Metering Panel 1

1. Statistical measurements will be done on the two 66kV feeders. One metering module will be supplied for both the 66kV feeders and will be fitted in Metering Panel 1.

2. Statistical measurements will be done on the 66/11kV Transformer 1 & 2. One metering module will be supplied for both transformers and will be fitted in Metering Panel 1 as well.

3. Statistical measurements will be done on the 66/11kV Transformer 3 & 11kV feeder 3. One metering module will be supplied for both transformer and 11kV feeder and will be fitted in Metering Panel 1 as well.

4. A modem will be installed in the panel to facilitate the remote interrogation and downloads from the meters.

5. A Vectograph and vectograph module will be installed which will enable QOS to monitor the 11kV supplies. EDFS must build the Vectograph module and install it in the top of metering panel 1. The Vectograph must be connected to the 11kV busbar 2 by obtaining the VT supply directly from the VTJB 2. The auxiliary supply for the Vectograph will be 240V AC lopped from the vectograph module in 11kV tariff metering panel.

6. The RS485 port of the Vectograph must be looped to 11kV tariff metering panel and connected to port 2 of the Nport on the RASM type A.

11kV Tariff Metering Panel 1

1. Tariff measurements will be done on 11kV feeders 1, 2 & 4. Three metering modules will be fitted in 11kV tariff metering panel 1 and they will accommodate all three of the feeders.

2. A modem will be installed in the panel to facilitate the remote interrogation and downloads from the meters.

3. A Vectograph and vectograph module will be installed which will enable QOS to monitor the 11kV supplies. EDFS must build the Vectograph module and install it in the top of 11kV tariff metering panel 1. The Vectograph must be connected to the 11kV busbar 1 by obtaining the VT supply directly from the VTJB 1. The auxiliary supply for the Vectograph will be 240V AC obtained directly from the AC distribution panel.

4. A RASM of type A must also be installed in 11kV metering panel 1. The Vectograph's RS485 port must be connected to port 1 of the Nport on the RASM. The Remote Access RASM will provide connection to the Vectograph via EDnet and thus Network Services – Plant (Quality of Supply) will also be able to connect to the Vectograph using an Nport on their end.

See table below for the equipment details:

3.1.1.1 Metering Schemes and Transducers

QTY	SCHEME (MANUF)	DESCRIPTION	ENC
2	**Landis & Gyr**	Demand Energy Meters Class 0.5 @ R3000 each	SAP: 213154
6	**3.1.1.1.1.1.1 WirConn**	Metering module from Wircon • R 7836.40 each	None
1	**3.1.1.1.1.1.2 ABB**	• Digital transducer mounted on a din rail with a femaleDB25 connector and a terminal arrangement to standardise the interface to the unit. • The unit is factory pre-programmed and configured to provide the necessary feeder/TRFR scheme analogue indications. • R 17500 each • According to Eskom drawing D-DT-9121	-
2	**3.1.1.1.1.1.3 iSTAT I5MT**	iSTAT I5MT Comm Multifunc 3 Ph Transducer. RS232/RS485 with MODBUS RTU or DNP3 comms protocol. 4 Ana O/P and Rem Displ port, Pin Terminals. Product code: I5MTX2H1DCLLLLPX	None
2	**3.1.1.1.1.1.4 Measuretronics**	• Voltage Transducer (Model:KV1-V110-A5M-C5-0 Type: MEAN RV/A, IN-110V AC, Out- 0-5mA DC, Load- 2kOhm , Calib-80...100% , Class- 0.5)	None
2	**3.1.1.1.1.1.5 CT LAB**	• 19' rack mounted Vectograph complete with modem	None
2	**Trucom Smartoo**	GSM Modem (Including antennae & power supply) R 2,278.4	223364
1		Cable, comm. ZMD meter (between GSM modem & 1st meter) R 34.75	207023

4 PR IMARY PLANT REQUIREMENTS

4.1 66kV Single Pole Breakers

Two 66kV single pole breakers are required for the two 66kV feeder bays.

4.2 66kV Three Pole Breakers

Two 66kV three pole breakers are required, one for the transformer 3 bay and one for the bus coupler.

4.3 66kV Current Transformers

A total of twenty one 66kV CT's are required. The two 66kV feeder bays each require a set, the three transformer bays also requires a set and two sets for the bus coupler.
The CT's must have a Buszone ratio of 500/1A.

4.4 66kV Voltage Transformers

Six 66kV VT's will be installed. One set on each 66kV busbar. A VT JB will be installed on the white phase VT structure for each set.

4.5 66kV Isolators

Sixteen 66kV isolators are required for the two 66kV feeder bays, three transformer bays and buscoupler. This includes the two feeder bypass isolators, one per feeder bay.
Project Engineering to ensure mechanism boxes are supplied with the new standard box specified by ED Project Engineering which contains the Type "GS" contacts.

4.6 66kV Surge Arrestors

Fifteen 66kV surge arrestors will be installed, three on each 66kV feeder and three on each transformer.

4.7 Isolator Junction Boxes

Six double insert isolator junction boxes will be installed. One on each transformer bay and one on each of the 66kV feeder bays and one on the 66kV bus coupler bay.

4.8 Current Transformer Junction Boxes

A total of seven CTJB's will be installed on the white phase CT steel work of the three transformers, the two 132kV feeders and the two sets of CT's in the 132kV Bus-coupler bay.

5 TELECONTROL DESIGN

5.1 Equipment Requirements

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

5.2 Control Room Layout

Refer to substation floor plan.

5.3 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.

5.4 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.

5.5 Communication Medium

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

5.6 Power Requirements

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

5.7 Teleprotection

Teleprotection on the King Williams Town 1 66kV feeder and Fort Murray 66kV feeder will be via ADSS. Additional equipment as per the distance scheme will be used.

6 REMOTE ENGINEERING ACCESS & TIME SYNCHRONISATION

6.1 Remote Access

A new remote access switch PT 7728-R-HV will be used for remote access capabilities. This switch comes as a Rackmount Ethernet Switch System with four slots for additional modules. The additional modules required are 2xPM 7200-8TX and 1xPM 7200-8SFP will need to be fitted buy the technician in slots 1, slot 2 and slot 3 respectively. In addition to PM 7200-8SFP, two SFP-1FESLC-T 100BaseFX single mode long range Fibre ports for the fibre optic link from King Williams Town to Fort Murray 66 kV feeders and two SFP-1FEMLC-T 100BaseFX multi-mode fibre ports . The following notes should be adhered to during commissioning:-

1. The switch and remote access computer will be powered by an 110V DC supply as indicated on the remote access drawings D-SR-228 Set 31.

2. A remote access computer will be installed in the combined remote access and recorder panel and will be connected via an Ethernet connection directly to port 1 of module PM 7200-8TX . The following additional connections will be made to the remote access PC:

   - PC com-port 1 will be serially wired to the sherlog reconder 1 through a RS 232 Port
   - PC com-port 2 will be serially wired to the sherlog reconder 2 through a RS 232 Port
   - The GPS for the time synchronizasion will be serially connect to the PC trhough a RS 232 Port

3. A Fibre Optic Patch panel will be installed in the Telecoms panel and will act as the interface to the King Williams Town PT7728-R-HV via an ADSS optic fibre cable between Good Hope Textiles and King Williams Town connected to the first SFP-1FESLC-T 100BaseFX single mode short range Fibre port in the PM 7200-8SFP at Good Hope Textiles.

4. The second SFP-1FESLC-T 100BaseFX single mode short range Fibre port will facilitate the ADSS optic fibre cable connection between Good Hope Textiles and the Fort Murray FDR.

5. Relays excluded from the 100BaseTx copper Ethernet loop are the main and backup relays on the new 4FZ 3940 schemes. There are a total of two, namely the 66kV King Williams Town 1 feeder and Fort Murray 66kV feeder. Access to these relays will be achieved via a 100FX fibre optic Ethernet link from fibre port 2 on the SFP-1FEMLC-T module to RS900 switch situated in 4FZ3940 of FDR 1 scheme. This RS900 switch will be daisy chained to next RS900 card of the 4FZ3940 FDR2 scheme , and a closed loop will formed by a connection back to fibre port 4 on the SFP-1FEMLC-T module through 100BaseFX multimode fibre cable. Then following connections will be made:-

   - The fibre optic loop between the two feeder panels must be placed in over-head trunking as per the new standard specified by EDNS to prevent any damage.
   - Note that the 3phase digital transducers in each scheme still require a RASM, therefore the Type A remote access modules will be installed in each feeder scheme and will be connected from its N-port' Ethernet copper port to their respective port 5 Ethernet copper port in the RS 900 switch via 100BaseTX copper Ethernet cable. And the corresponding serial ports on each N-port will be serially connected to the respective transducer's serial ports.
   - Both main relays of the 4FZ3940 (RED670) FDR schemes will be connected through their Fibre port to the port 9 Fibre optic ports of their respective RS900 card via a 100BaseFX multimode fibre optic Ethernet cable.
   - Both backup relays of the 4FZ3940 (REF615) FDR schemes will be connected through their Ethernet copper ports to the port 6 copper ports of their respective RS900 switch via a 100BaseTX Ethernet copper cable.

6. The rest of the schemes (Trfr 1, 2 & 3; 11kV Fdr 1, 2, 3 & 4; Buszone; Bus coupler; Vectograph and UFLS) in which a specific Type RASM will be installed as a remote access capability, will be daisy chained via their corresponding Ethernet copper ports of their N-port to port 6 on the PM-7200-8TX module in slot 1. For better redundancy the daisy chain link will be closed to form a loop by connecting from the last scheme in the chain to port 7 on the PM-7200-8TX module in slot 1. Screened Ethernet cable will be used and must be placed in suitable over-head trunking as per the new standard conduit specified by EDNS to prevent any damage.

7. Each panel requiring remote access will be fitted with an application specific Remote Access RASM. There are three types of Remote Access RASM; the various components they consist of are as follows:

   - Module Type A (Standard Type)
     - 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.

   - Module Type B (Transformer Type)
     - 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.

   - Module Type C (Transformer Type)
     - 5U blanking pate.
     - 2A double pole C-curve MCB.
     - Meanwell MDR-20-12 power supply.
     - **1 x** Moxa Nport (IA5250) 2 port serial to Ethernet converter.
     - IBTS703R GPS receiver isolation unit.
     - SPA ZA 22/1 485/Fibre converter.

8. The Remote Access 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 RASM will be supplied by EDNS.

9. There will be two Sherlog recorder units, each with 32 analogue inputs and 128 binary inputs. Each unit must be connected directly to the Moxa PT 7728-R-HV switch on the PM-7200 8TX module ports 4 and 5 via their own Ethernet cable which is supplied with the unit.

   M1 P3
   M1 P4

   - The sherlog recorders serial ports will be serially connected to the remote access pc for substation local access.

10. 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.

    Juniper SRX240 + 2x Sync Serial (X.21)

11. For Remote Access Network Flexibility, a ~~3Com3012 Router~~ will be installed in the remote access panel and will be connected to the PM7200-2MSC4TX module on Ethernet copper port 4 via a 100BaseTX Ethernet copper cable.

    M1 P9

6.2 Time Synchronisation

1. For post-fault investigation and record assimilation, a 19" Meinberg time synchroniser will be installed in the recorder/remote access panel and will be connected to all the SEL, RED670, GE Multilin F35 and REF615 relays.

2. A transmitter card type IBTS703T is needed when connecting to multiple devices which use the IRIG-B protocol for synchronisation. One IBTS703R receiver isolation unit is required per panel requiring IRIG-B synchronisation but it should be noted that a maximum of three relays can be synchronised per IBTS703R.

3. The RED670 and the REF615 relays in the 66kV feeder schemes use the IRIGB protocol for time synchronisation. Receiver and transmitter cards are required.

4. The cabling contractor is to mount and connect the GPS antennae for the Meinberg device as well as install an inline surge protection device (N PROTECT BHEAD MA FEM 230V Part #: CNC7J01028A0046) between the Meinberg device and the antennae. EDNS will order and supply the surge protection device.

7 CONTROL BUILDING

The existing control room building will be modified by converting the old store room as part of the control room. The wall between the control room and the store room will be broken down and cable trenches with covers will be added by extending the existing cable trenches into the new room. The store room access door, all air vents and windows will be bricked up and closed. Emergency lights will be fitted in the relay room. All these lights will be switched by the new 60min timer located at the relay room door.

The civil contractor must mount all GPS antennas on the provided bracket on the apex of the control building roof as per the drawings.

COC wiring certificate needs to be issued for the relay room.

8 STAKEHOLDERS

The following stakeholders were involved:

- I Kruger - Design Engineer (Protection)
- W van Heerden - Design Engineer (Telecontrol)
- R Mclaren - EDFS Ducats (Protection & DC)
- P Hobson - EDFS Ducats (Metering)
- A Craib - EDNS Technology
- G Geddie - EDNS Technology
- J Enslin - EDNS Technology
- T Masinga - NS Project Engineering
- B Mutangadura - NS Project Engineering

9 BILL OF MATERIALS

- 2 * 66kV single pole impedance schemes (4FZD3940)
- 1 * Bus Zone scheme (4BZ5700)
- 1 * Under Frequency Load Shed Scheme (4LM3400)
- 2 * VTJB
- 5 * Swing-frame cabinets
- 2 * Double entry cabinets for recorder & remote access
- 7 * CTJB's
- 2 * Sherlog Recorder Units
- 1 * Substation PC
- 1 * D20 RTU & IDF
- 6 * Metering modules
- 2 * Measuretronics Voltage Transducers
- 3 * ABB Transducers
- 2 * Landis & Ger meters class 0.5
- 2 * Vectograph
- 6 * Isolator JB's
- 1 * AC Distribution panel with modules
- 1 * DC Distribution panel with modules
- 4 * Allen Bradley Contactors
- 1 * N PROTECT BHEAD MA FEM 230V inline surge protection device
- 9 * RASM type-A
- 3 * RASM type-B

10 STAKEHOLDERS SIGNATURES

Name	Signature	Comments
R.VANTS		THANKS
J M Ch		See covering