Eskom	Standard	Technology

Title: **STANDARD FOR TRANSMISSION AND DISTRIBUTION PROTECTION SCHEMES: COMMON REQUIREMENTS**

Unique Identifier:	**240-65336348**
Alternative Reference Number:	**<n/a>**
Part:	**Part 15 – Protection**
Revision:	**1**
Total Pages:	**66**
Next Review Date:	**April 2019**
Disclosure Classification:	**Controlled Disclosure**

Compiled by	Approved	Authorized by
Thys Bower	**Prince Kara**	**Richard McCurrach**
Senior Consultant	**PTM&C Protection T&S Manager**	**PTM&C COE Manager**
Date: 11/04/2014	Date: 11. 4. 2014	Date: 16/4/2014

Supported by SCOT/SC

Graeme Topham

SCOT Protection and Automation Study Committee Chairperson

Date: 15/4/2014

PCM Reference:

SCOT Study Committee Number/Name: **WG08 - Protection & Automation**

Content

Tables

1. Introduction

This document describes the common requirements for protection scheme and module solutions for use within Eskom Transmission and Distribution. This standard supersedes corresponding requirements previously stipulated in TST 41-1062.

This document shall be referenced in the product/application-specific protection scheme standards, the latter documents providing specific details of the required functionality for each scheme.

2. Supporting clauses

2.1 Scope

This standard defines the generic requirements for protection schemes and modules. The details protection product specifications shall be based on this document structure and requirements.

2.1.1 Purpose

This standard details the generic requirements for protection schemes and modules. The requirements presented in this standard shall be supplemented by scheme/module-specific requirements in the detailed standards prepared per scheme type.

2.1.2 Applicability

This standard shall apply to PTM&C within Eskom Group Technology.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] Cigré Working Group B5.27: Implications and Benefits of Standardised Protection and Control Schemes

[3] IEC 60255-5: Electrical relays – Part 5: Electrical relays – Insulation coordination for measuring relays and protection equipment – Requirements and tests

[4] Cigre SC34: “Eskom’s certification testing requirements for EHV numerical transmission line protection relays” 1999

[5] Network Code: The South African Grid Code (Revision 8.0)

[6] 240-42066934: IEC 61850 protocol implementation document for the purposes of substation Automation (Revision 0)

[7] TST41-1062: Standard for electronic protection and fault monitoring equipment for power systems

[8] TST41-627: Standard for labelling of secondary plant equipment

[9] TST41-1064: Standard for earthing of protection equipment

[10] TSP41-1043: Specification for Control, Selector, Isolation and Test Switches

[11] TST41-689: Standard for the Protection and Control of Extra High Voltage Transmission Lines on the Eskom Power System

[12] EHVFDR05: Eskom Transmission Specification for Phase V EHV Transmission Line Protection Schemes

2.2.2 Informative

[13] 32-9: Definition of Eskom documents

[14] 32-644: Eskom documentation management standard

[15] 474-65: Operating manual of the Steering Committee of Technologies (SCOT)

2.3 Definitions

2.3.1 General

Definition	Description
Intelligent electronic device	A microprocessor-based device that encompasses all or some of the following functionalities: protection, control and automation, metering, telecontrol, substation DC and auxiliary supply systems, quality of supply monitoring, and disturbance and event recording.
Junction box not healthy	An alarm condition indicating that the junction box is not able to perform part or all of its intended protective function.
Process Interface Unit (PIU)	Also referred to as a 'digital merging unit' or 'binary input/output device'; an Intelligent Electronic Device (IED) that collects binary data from process devices, typically electrical primary plant equipment, by way of status contacts, and processes and publishes this data to other IEDs in a digital format (e.g. IEC 61580-based communication). The device similarly converts digital commands from other IEDs into electrical control signals to the primary equipment. PIUs are typically installed on or near the primary equipment with which they exchange data.
Protection not healthy	An alarm condition indicating that the protection system is not able to perform part or all of its intended protective function.
Scheme	A set of components that work together in order to execute a specific behaviour under predefined power system conditions sensed through the scheme interface (Cigré Working Group B5.27). 'Scheme' is most commonly applied in the context of power system protection equipment where it historically applied to the secondary plant components associated with the protection and control of a specific primary bay. In the latest design philosophy each main or back-up protection module associated with a specific primary bay are designated as separate, independent schemes.
Switch	A mechanical device which, by manual operation (through rotation, pressing, pulling or axial movement), will either close or open contacts forming part of an electrical circuit.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
A	Ampere(s)
AC	Alternating Current
ACF	Alternating Current fail
ARC	Auto Reclose(r)
BCD	Bay Control Device
BFI	Circuit-breaker Fail Isolated
BZI	Buszone Isolated
°C	Degrees Celsius
CT	Current transformer
CTTB	Current transformer test block
D	Depth
DC	Direct current
DCI	Direct current isolation
EHV	Extra high voltage
ETHSW	Ethernet switch
F	Frequency
GOOSE	Generic Object Oriented Substation Event
GW	Gateway
H	Height
HV	High voltage
HMI	Human machine interface
I1R	Isolator 1 repeat relay
I2R	Isolator 2 repeat relay
IEC	International Electrotechnical Committee
IED	Intelligent electronic device

Abbreviation	Description
IND	Indication
ITR	Transfer isolator repeat relay
JB	Junction box
JBNH	Junction box not healthy
LOR	Local Off Remote
MCB	Miniature Circuit-Breaker
MI	Motorised isolator
MMS	Manufacturing Message Specification
MTR	Master trip relay
MV	Medium voltage
Q	Reactive power
P	Active power
PF	Power factor
PIU	Process interface unit
PNH	Panel Not Healthy
PVC	Polyvinyl chloride
QA	Quality assurance
SANS	South African National Standard
SCADA	Supervisory Control And Data Acquisition
SF_6	Sulphur Hexafluoride
SIS	Supervisory Isolate Switch
SR	Spring rewind
SYNC	Synchronism check
TCD	Tap change drive
TNS	Test Normal Selection
TPIS	Teleprotection isolating switch

Abbreviation	Description
TPK	Transfer permission key
TST	Transmission standard
V	Voltage
VT	Voltage transformer
VTTB	Voltage transformer test block
W	Width

2.5 Roles and responsibilities

Protection design shall utilise this document as basis for the detailed protection solutions standards.

2.6 Process for monitoring

The SCOT Protection & Automation study committee shall evaluate and monitor the compliance to this standard.

2.7 Related/supporting documents

Not applicable.

3. Requirements

3.1 Introduction

This standard describes the common requirements for protection scheme and module solutions. The specific scheme application requirements will be within the detailed functional standards. The scheme/module will house a single main or back-up protection system and the required bay controls.

3.2 Scheme variants & model numbers

Each scheme/module type and variant shall be assigned a unique model number. The number shall be allocated as per Eskom's numbering system (4.2.1 to 4.2.4) and shall be approved by an Eskom protection representative. The scheme/module type number shall be utilised to identify the solution, use for codification, applied to the scheme diagrams and all relevant documentation.

3.2.1 Scheme hardware identification

The protection schemes are to be identified by an 11- or 12-digit code as follows:-

6	FZ	-	#	1	00	-	1	0	0		0
Generation of scheme (Phase)	Scheme group code (Type)		Manufacturer code (Vendor ID)	Series number (Scheme Type)	Major revision number (Scheme design revision)		Voltage level (110 VDC=1 and 220 VDC =2)	Option 1 selected (0= not selected, 1 = selected)	Option 2 selected (0= not selected, 1 = selected)		Option n selected (0= not selected, 1 = selected)

3.2.2 Generation of scheme

The next generation of protection equipment will be identified by using phase number 6. The phase number will increment by 1 for any subsequent group of core commodity contracts (typically after an 8 year contract period).

3.2.3 Scheme group code

The function of a scheme will be identifiable via the scheme group code of this table.

Code	Description	Code	Description
AC	A.C. board	GD	Differential generators
AD	A.C./D.C. Modules	LM	Under Frequency Load shedding
BC	Bus coupler/section	LS	Load shedding
BP	Busbar protection	MP	Metering panel
BZ	Bus zone	MS	Metering statistic
CB	Shunt Capacitor bank	MT	Metering Tariff
CF	Cable Feeder	NCAS	Nuclear Auto-Start
CO	Chop-over/Change-over	RF	Rural feeder
DC	D.C. board	SC	Series Capacitor bank
DIP	Diameter Interface	SR	Series or Shunt reactor
DR	Disturbance Recorder	TA	Auto-transformer
FC	Phase comparison/Differential feeders	TC	Tap-changer

Code	Description	Code	Description
FD	Differential feeder	TM	Power transformer
FP	Pilot wire feeder	TSS	Transient Stability System
FZ	Distance protection feeder	TT	Traction transformer
FZD	Distance/Diff protection feeder		

Note: "B" added for breaker-and-a-half applications, e.g.:

- **FZ - Standard double busbar distance protection feeder;**
- **FZB – Breaker-and-a-half distance protection feeder.**

3.2.4 Manufacturer code

The scheme manufacturer will be identifiable by a number following the scheme group code. Additional numbers will be assigned on contract award:

Code	Manufacturer
0	[Vacant]
1	Actom
2	Siemens
3	ABB
4	[Vacant]
5	Powertech System Integrators
6	VAMP Solutions
7	Consolidated Power Projects (CONCO)

3.2.5 Series number (Scheme Type)

The series number shall be allocated to differentiate between scheme permutations where the same main protection IED is used (e.g. 1, for scheme with transfer and 2, for the same scheme but without transfer).

3.2.6 Major revision number (Scheme design revision)

The starting number for the first approved production schemes shall be 00. This number shall be incremented for any major scheme design change or IED hardware change.

3.2.7 Voltage level

Eskom utilise the following standard station DC voltage supplies:

- 110 VDC (Code = 1); and,
- 220 VDC (Code = 2).

3.2.8 Option 1 selection

First selectable option within the standard scheme design (e.g. with or without teleprotection device) (0= not selected, 1 = selected).

3.2.9 Option 2 selection (0= not selected, 1 = selected)

Second selectable option within the standard scheme design (e.g. with or without busbar voltage selection) (0= not selected, 1 = selected).

3.2.10 Option “n” selection (0= not selected, 1 = selected)

Selectable option “n” within the standard scheme design (0= not selected, 1 = selected).

3.3 Performance requirements

3.3.1 Sensitivity

The sensitivity of the protection functions is the measure of the ability of the relay to detect faults, either with low primary quantities, or with small deviations from the healthy state.

The protection system is required to respond correctly, including correct phase selection, without and with pre-fault load flow, for faults down to zero infeed conditions.

Within the measurement capability of the IED, e.g. minimum current, minimum deviation from healthy state, voltage limit for accurate reach point measurement, the phase selection / directional determination shall be assured, and the variation in IED performance (tripping time) must be in accordance with the given acceptable tripping profiles.

3.3.2 Reliability: Security & Dependability

3.3.2.1 Security

Security is defined as the probability of not having an unwanted operation under given conditions for a given time interval. The protection system shall have as high a security as possible.

3.3.2.2 Dependability

Dependability is defined as the probability of not having a failure to operate under given conditions for a given time interval. The protection system shall have as high dependability as possible.

3.3.2.3 Directionality

Directionality is the ability of a protection functions to distinguish between forward and reverse fault conditions, and in-zone and out of zone faults. The protection functions shall be capable of correctly determining the fault position, without any added delay to the overall tripping time, for any fault occurring and for any network condition.

3.3.3 Speed

Clearance of network faults in the shortest time is a fundamental requirement, but this must be seen in conjunction with performance requirements for the specific application. The Protection Systems applied shall comply with the operating times specified within the product specific documentation. Speed shall not compromise dependability and security.

3.3.4 Longevity

The protection scheme/module shall be designed for a minimum operational life of 20 years.

3.4 Scheme interfaces

3.4.1 Auxiliary supplies

3.4.1.1 230V AC supply

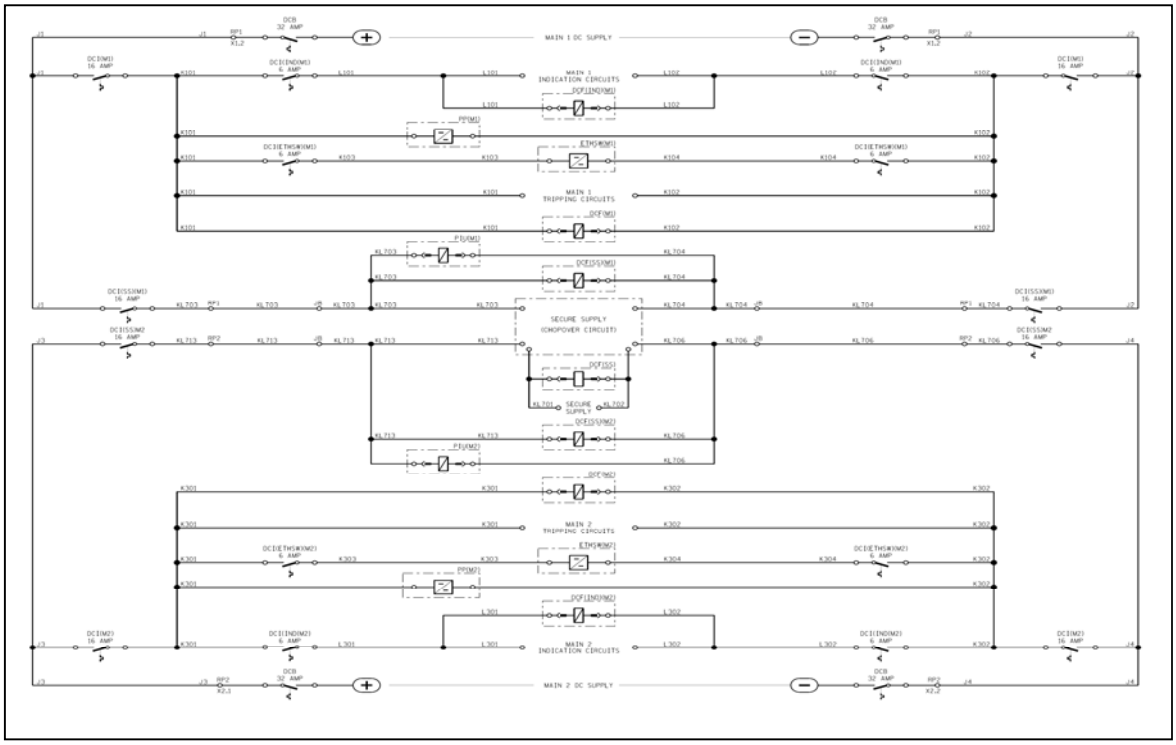
The 230V AC supply via a 10A miniature circuit-breaker (MCB(AC)), shall be used to illuminate the red alarm 'panel not healthy' and 'JB not healthy' lamps in the event of any abnormal switch selection, DC supply failure or equipment failure. The MCB(AC) shall be wired with the source supply to the top, and load supply from the bottom.

3.4.1.2 DC supply

Each scheme/module shall be provided with a DC supply for the protection IED, ethernet switch, tripping circuits and indications. The DC supply from the DC board shall also be routed to the JB via a 2-pole 16A MCB (DCI(SS)(M#)) that is located on the scheme/module. This supply shall be protected with a 2-pole 16A MCB (DCI(M#)). Thereafter, the DC supply shall be routed to:

- The Main # tripping system;
- Main # protection IEDs (connected in the first loop);
- A dedicated indication supply, DCI(IND) 6A MCB, shall be used where the scheme have more than three indication lamps;
- via the DCI(CL) 6A MCB to the closing circuits (where applicable);
- via the DCI(ETHSW) 6A MCB to the ethernet switch: and,
- Main # DC fail monitoring (connected in the last loop).

The spring rewind and motorised isolators DC supplies will be supplied from the DC board to the Junction box.



3.4.2 Current Transformer circuits

The standard current transformer secondary inputs are 1 amp, with a continuous rating of 2 amp. The standard practice is to earth the neutral (4th wire) where the CT cable is connected to the terminals within the panel/module. Dedicated 4mm2 cables shall be used for the CT secondary connections between the CTs and the protection scheme/module, the CT quantities shall not be routed via the bay JB. Each CT input shall have a dedicated four-way current transformer test block.

3.4.2.1 Protection CT Circuits

The protection and control scheme/module shall use the protection CT cores for protection purposes, and the metering core(s) for measurements purposes.

The CT connections shall be routed through the four-way current transformer test block, CTTB, to the protection/control IED. The current transformer star point shall be applied at the IED terminals. In the event that an external disturbance recorder is required to be connected to the protection CTs, the current transformer star point shall be applied at the terminal rail.

The external disturbance recorder is a separate device and shall obtain its current signals from the main 1 protection class CT core. A dedicated disturbance recorder four-way current transformer test block shall then be provided for and be applied between the terminals (where the CT star point will normally be) and the terminal for connection to the external disturbance recorder.

3.4.2.2 Measurements CT Circuits

The IED that will be utilised to report the measurements quantities (local and remote) shall be fed from one of the metering CT cores via a dedicated four-way CT test block. Provision shall be made, between the CT supply and the CT Measurements test block, to interconnect to a tariff-metering panel as and when required.

3.4.3 Voltage Transformer circuits

The standard voltage transformer secondary inputs are 63.5 volt per phase (110 volt, phase-phase). The standard practice is to earth the neutral (4th wire) in the VT JB. Dedicated 4mm2 cables shall be used for the VT secondary connections between the VTs and the protection scheme/module, the VT quantities shall not be routed via the bay JB. Each VT input shall have a dedicated four-way voltage transformer test block.

The MCB protection of the VT circuits shall be located within the VT JB. The VT JB shall have single phase MCBs for IEDs that include also a neutral current for fuse fail detection. These single phase MCBs will be fitted with auxiliary normally closed contract, wired in series, for reporting purposes. All other circuits will be protected with a three phase MCB with normally closed contact for functional blocking and reporting. VT MCBs within the scheme/module is only necessary when any one of the IED VT inputs is not directly connected to the VT JB (e.g. switched busbar VTs).

3.4.3.1 Protection VT Circuits

The protection and control scheme/module shall use the protection VT cores for protection purposes, and the metering core(s) for measurements purposes.

The VT connections shall be routed through the four-way voltage transformer test block, VTTB, to the main protection device and the device housing the synchronism check functionality. The voltage transformer star point shall be applied within the VT JB. A dedicated disturbance recorder four-way voltage transformer test block shall be provided for and be independently protected (MCB) as and when required.

3.4.3.2 Measurements VT Circuits

The IED that will be utilised to report the measurements quantities (local and remote) shall be fed from the metering VT cores via a dedicated four-way VT test block. The voltage transformer star point shall be applied within the VT JB.

3.4.3.3 Synchronising VT Circuits

The 'incoming voltage' input of the synchronism check function shall use the object VT input to the protection IED when the synchronizing function is integrated within the protection IED. When the synchronism function is within a dedicated bay control IED then the object VT metering core via a separate VT test block (VTTB(SYN)) shall be used. The voltage input to the bay control IED shall either as a three phase or red phase to white phase voltages. In the event that more than one IED is connected to the VT metering core, this circuit shall be protected be a 4A MCB within the panel/module.

The 'running volts' input from busbar 1 and busbar 2 VTs shall be fed via separate 4A MCBs and the same VTTB(SYN) test block. When the busbar 1 and busbar 2 voltage inputs to the IED is directly connected to the VT JB, then the 4A MCBs is not required. The busbar 1 and busbar 2 voltages shall be independently connected to the IED. The correct 'running volts' input, dependent upon the busbar to which the line is connected, shall automatically be selected within the IED in accordance with the status of busbar isolator 1, busbar isolator 2 or transfer isolator. It is permissible (with Eskom approval) that the running voltage input selection is done external to the IED via busbar isolator 1 (I1R), busbar isolator 2 (I2R) or transfer isolator (ITR) latching relays. Care shall then be taken to prevent paralleling of the busbar 1 and busbar 2 VTs.

The MCBs provides for the protection and isolation of the Synchronising VT supply (ON or OFF) to the IED shall have normally closed auxiliary contacts to block synchronism check (internal to the IED) when the MCB(s) is in the trip position. Blocking shall be dependent on the selected 'running volts' VT source.

3.4.4 Binary signals

The detailed input and output requirement details will be within the functional standards.

3.4.4.1 IED Binary inputs

The primary protection device shall constitute a single node through which all protection tripping shall be routed (all internal protection functions, plus all trip commands from the external devices, and teleprotection signals that are routed to binary inputs or received GOOSE messages). The required binary inputs will be within the functional standards.

3.4.4.2 IED Binary outputs

Binary outputs are required for the following:

- Trip signal to the circuit-breaker (independent trip signal per breaker);
- Breaker fail signals to the busbar protection;
- Trip test points;
- External disturbance recorder; and,
    - Any output required for interfacing with equipment within the station (detailed requirements will be within the functional standards).

The required binary outputs will be within the functional standards.

3.4.4.3 GOOSE messaging

The GOOSE data is utilised to communicate plant information and protection information between IEDs (and test equipment). The detailed functional standards will include the list of GOOSE data points (Logical nodes and data attributes) for horizontal communication. The vendors shall use IEC 61850 as "purely" as possible (e.g. defined logical node names and data attributes). The vendor shall comply with the IEC61850 standards and Eskom's requirements as per document 240-42066934. The following data will in general be sent via a GOOSE message:

- Primary plant status, alarms and trip signals from the PIUs to the IEDs;
- Breaker fail signals to the busbar protection;
- Transfer functionality; and,

- Tap change control between the IED and PIU.

3.4.4.4 EHV Circuit-breaker Process Interface GOOSE and MMS Signals

	EHV Breaker PIU - Data Broadcast	Logical Node	240-42066934	Subscriber (IED)
1	Breaker Red Phase Status	XCBR	6.11.1	Protection & BCD
2	Breaker White Phase Status	XCBR	6.11.1	Protection & BCD
3	Breaker Blue Phase Status	XCBR	6.11.1	Protection & BCD
4	Breaker Red Phase Status (2nd CB)	XCBR	6.11.1	Protection & BCD
5	Breaker White Phase Status (2nd CB)	XCBR	6.11.1	Protection & BCD
6	Breaker Blue Phase Status (2nd CB)	XCBR	6.11.1	Protection & BCD
7	Breaker Charged	GGIO	6.6.2	BCD
8	Breaker LOR Off Remote	GGIO	6.6.2	BCD & GW
9	Breaker Red Phase SF6 Gas	SIMG	6.10.1	BCD & GW
10	Breaker White Phase SF6 Gas	SIMG	6.10.1	BCD & GW
11	Breaker Blue Phase SF6 Gas	SIMG	6.10.1	BCD & GW
12	Breaker Red Phase SF6 Gas (2nd CB)	SIMG	6.10.1	BCD & GW
13	Breaker White Phase SF6 Gas (2nd CB)	SIMG	6.10.1	BCD & GW
14	Breaker Blue Phase SF6 Gas (2nd CB)	SIMG	6.10.1	BCD & GW
15	Breaker Mechanism Box Loss of Heater Supply	KHTR	6.15.1	GW
16	Breaker Red Phase Closing Fail (APT, CLIR)	GGIO	6.6.2	BCD & GW
17	Breaker White Phase Closing Fail (APT, CLIR)	GGIO	6.6.2	BCD & GW
18	Breaker Blue Phase Closing Fail (APT, CLIR)	GGIO	6.6.2	BCD & GW
19	Breaker Red Phase Low Energy (Spring/Hyd)	GGIO	6.6.2	GW
20	Breaker White Phase Low Energy (Spring/Hyd)	GGIO	6.6.2	GW
21	Breaker Blue Phase Low Energy (Spring/Hyd)	GGIO	6.6.2	GW
22	Breaker Red Phase Low Energy (Spring/Hyd) (2nd CB)	GGIO	6.6.2	GW
23	Breaker White Phase Low Energy (Spring/Hyd) (2nd CB)	GGIO	6.6.2	GW
24	Breaker Blue Phase Low Energy (Spring/Hyd) (2nd CB)	GGIO	6.6.2	GW
25	Breaker Red Phase Loss of Motor DC Supply	GGIO	6.6.2	GW
26	Breaker White Phase Loss of Motor DC Supply	GGIO	6.6.2	GW

27	Breaker Blue Phase Loss of Motor DC Supply	GGIO	6.6.2	GW
28	Breaker Red Phase Trip and Close Block (Low Energy)	XCBR	6.11.1	GW
29	Breaker White Phase Trip and Close Block (Low Energy)	XCBR	6.11.1	GW
30	Breaker Blue Phase Trip and Close Block (Low Energy)	XCBR	6.11.1	GW
31	Breaker Red Phase Motor Running (Alarmed after TD)	GGIO	6.6.2	GW
32	Breaker White Phase Motor Running (Alarmed after TD)	GGIO	6.6.2	GW
33	Breaker Blue Phase Motor Running (Alarmed after TD)	GGIO	6.6.2	GW
34	Point on Wave Unhealthy	LPHD	6.2.1	BCD & GW
35	Red Phase CT SF6 Gas	SIMG	6.10.1	BCD & GW
36	White Phase CT SF6 Gas	SIMG	6.10.1	BCD & GW
37	Blue Phase CT SF6 Gas	SIMG	6.10.1	BCD & GW
38	Red Phase CT SF6 Gas (TIE BAY)	SIMG	6.10.1	BCD & GW
39	White Phase CT SF6 Gas (TIE BAY)	SIMG	6.10.1	BCD & GW
40	Blue Phase CT SF6 Gas (TIE BAY)	SIMG	6.10.1	BCD & GW
41	Busbar 1 Isolator Status (Contacts in Series)	XSWI	6.11.2	Protection & BCD
42	Busbar 1 Motorised Isolator DC Supply Failed	GGIO	6.6.2	BCD & GW
43	Busbar 1 Isolator Loss of Heater Supply	KHTR	6.15.1	GW
44	Busbar 1 Motorised Isolator LOR Off Remote	GGIO	6.6.2	BCD & GW
45	Busbar 2 Isolator Status (Contacts in Series)	XSWI	6.11.2	Protection & BCD
46	Busbar 2 Motorised Isolator DC Supply Failed	GGIO	6.6.2	BCD & GW
47	Busbar 2 Isolator Loss of Heater Supply	KHTR	6.15.1	GW
48	Busbar 2 Motorised Isolator LOR Off Remote	GGIO	6.6.2	BCD & GW
49	Object Isolator Open (Contacts in Series)	XSWI	6.11.2	Protection & BCD
50	Object Motorised Isolator DC Supply Failed	GGIO	6.6.2	BCD & GW
51	Object Isolator Loss of Heater Supply	KHTR	6.15.1	GW
52	Object Motorised Isolator LOR Off Remote	GGIO	6.6.2	BCD & GW
53	4th Isolator Open (Contacts in Series)	XSWI	6.11.2	Protection & BCD

54	4th Motorised Isolator DC Supply Failed	GGIO	6.6.2	BCD & GW
55	4th Isolator Loss of Heater Supply	KHTR	6.15.1	GW
56	4th Motorised Isolator LOR Off Remote	GGIO	6.6.2	BCD & GW
57	Breaker Earth Switch Busbar Side Status (Contacts in Series)	XSWI	6.11.2	BCD
58	Breaker Earth Switch Busbar Side Loss of Heater Supply	KHTR	6.15.1	GW
59	Breaker Earth Switch Line Side Status (Contacts in Series)	XSWI	6.11.2	BCD
60	Breaker Earth Switch Line Side Loss of Heater Supply	KHTR	6.15.1	GW
61	Object Earth Switch status (Contacts in Series)	XSWI	6.11.2	BCD
62	Object Earth Switch Loss of Heater Supply	KHTR	6.15.1	GW
63	Busbar# Earth Switch Status (Contacts in Series)	XSWI	6.11.2	BCD
64	Busbar# Earth Switch Loss of Heater Supply	KHTR	6.15.1	GW
65	Other Main PIU Failed	LPHD	6.2.1	BCD & GW
66	Other Main IEC Communications Failed	GGIO	6.6.2	BCD & GW
67	Secure Supply Main1 DC Fail	GGIO	6.6.2	BCD & GW
68	Secure Supply Main2 DC Fail	GGIO	6.6.2	BCD & GW
69	Secure Supply DC Fail	GGIO	6.6.2	BCD & GW
70	Closing DC Fail	GGIO	6.6.2	BCD & GW
71	Common DC Fail	GGIO	6.6.2	BCD & GW
72	AC Fail	GGIO	6.6.2	BCD & GW
73	Object Voltage Unhealthy (MCB Tripped)	GGIO	6.6.2	BCD & GW
74	Busbar# Voltage Unhealthy (MCB Tripped)	GGIO	6.6.2	BCD & GW
75	3rd Voltage Unhealthy (MCB Tripped)	GGIO	6.6.2	BCD & GW

	EHV Breaker PIU - Data Subscribed	**Logical Node**	**240-42066934**	**Broadcaster**
1	Breaker Control	CSWI	6.5.5	BCD
2	Busbar 1 Isolator Control	CSWI	6.5.5	BCD
3	Busbar 2 Isolator Control	CSWI	6.5.5	BCD
4	Object Isolator Control	CSWI	6.5.5	BCD
5	4th Isolator Control	CSWI	6.5.5	BCD

3.4.4.5 Transformer Process Interface Unit GOOSE and MMS Signals

	Transformer PIU - Data Broadcast	**Logical Node**	**240-42066934**	**Subscriber (IED)**
	Main Transformer			
1	Buchholz (Alarm & Trip)	SIML	6.10.2	Protection & GW
2	HV Winding Temperature (Alarm & Trip)	YPTR	6.13.1	Protection & GW
3	MV Winding Temperature (Alarm & Trip)	YPTR	6.13.1	Protection & GW
4	Oil Temperature Alarm	SIML	6.10.2	Protection & GW
5	Pressure Relief Trip (Normal)	SIML	6.10.2	Protection & GW
6	Pressure Relief Trip (Rapid)	SIML	6.10.2	Protection & GW
7	Auxiliary Transformer Shunt Trip	GGIO	6.6.2	Protection & GW
8	400 V MCB Tripped	GGIO	6.6.2	Protection & GW
9	Conservator Tank Bag Leak Alarm	SIML	6.10.2	Protection & GW
10	Conservator Oil Level Alarm	SIML	6.10.2	Protection & GW
11	Cooling any Motor Overload Tripped Alarm	CCGR	6.5.2	Protection & GW
12	Cooling any Motor MCB Tripped Alarm	CCGR	6.5.2	Protection & GW
13	Cooling Panel Control Circuit AC Supply Fail	CCGR	6.5.2	Protection & GW
14	Cooling Panel Heater AC Supply Fail	GGIO	6.6.2	Protection & GW
15	Cooling Control on Manual	CCGR	6.5.2	Protection & GW
16	Cooling Oil Flow Fail	CCGR	6.5.2	Protection & GW
17	Cooling tripped (from MTR)	CCGR	6.5.2	Protection & GW
	Auxiliary Transformer 1			
18	Buchholz (Alarm & Trip)	SIML	6.10.2	Protection & GW
19	Oil Temperature (Alarm & Trip)	SIML	6.10.2	Protection & GW
	Auxiliary Transformer 2			
20	Buchholz (Alarm & Trip)	SIML	6.10.2	Protection & GW
21	Oil Temperature (Alarm & Trip)	SIML	6.10.2	Protection & GW
	Tap Changer			
22	Pressure Surge Trip	SIML	6.10.2	Protection & GW
23	Oil Surge Trip	SIML	6.10.2	Protection & GW
24	Conservator Oil Level (High & Low Alarm)	SIML	6.10.2	Protection & GW
25	Buchholz (Alarm & Trip)	SIML	6.10.2	Protection & GW

	Transformer PIU - Data Subscribed	**Logical Node**	**240-42066934**	**Broadcaster**
1	Trip Cooling Control (from MTR)	PTRC	6.3.13	Protection

3.4.4.6 Tap Changer Process Interface Unit GOOSE and MMS Signals

	Tap Changer PIU - Data Broadcast	Logical Node	240-42066934	Subscriber (IED)
	Tap Changer			
1	Tap Position	YLTC	6.13.2	Tap Change Controller
7	Tap Change Raise Command (Controlled from TCD)	GGIO	6.6.2	Tap Change Controller
8	Tap Change Lower Command (Controlled from TCD)	GGIO	6.6.2	Tap Change Controller
9	Tap Change Raise in progress	YLTC	6.13.2	Tap Change Controller
10	Tap Change Lower in progress	YLTC	6.13.2	Tap Change Controller
11	Tap Change Motor running	GGIO	6.6.2	Tap Change Controller
12	Tap Change Motor Drive Tripped	GGIO	6.6.2	Tap Change Controller
	Monitoring Alarms			
13	Dry Keep System Alarm	LPHD	6.2.1	GW
14	On line Oil Filter System Supply Failed	GGIO	6.6.2	GW
15	Dissolved Gas Analyser Unit Unhealthy	LPHD	6.2.1	GW
16	Gas Caution Limits have been Reached	SIML	6.10.2	GW
17	Gas Alarm Limits have been Reached	SIML	6.10.2	GW
18	Transformer Sump Water drain valve open Alarm	SPOS	6.10.3	GW
19	Transformer Digital temperature instrument fail Alarm	LPHD	6.2.1	GW
20	Transformer Mechanism Box heater fail Alarm	KHTR	6.15.1	GW

	Tap Changer PIU - Data Subscribed	Logical Node	240-42066934	Broadcaster
1	Tap Change Raise Command	YLTC	6.13.2	Tap Change Controller
2	Tap Change Lower Command	YLTC	6.13.2	Tap Change Controller
3	Tap Change Emergency Trip (Include TC MRT Lapsed)	PTRC	6.3.13	Tap Change Controller
4	Tap Change Undercurrent Block (Switch Positive)	PTUC	6.13.17	Tap Change Controller

3.4.4.7 EHV Circuit-breaker Process Interface Unit Binary Signals

	EHV Breaker PIU - Binary Inputs	Abbreviation	DC
1	Breaker Red Phase Open	52bRPh	M#
2	Breaker White Phase Open	52bWPh	M#
3	Breaker Blue Phase Open	52bBPh	M#
4	Breaker Red Phase Closed	52aRPh	M#
5	Breaker White Phase Closed	52aWPh	M#

6	Breaker Blue Phase Closed	52aBPh	M#
7	Breaker Red Phase Open (2nd CB)	52bRPhCB2	M#
8	Breaker White Phase Open (2nd CB)	52bWPhCB2	M#
9	Breaker Blue Phase Open (2nd CB)	52bBPhCB2	M#
10	Breaker Red Phase Closed (2nd CB)	52aRPhCB2	M#
11	Breaker White Phase Closed (2nd CB)	52aWPhCB2	M#
12	Breaker Blue Phase Closed (2nd CB)	52aBPhCB2	M#
13	Breaker Charged	CBCH	CL
14	Breaker LOR Off Remote	CBLORNR	CL
15	Breaker Red Phase SF6 Gas Urgent	RPhCBSF6L	CL
16	Breaker White Phase SF6 Gas Urgent	WPhCBSF6L	CL
17	Breaker Blue Phase SF6 Gas Urgent	BPhCBSF6L	CL
18	Breaker Red Phase SF6 Gas Non Urgent	RPhCBSF6C	COM
19	Breaker White Phase SF6 Gas Non Urgent	WPhCBSF6C	COM
20	Breaker Blue Phase SF6 Gas Non Urgent	BPhCBSF6C	COM
21	Breaker Red Phase SF6 Gas Urgent (2nd CB)	RPhCBSF6L2	CL
22	Breaker White Phase SF6 Gas Urgent (2nd CB)	WPhCBSF6L2	CL
23	Breaker Blue Phase SF6 Gas Urgent (2nd CB)	BPhCBSF6L2	CL
24	Breaker Red Phase SF6 Gas Non Urgent (2nd CB)	RPhCBSF6C2	COM
25	Breaker White Phase SF6 Gas Non Urgent (2nd CB)	WPhCBSF6C2	COM
26	Breaker Blue Phase SF6 Gas Non Urgent (2nd CB)	BPhCBSF6C2	COM
27	Breaker Mechanism Box Loss of Heater Supply	CBHSF	COM
28	Breaker Red Phase Closing Fail (APT, CLIR)	CBCLFRPh	CL
29	Breaker White Phase Closing Fail (APT, CLIR)	CBCLFWPh	CL
30	Breaker Blue Phase Closing Fail (APT, CLIR)	CBCLFBPh	CL
31	Breaker Red Phase Low Energy (Spring/Hyd)	CBLOWENRPh	CL
32	Breaker White Phase Low Energy (Spring/Hyd)	CBLOWENWPh	CL
33	Breaker Blue Phase Low Energy (Spring/Hyd)	CBLOWENBPh	CL
34	Breaker Red Phase Low Energy (Spring/Hyd) (2nd CB)	CBLOWENRPh2	CL
35	Breaker White Phase Low Energy (Spring/Hyd) (2nd CB)	CBLOWENWPh2	CL
36	Breaker Blue Phase Low Energy (Spring/Hyd) (2nd CB)	CBLOWENBPh2	CL
37	Breaker Red Phase Loss of Motor DC Supply	CBMDCFRPh	CL
38	Breaker White Phase Loss of Motor DC Supply	CBMDCFWPh	CL
39	Breaker Blue Phase Loss of Motor DC Supply	CBMDCFBPh	CL
40	Breaker Red Phase Trip and Close Block (Low Energy)	CBTCBLKRPh	CL
41	Breaker White Phase Trip and Close Block (Low Energy)	CBTCBLKWPh	CL
42	Breaker Blue Phase Trip and Close Block (Low Energy)	CBTCBLKBPh	CL

43	Breaker Red Phase Motor Running (Alarmed after TD)	MOTRUNRPh	CL
44	Breaker White Phase Motor Running (Alarmed after TD)	MOTRUNWPh	CL
45	Breaker Blue Phase Motor Running (Alarmed after TD)	MOTRUNBPh	CL
46	Point on Wave Unhealthy	POWUNH	COM
47	Red Phase CT SF6 Gas Non Urgent	RPhSF6L	COM
48	White Phase CT SF6 Gas Non Urgent	WPhSF6L	COM
49	Blue Phase CT SF6 Gas Non Urgent	BPhSF6L	COM
50	Red Phase CT SF6 Gas Urgent	RPhSF6C	COM
51	White Phase CT SF6 Gas Urgent	WPhSF6C	COM
52	Blue Phase CT SF6 Gas Urgent	BPhSF6C	COM
53	Red Phase CT SF6 Gas Non Urgent (TIE BAY)	RPhSF6LTB	COM
54	White Phase CT SF6 Gas Non Urgent (TIE BAY)	WPhSF6LTB	COM
55	Blue Phase CT SF6 Gas Non Urgent (TIE BAY)	BPhSF6LTB	COM
56	Red Phase CT SF6 Gas Urgent (TIE BAY)	RPhSF6CTB	COM
57	White Phase CT SF6 Gas Urgent (TIE BAY)	WPhSF6CTB	COM
58	Blue Phase CT SF6 Gas Urgent	BPhSF6CTB	COM
59	Busbar 1 Isolator Open (NC in Series)	BB1IOPEN	M#
60	Busbar 1 Isolator Closed (NO Series)	BB1ICLSD	M#
61	Busbar 1 Motorised Isolator DC Supply Failed	BB1MIDCF	COM
62	Busbar 1 Isolator Loss of Heater Supply	BB1IHSF	COM
63	Busbar 1 Motorised Isolator LOR Off Remote	BB1MILORNR	M#
64	Busbar 2 Isolator Open (NC Series)	BB2IOPEN	M#
65	Busbar 2 Isolator Closed (NO Series)	BB2ICLSD	M#
66	Busbar 2 Motorised Isolator DC Supply Failed	BB2MIDCF	COM
67	Busbar 2 Isolator Loss of Heater Supply	BB2IHSF	COM
68	Busbar 2 Motorised Isolator LOR Off Remote	BB2MILORNR	M#
69	Object Isolator Open (NC Series)	LIOPEN	M#
70	Object Isolator Closed (NO in Series)	LICLSD	M#
71	Object Motorised Isolator DC Supply Failed	LMIDCF	COM
72	Object Isolator Loss of Heater Supply	LIHSF	COM
73	Object Motorised Isolator LOR Off Remote	LMILORNR	M#
74	4th Isolator Open (NC in Series)	TIOPEN	M#
75	4th Isolator Closed (NO in Series)	TICLSD	M#
76	4th Motorised Isolator DC Supply Failed	TMIDCF	COM
77	4th Isolator Loss of Heater Supply	TIHSF	COM
78	4th Motorised Isolator LOR Off Remote	TMILORNR	M#
79	Breaker Earth Switch Busbar Side Opened (NC in Series)	CBESBBSOPEN	M#

80	Breaker Earth Switch Busbar Side Closed (NO in Series)	CBESBBSCLSD	M#
81	Breaker Earth Switch Busbar Side Loss of Heater Supply	CBESBBSHSF	M#
82	Breaker Earth Switch Line Side Opened (NC in Series)	CBESLSOPEN	M#
83	Breaker Earth Switch Line Side Closed (NO in Series)	CBESLSCLSD	M#
84	Breaker Earth Switch Line Side Loss of Heater Supply	CBESLSHSF	M#
85	Object Earth Switch Opened (NC in Series)	OBJESOPEN	M#
86	Object Earth Switch Closed (NO in Series)	OBJESCLSD	M#
87	Object Earth Switch Closed Loss of Heater Supply	OBJESHSF	M#
88	Busbar# Earth Switch Opened (NC in Series)	BB#ESOPEN	M#
89	Busbar# Earth Switch Closed (NO in Series)	BB#ESCLSD	M#
90	Busbar# Earth Switch Closed Loss of Heater Supply	BB#ESHSF	M#
91	Other Main PIU Failed	OTHMPIUF	M#
92	Other Main IEC Communications Failed	OTHMIECCOMF	M#
93	Secure Supply Main1 DC Fail	M1SSDCF	M2
94	Secure Supply Main2 DC Fail	M1SSDCF	M1
95	Secure Supply DC Fail	DCFSS	COM
96	Closing DC Fail	DCFCL	M#
97	Common DC Fail	DCFCOM	M3
98	AC Fail	ACF	COM
99	Object Voltage Unhealthy (MCB Tripped)	LVTUNH	CL
100	Busbar# Voltage Unhealthy (MCB Tripped)	BB#VTUNH	CL
101	3rd Voltage Unhealthy (MCB Tripped)	CON#VTUNH	CL
102	Spare	Spare	
103	Spare	Spare	
104	Spare	Spare	
105	Spare	Spare	
106	Spare	Spare	

	EHV Breaker PIU - Binary Outputs	**Abbreviation**	**DC**
1	Breaker Red Phase Trip and Open Command	TRIPRPh	M#
2	Breaker White Phase Trip and Open Command	TRIPWPh	M#
3	Breaker Blue Phase Trip and Open Command	TRIPBPh	M#
4	Breaker Red Phase Close Command	CLCMDRPh	CL
5	Breaker White Phase Close Command	CLCMDWPh	CL
6	Breaker Blue Phase Close Command	CLCMDBPh	CL
7	Busbar 1 Isolator Open Command	BB1IOCMD	COM
8	Busbar 1 Isolator Closed Command	BB1ICCMD	COM

9	Busbar 2 Isolator Open Command	BB2IOCMD	COM
10	Busbar 2 Isolator Closed Command	BB2ICCMD	COM
11	Object Isolator Open Command	LIOCMD	COM
12	Object Isolator Closed Command	LICCMD	COM
13	4th Isolator Open Command	TIOCMD	COM
14	4th Isolator Closed Command	TICCMD	COM
15	IEC61850 Communications Failure	IECCOMSF	M#
16	PIU Fail (Normally Close Contact)	PIUFAIL	M#
17	Spare	Spare	
18	Spare	Spare	
19	Spare	Spare	
20	Spare	Spare	
21	Spare	Spare	

3.4.4.8 Transformer Process Interface Unit Binary Signals

	Transformer PIU - Binary Inputs	**Abbreviation**	**DC**
	Main Transformer		
1	Buchholz Alarm	TRFBUCAL	M#
2	Buchholz Trip	TRFBUCHTR	M#
3	HV Winding Temperature Alarm	TRFHVWTAL	M#
4	HV Winding Temperature Trip	TRFHVWTTR	M#
5	MV Winding Temperature Alarm	TRFMVWTAL	M#
6	MV Winding Temperature Trip	TRFMVWTTR	M#
7	Oil Temperature Alarm	TRFOTAL	M#
8	Oil Temperature Trip	TRFOTTR	M#
9	Pressure Relief Trip (Normal)	TRFPRRELTR	M#
10	Pressure Relief Trip (Rapid)	TRFRAPPRTR	M#
11	Auxiliary Transformer Shunt Trip	AUXTRFSTR	M#
12	400 V MCB Tripped	400VMCBTR	M#
13	Conservator Tank Bag Leak Alarm	TRFCTBAGAL	M#
14	Conservator Oil Level High Alarm	TRFOILHIGH	M#
15	Conservator Oil Level Low Alarm	TRFOILLOW	M#
16	Cooling any Motor Overload Tripped Alarm	TRFCAMOT	M#
17	Cooling any Motor MCB Tripped Alarm	TRFCAMMCBT	M#
18	Cooling Panel Control Circuit AC Supply Fail	TRFCCPAC	M#
19	Cooling Panel Heater AC Supply Fail	TRFCPHSF	M#
20	Cooling Control on Manual	TRFCCMAN	M#
21	Cooling Oil Flow Fail	TRFCOILFLWFL	M#

22	Cooling tripped (from MTR)	TRFCOILTR	M#
	Auxiliary Transformer 1		
23	Buchholz Alarm	ATRF1BUCAL	M#
24	Buchholz Trip	ATRF1BUCHTR	M#
25	Oil Temperature Alarm	ATRF1OTAL	M#
26	Oil Temperature Trip	ATRF1OTTR	M#
	Auxiliary Transformer 2		
27	Buchholz Alarm	ATRF2BUCAL	M#
28	Buchholz Trip	ATRF2BUCHTR	M#
29	Oil Temperature Alarm	ATRF2OTAL	M#
30	Oil Temperature Trip	ATRF2OTTR	M#
	Tap Changer		
31	Pressure Surge Trip	TCPRSRGTR	M#
32	Oil Surge Trip	TCOSRGTR	M#
33	Conservator Oil Level High Alarm	TCOILHIGH	M#
34	Conservator Oil Level Low Alarm	TCOILLOW	M#
35	Buchholz Alarm	TCBUCAL	M#
36	Buchholz Trip	TCBUCHTR	M#
37	Spare	Spare	
38	Spare	Spare	
39	Spare	Spare	
40	Spare	Spare	
41	Spare	Spare	

	Transformer PIU - Binary Outputs	**Abbreviation**	**DC**
1	IEC61850 Communications Failure	IECCOMSF	M#
2	PIU Fail (Normally Close Contact)	PIUFAIL	M#
3	Trip Cooling Control (from MTR)	TRIPCCTRL	M#
4	Spare	Spare	
5	Spare	Spare	
6	Spare	Spare	
7	Spare	Spare	
8	Spare	Spare	

3.4.4.9 Tap Changer Process Interface Unit Binary Signals

	Tap Changer PIU - Binary Inputs	Abbreviation	DC
	Tap Changer		
1	BCD 1	TAPPOSBIT1	TC
2	BCD 2	TAPPOSBIT1	TC
3	BCD 4	TAPPOSBIT1	TC
4	BCD 8	TAPPOSBIT1	TC
5	BCD 10	TAPPOSBIT1	TC
6	BCD 20	TAPPOSBIT1	TC
7	Tap Change Raise Command (Controlled from TCD)	TCCMDRTAP	TC
8	Tap Change Lower Command (Controlled from TCD)	TCCMDLTAP	TC
9	Tap Change Raise in progress	TCRTAPIP	TC
10	Tap Change Lower in progress	TCLTAPIP	TC
11	Tap Change Motor running	TCMOTRUN	TC
12	Tap Change Motor Drive Tripped	TCMOTDRTR	TC
	Monitoring Alarms		
13	Dry Keep System Alarm	DRYKPSF	TC
14	On line Oil Filter System Supply Failed	OILFILTSSF	TC
15	Dissolved Gas Analyser Unit Unhealthy	DGAUUNH	TC
16	Gas Caution Limits have been Reached	GCAUTLIMIT	TC
17	Gas Alarm Limits have been Reached	GALMLIMIT	TC
18	Transformer Sump Water drain valve open Alarm	TRFSWDVA	TC
19	Transformer Digital temperature instrument fail Alarm	TRFDTIF	TC
20	Transformer Mechanism Box heater fail Alarm	TRFHSF	TC
21	Spare	Spare	
22	Spare	Spare	
23	Spare	Spare	
24	Spare	Spare	
25	Spare	Spare	

	Tap Changer PIU - Binary Outputs	Abbreviation	DC
1	IEC61850 Communications Failure	IECCOMSF	TC
2	PIU Fail (Normally Close Contact)	PIUFAIL	TC
3	Raise Command	TCRAISETAP	TC
4	Lower Command	TCLOWTAP	TC
5	Tap Change Emergency Trip (Include TC MRT Lapsed)	TCETRIP	TC
6	Tap Change Undercurrent Block (Switch Positive)	TCCURBLK	TC

7	Tap Change Undercurrent Block (Switch Negative)	TCCURBLK	TC
8	Spare	Spare	
9	Spare	Spare	
10	Spare	Spare	
11	Spare	Spare	
12	Spare	Spare	

3.4.5 Human and machine Interface to the protection panel

3.4.5.1 Local controls, Panel mimic and HMI Mimic

The primary local operator interface shall be provided via the substation HMI. Local controls will, however be required on the scheme/module. The preferred method of providing local controls is via integrated programmable push buttons on IEDs, as an alternative, the required local controls can be provided for (push buttons with indications) on the panel local control mimic. The required local controls (requirements will be within the detailed functional standard):

- Supervisory isolating switch;
- Circuit-breaker control switch (emergency trip);
- Auto-reclose mode selections (line protection schemes);
- Circuit-breaker trip testing (line protection schemes);
- Transfer permission (line protection schemes);
- Protection ON/OFF (bus-coupler and bus-section); and,
- Tap change controls (tap change control scheme).

Supervisory isolating switch

The supervisory isolating switch select between local control (HMI, scheme/module) and remote control (Station HMI and Control Centres). The circuit-breaker emergency open command shall be independent on the SIS position being selected. The detailed requirements will be within the detailed functional standard.

Circuit-breaker control switch (emergency trip)

An emergency trip function shall always be provided for via a discrete push button or control switch that is independent of any IED. The circuit-breaker control function is used to electrically open and close the associated circuit-breaker(s) via the scheme front panel. The switch shall require a double action to operate (e.g. press and turn). It shall be possible to trip the applicable circuit-breaker via the scheme front panel, even in the event of an IED failure.

The circuit-breaker emergency trip function shall be connected to the main trip circuit of the scheme. The circuit-breaker emergency trip function shall be connected to the back-up trip circuit of the scheme for all schemes using both main and back-up protection. For those schemes using only a main D.C. circuit, or circuit-breakers having only one tripping coil, the trip function shall be connected to that circuit.

For schemes controlling multiple circuit-breakers (e.g. transformer protection schemes and breaker-and-a-half protection schemes), the control labels shall clearly and uniquely differentiate the functions (e.g. HV circuit-breaker trip, MV circuit-breaker trip, Bay # circuit-breaker trip, Tie Bay circuit-breaker trip, etc.).

The actuator(s) for local opening and closing of the circuit-breaker shall be identifiable by all two of the following methods:

a) By labels reading “TRIP” and “CLOSE” respectively. The symbols “O” and “I” may be used as additional means to identify the respective trip and close controls.

b) By colour coding. The colour green shall be associated with the trip control and red with the close control. Alternatively the controls shall be without unique colour. An emergency trip push button shall be red. The breaker status shall be via indication LED's operated by the Breaker auxiliary contacts.

NOTE: The Eskom colour coding convention for trip/close actuators is opposite to that specified in IEC 60073 (i.e. IEC requires trip red and close green).

Auto-reclose mode selections

The preferred method of providing local auto-reclose mode selection controls is via integrated programmable push buttons on IEDs. Alternately these controls with indications can be provided for on the scheme/module. The selection shall be latched within the IED and be retained even in the event that the IED restarts. The following auto-reclose mode selections are required:

- ON and OFF;
- 1-Pole, 3-Pole and 1&3-Pole;
- 3-cycle and 5-cycle;
- Fast and Slow 3-pole reclose; and,
- Master and Slave

Circuit-breaker trip testing

A trip test function shall be provided for so as to allow protection field technicians an easy means to test the operation of the ARC function on a scheme. A trip test function shall be provided on all schemes that include an ARC function. Trip testing on single pole circuit-breakers shall only be single pole and be dependent on the auto-reclose selected for single-pole and be ready for a 1-pole auto-reclose cycle. Trip testing shall be routed via the IED to the circuit-breaker. For breaker-and-a-half applications, trip testing is also dependent on the adjacent circuit-breaker in the diameter to be closed.

Transfer permission (TPK)

The preferred method of providing local TPK controls is via integrated programmable push buttons on IEDs. Alternately these controls with indications can be provided for on the scheme/module. The selection shall be latched within the IED and be retained even in the event that the IED restarts. When the line protection system is required to operate in the transfer/bypass mode, the transfer permission key relay (TPK) is switched from the "Normal" position to the "Transfer" position. The TPK function shall be switchable from remote when the Supervisory Isolating Switch (SIS) is selected to the "ON" position. The TPK function associated with the bus/transfer coupler protection scheme shall also be switched to the transfer/bypass mode of operation. Operation of the TPK function shall enable control of the transfer isolator. The detailed transfer requirements will be within the detailed functional standard.

Protection ON/OFF (bus-coupler and bus-section)

The protection ON/OFF control is required to select the bus-coupler /bus-section protection. The nominal operation shall be selected OFF. The ON selection is required to activate the bus-coupler/bus-section protection for the purpose of energising new primary plant of primary plant being returned from maintenance. The detailed requirements will be within the detailed functional standard.

Tap change controls

The preferred method of providing local tap changer controls and commands is via integrated programmable push buttons on IEDs. Alternately these controls with indications can be provided for on the scheme/module. The selection shall be latched within the IED and be retained even in the event that the IED restarts. The detailed requirements will be within the detailed functional standard. The following controls and commands are required:

- Supervisory selection;
- Master, Follower, Independent selection;
- Raise and Lower Commands;

- Emergency trip; and,
- Lockout reset.

Isolators

Isolator controls shall only be permitted from the station HMI and the control centres. Local (IED HMI and scheme/module) isolator controls is not required.

3.4.5.2 Local indications, Panel mimic and HMI Mimic

The panel/module mimic shall have a single line diagram representing the applicable bay, with the required controls and indications. The panel mimic and IED HMI indications shall reflect the true status being selected by either the remote or the IED HMI/panel mimic controls. The plant status and selected modes shall continuously be illuminated and health verified with the lamp check function. The following indications shall be available on the IED HMI or on the scheme/module:

- Circuit-breaker status;
- Auto-reclose mode selections;
- Transfer permission;
- Protection ON/OFF selection;
- Tap change control;
- Isolators;
- Earth switches;
- Panel/module not healthy indication; and,
- JB not healthy indication.

Circuit-breaker status

The circuit-breaker open indication shall be on the left (or bottom), and the closed indication on the right (or top) of the circuit-breaker control switch. The circuit-breaker status indications shall independently indicate the states “any pole open” and “any pole closed”. The one state shall not be derived from the logical inverse of the other. Status indications shall be visually eye-catching such that they may be seen at the first glance at the IED, scheme or module.

Auto-reclose mode selections

The selected auto-reclose modes shall independently indicate the mode being selected. The one state shall not be derived from the logical inverse of the other. Status indications shall be visually eye-catching such that they may be seen at the first glance at the IED, scheme or module.

Transfer permission

The selected transfer mode ("Normal" or "Transfer") shall independently indicate the mode being selected. The one state shall not be derived from the logical inverse of the other. Status indications shall be visually eye-catching such that they may be seen at the first glance at the IED, scheme or module.

Protection ON/OFF selection

The selected protection mode ("Off" or "On") shall independently indicate the mode being selected. The one state shall not be derived from the logical inverse of the other. Status indications shall be visually eye-catching such that they may be seen at the first glance at the IED, scheme or module.

Tap change control

The tap change control and status indications shall independently indicate the condition and status. The one state shall not be derived from the logical inverse of the other. Status indications shall be visually eye-catching such that they may be seen at the first glance at the IED, scheme or module.

Isolators

Isolator status indications, displayed on the IED HMI, shall independently indicate the states “all phases open” and “all phases closed”. The one state shall not be derived from the logical inverse of the other. Status indications shall be visually eye-catching such that they may be seen at the first glance at the IED.

Earth switches

Earth switch status indications, displayed on the IED HMI, shall independently indicate the states “all phases open” and “all phases closed”. The one state shall not be derived from the logical inverse of the other. Status indications shall be visually eye-catching such that they may be seen at the first glance at the IED.

Panel/module not healthy indication

This indication shall be illuminated for any switch abnormal status selection, any supply failure or any device failure on the panel/module.

JB not healthy indication

This indication shall be illuminated for any switch abnormal status selection, any supply failure or any device failure on the JB. This indication shall be located on both the panel/module and the JB.

3.4.5.3 Remote controls

The detailed functional standards will include the list of commands (Logical nodes and data attributes) to be executed and status reporting. The vendors shall use IEC 61850 as “purely” as possible (e.g. defined logical node names and data attributes).

Remote controls are required for all primary plant equipment, protection mode selections, auto-reclose mode selections and tap change control. The requirement will be within the detailed functional standard.

3.4.5.4 Remote indications, info and status to be reported

The detailed functional standards will include the list of MMS data points (Logical nodes and data attributes) for vertical communication. The vendors shall use IEC 61850 as “purely” as possible (e.g. defined logical node names and data attributes).

Remote information reporting are required for all primary plant equipment, protection mode selections, auto-reclose mode selections, tap change control, plant health, equipment health and protection operations. The requirement will be within the detailed functional standard.

3.4.6 Testing facilities

3.4.6.1 GOOSE data for testing

The IED(s) shall be configured with GOOSE data to verify each setting within the IED. The test equipment will utilise the GOOSE data points to monitor each function under test. The test equipment will also simulate test points for verification and fault playback purposes. The simulated GOOSE signals shall be enabled (TNS Test 2 Selected) and disabled (TNS Normal and Test 1 selected) within the IED to prevent any simulated GOOSE signal to remain high and hence adversely affect the in-service performance of the IED. All functions to be tested shall be enabled with the TNS selected to Test 2.

The GOOSE data requirement details will be within the functional standards.

3.4.6.2 Test points

Test points shall be provided for all hardwire tripping interfaces from the scheme/module. The test points shall be potential free, shall be independent on the TNS selection and shall be accessible on the scheme’s front panel.

3.4.6.3 Current transformer test block

Every current transformer circuit entering the protection scheme/module shall be provided with a four-way test block located between the panel input terminals and the protection/control IED. The test block for a current transformer shall provide for:

- Automatic short circuiting of the incoming current transformer circuit;
- Measurement of the current in the incoming current transformer circuit of all three phases and the neutral individually, with a test plug and meter;
- Injection of test currents into the panel circuits on all three phases and the neutral individually, with a test plug and source; and,
    - The test facilities incorporated within individual IEDs will not be considered as substitutes for the test blocks called for in this standard.

3.4.6.4 Voltage transformer test block

Every voltage transformer circuit entering the protection scheme/module shall be provided with a four-way test block located between the panel input terminals and the protection/control IED. The test block for a voltage circuit shall provide for:

- Open circuiting of the incoming voltage transformer circuit;
- Measurement of the phase to phase and phase to neutral voltage of the incoming voltage transformer circuit with a test plug and meter;
- Injection of test voltage into the panel circuits with a test plug and source; and,
    - The test facilities incorporated within individual IEDs will not be considered as substitutes for the test blocks called for in this standard.

3.4.6.5 Test Block Types

Only the following type of test blocks shall be for use in Eskom's protection panels.

- PK2 four way and six way test blocks.

Other types of test blocks may be considered for special applications, and shall be approved by Eskom.

3.5 Functional Element Description

This section defines the scheme functional elements, grouped as far as possible per the Logical Node groupings of IEC 61850-7-4. Functions are described wherever possible without reference to the IEDs that will perform them, that is, this section describes "what" rather than "how".

The description of each functional element will include a description of input conditions, the desired scheme response to an output (e.g. tripping) and the functional requirements (what is required from the element and the performance requirements).

The detailed logical node standard descriptions regarding functional requirements, settings, performance, inputs, outputs and data attributes will be compiled, at a later stage, as standalone documents. Due to the unavailability of the detailed logical node documents, the detail requirements will be included within each detailed functional spec.

3.5.1 Protection functions (Group P)

Refer to each detailed functional standard for the detailed protection functional and interface requirements.

3.5.2 Protection-related functions (Group R)

Refer to each detailed functional standard for the detailed protection-related functional and interface requirements.

3.5.3 Measurement functions (Group M)

The IED HMI shall be used for local measurements display without human intervention to view the values. Measurements quantities shall be provided as per the requirements of the detail functional standards. Where a mandatory analogue measurement cannot be set as the default display on the main or back-up IED (i.e. where no human intervention is necessary to view the value), it shall be indicated using a stand-alone analogue or digital gauge to Eskom approval. Where required, analogue gauges shall be transducer driven, accepting a 0 – 5mA input signal (5mA corresponding to the rated quantity). Suitable transducers shall be supplied as part of the scheme. Analogue Gauges shall be scaled to 150% of rated.

The preference shall be to provide the requisite remote analogue indications via Ethernet communications (IEC61850) from the IED (i.e. avoiding the requirement for measurement transducers wherever possible). Digital indications shall be provided via the Ethernet SCADA communication link. The measurements quantities shall be derived from metering class CTs and VTs. The IED analogue input class for connection to the metering class CTs and VTs shall be 0.5 or better.

The measurement for each quantity shall be measured separately and continuously. The local IED HMI shall display the quantities continuously. Integral dead-band reporting shall be used for remote reporting (Station HMI and control centres). The measured value is reported if the time integral of all changes exceeds a pre-set limit. A minimum settable value shall be possible for all the measured quantities, typical 5% for currents, active power, reactive power and apparent power, and 3% for voltage and frequency.

The IED HMI shall have the capability to display and remote reporting of the following measurements quantities:

- Active Power (P);
- Reactive Power (Q);
- Power factor (PF);
- Frequency (F);
- Phase-phase voltages (R-W, W-B and B-R); and,
- Phase currents (R-N, W-N AND B-N).

The IED HMI shall have the capability to display and remote reporting of the following synchronism check measurements quantities (when applicable):

- Voltage difference (ΔV);
- Frequency difference (ΔF); and,
- Angular difference (ΔΦ).

3.5.4 Supervision and Monitoring functions (Group S)

Refer to each detailed functional standard for the detailed supervision, monitoring functional and interface requirements.

3.5.4.1 Trip circuit supervision

Trip circuit supervision shall continuously monitor each phase of the trip circuit of the circuit-breaker. The trip circuit supervision shall be integrated within the protection IED and shall monitor the circuit-breaker in the close and open positions. Trip circuit supervision shall be alarmed, local and remote. The trip circuit supervision shall not adversely affect the dependability and security of the trip circuit.

3.5.4.2 Circuit-breaker monitoring

The protection IED shall have the ability to summate the switched currents (per phase). The summed value shall be reported both local and remote. This summed value shall be resettable from the IED HMI.

3.5.4.3 Circuit-breaker charging fail

A circuit-breaker charging failed timer (delay-on-drop-off) shall be provided to raise an alarm in the event of a failure of any of the circuit-breaker charging mechanisms and shall be alarmed, local and remote.

3.5.4.4 Circuit-breaker SF_6 gas monitoring

The circuit-breaker SF_6 gas insulation medium monitoring device(s) low and critical signals (per breaker) shall be reported local and remote and shall at bay level, block manual closing.

3.5.4.5 Circuit-breaker trip counting

Each scheme/module shall be fitted with a counter per circuit-breaker (per phase) that may be user-configured either as a trip counter (i.e. counting circuit-breaker operations) or a fault counter (i.e. counting protection trips and supervised with opening of the circuit-breaker). The trip/fault counter shall be integrated into the IED and shall accessible by no more than two keystrokes on the IED front panel. The integrated trip/fault counter shall be provided in non-volatile memory and shall include the facility to pre-load any number of operations (e.g. so as to continue from a previous counter value). Trip/fault counting shall be inhibited when the TNS is not selected the NORMAL position (or when the transmission line is on transfer). It shall be ensured that only one count (per phase) takes place for a single trip event. The counter value shall be reported remotely by the supervisory system.

3.5.4.6 Current transformer SF_6 gas monitoring

The current transformer SF_6 gas insulation medium monitoring device, low and critical signals (per CT) shall be reported local and remote.

3.5.4.7 Indications

All indications shall be visible by default, that is, no external influence shall be required to view any indication. The status of all locally and remotely controllable functions and power plant equipment shall be indicated on the scheme.

Indication lamp colours shall be as follows:

- Red: Trip conditions, not healthy condition
- Amber: Alarm conditions
- White (or Amber): Earth applied, Automatic Voltage Control on Manual

3.5.4.8 Lamp check

The lamp check pushbutton shall be provided for to verify the health of the panel/module lamps, this includes both D.C. and A.C. powered lamps. Where possible, this function shall also cause all IEDs' integrated indications to be illuminated.

3.5.4.9 Panel Not Healthy indication

The PNH is an alarm condition that indicates that the scheme or module is in an abnormal state. The following conditions shall activate the PNH alarm:

- Any device hardware failure;
- Any switch or MCB in an abnormal state; and
- Loss of DC supplies

The following conditions shall be reported separately via IED indications and shall not activate the PNH alarm:

- VT Fuse Fail;
- CT circuit supervision;
- Teleprotection channel failure;
- Current differential communications failure;

- Substation communication failure; and,
- Trip Circuit supervision failure.

The Panel Not Healthy (PNH) indication shall be provided external to any IED. The PNH lamp shall be positioned on the top left hand side of the panel/module. The PNH lamp shall be red and supplied by 230 VAC.

3.5.4.10 JB Not Healthy indication

The alarm "Junction Box Unhealthy" (JBNH) shall be used to indicate "PNH" type alarm conditions that occur in the bay JB. The JBNH is an alarm condition that indicates that the JB is in an abnormal state. The following conditions shall activate the JBNH alarm:

- Any device hardware failure;
- Any switch or MCB in an abnormal state; and
- Loss of DC supplies

The JB Not Healthy (JBNH) lamp shall be positioned on the top right hand side of the panel/module. The JBNH lamp shall be red and supplied by 230 VAC.

3.5.4.11 DC supply monitoring

Each DC supply rail shall be monitored and reported (local and remote). Each monitoring device shall be energised upon application of the DC supply it is monitoring, with its associated DC fail normally closed alarm contacts being maintained in an open circuit condition. In the event of a DC supply failure, or the switching to the 'Off' position of the relevant DC MCB, the DC fail monitoring device shall be de-energised, resulting in the closing of the alarm contacts. The DC supply fail monitoring device shall be connected to the last loop of the supply being monitored. Each supply rail controlled by an MCB shall be monitored.

The following DC rail monitoring is required:

- Main # tripping supply rail;
- Main # indication supply rail;
- Main # secure supply rail;
- Secure supply rail;
- Circuit-breaker closing supply rail;
- Common circuit supply rail;
- Spring rewind circuit supply rail; and,
- Motorised Isolator circuit supply rail

The following equipment failure alarms are required:

- Main # protection device failed;
- Main # control device failed;
- Main # ethernet switch failed;
- Main # process interface unit failed;

3.5.4.12 AC supply monitoring

An AC fail relay, ACF(Scheme), shall monitor the status of the 230V AC 'panel not healthy' and 'JB not healthy' indications supply. This relay will be energised upon application of the AC supply it is monitoring, with its associated AC fail normally closed alarm contacts being maintained in an open circuit condition. In the event of an AC supply failure, the AC fail relay shall be de-energised, resulting in the closing of the alarm contacts. The AC supply fail monitoring relay shall be connected to the last loop of the supply being monitored. The AC supply fail monitoring alarm contact shall be remotely reported.

3.5.5 Control functions (Group C)

Refer to each detailed functional standard for the detailed control functional and interface requirements.

3.5.5.1 Supervisory Isolating Switch

The Supervisory Isolating Switch (SIS) provides for the selection between local (OFF selected) and remote (ON selected) controls. The SIS selection shall be done via a two position rotary switch located on the front of the panel. The enabling and disable of the relevant functions, as per the table below, shall be done within the IED. The OFF selection shall be remotely reported (station HMI and control centre). The circuit-breaker emergency trip shall be independent on the SIS selection. For schemes using a single IED for supervisory controls, the Supervisory Isolate Switch (SIS) shall be provided as an integrated function of that IED, activated by on-board push buttons.

Description	Selection between local control and remote.
OFF	Enable local control from IED HMI or front panel controls: • Auto-reclose mode selection; • Transfer permission key selections; and, • Tap changer raise and lower commands. Disable remote controls from the station HMI and control centre: • Open and close commands to all the isolators and the circuit-breaker; • Auto-reclose mode selections; • Transfer permission key selections: and, • Tap changer raise and lower commands.
ON	Enable remote controls from the station HMI and control centre: • Open and close commands to all the isolators and the circuit-breaker; • Auto-reclose mode selections; • Transfer permission key selections: and, • Tap changer raise and lower commands. Disable local control from IED HMI or front panel controls: • Auto-reclose mode selection; • Transfer permission key selections; and, • Tap changer raise and lower commands.

3.5.5.2 Test Normal selection

The Test Normal selection (TNS) provides isolation of the trip outputs to the circuit-breaker(s) and/or the circuit-breaker fail inputs or output contacts for test purposes and permits or not auto-reclose initiation where applicable. Where the TNS only isolates the circuit-breaker fail trip output, it shall be termed the Breaker Fail Isolate (BFI) switch. The TNS selections shall be done via the IED HMI or alternatively by use on push buttons with indications on the front of the panel. The TNS selection shall be latched within the IED and shall retain the selection when the IED powers down and back up again. The enabling and disabling of the relevant functions, as per the table below, shall be done within the IED. The TNS selection shall not be selectable from remote (Station HMI and Control centre). The selected TNS position shall be clearly displayed (illuminated) on the HMI or on the panel. The TEST 1 and TEST 2 selections shall be remotely reported (station HMI and control centre).

Description	Selection of the desired test option for the protection tripping, breaker failure signal and auto-reclose initiations.
NORMAL	Enable: • Tripping to the main # trip-coils; • Auto reclose (1 & 3 pole) initiation and blocking; • One-pole auto-reclose enabled from the auto-reclose function; • Breaker trip counting; • Breaker fail to the busbar protection scheme; and, • Tripping to other protection schemes (e.g. series cap bank, line reactor breaker fail).
TEST1	Enable: • Tripping to the main # trip-coils; • Auto reclose (1 & 3 pole) initiation and blocking; • One-pole auto-reclose enabled from the auto-reclose function; and, • Breaker trip counting. Disable: • Breaker fail to the busbar protection scheme; and, • Tripping to other protection schemes (e.g. series cap bank, line reactor breaker fail).
TEST2	Disable: • Tripping to the main # trip-coils; • Auto reclose (1 & 3 pole) initiation and blocking; • One-pole auto-reclose enabled from the auto-reclose function; and, • Breaker trip counting; and, • Breaker fail to the busbar protection scheme; • Tripping to other protection schemes (e.g. series cap bank, line reactor breaker fail).

On a busbar protection panel, the TNS is termed the Bus Zone Isolate (BZI) switch. A TNS shall be provided on all schemes that issue trip commands to multiple circuit-breakers or which include circuit-breaker fail trip outputs.

3.6 Programmable logic & tripping matrix

The minimum amount of circuit-breakers shall be tripped to isolate a fault condition and on lines to auto-reclose for supply restoration.

The main # protection device shall trip (on a per phase basis where applicable) the main # trip coil of the circuit-breaker (or transfer circuit-breaker) through the trip-duty rated output contacts of the main # protection when the TNS(M1) is in the 'Normal' or 'Test 1' position.

All the protection functions shall initiate the breaker fail function. The busstrip command from the breaker fail function shall issue a busstrip command to trip the adjacent circuit-breakers:

- Buszone protection scheme with the TNS selected to the 'Normal' position;
- Routed to the buszone protection scheme via the bus coupler protection scheme when on transfer and with the relevant TNS selected to the 'Normal' position; and,
- Tripping of the other side of a transformer with the relevant TNS selected to the 'Normal' position;
- Remote line end with the relevant TPIS selected to the 'On' position.

The detailed tripping matric will be within the individual detailed standards.

3.7 Scheme composition

The scheme/module solution shall comprise all the required protection functions, bay control functionality (SCADA, auto-reclosing, measurements, etc.), ethernet switch, MCBs, test blocks, switches, pushbuttons and indications. The IED(s), MCBs, switches, indications, test blocks, indications and pushbuttons shall be located at the front of the panel/module. All the equipment shall have the capability to be mounted in a flush mount 19 inch rack system. The two main protection systems or main and back-up protection systems shall be independent and galvanically isolated. The unavailability of one of the two protection systems shall not adversely affect the availability and performance of the in-service protection system.

3.7.1 IEDs

The scheme/module shall preferably have one IED with all the required protection and bay control functions integrated within the IED. A maximum of two IEDs, where the protection functionality is fully integrated within the one IED and the bay control functionality within the second IED is permissible.

Process interface units (PIU) are required to interface (binary inputs and outputs) between the primary plant equipment and the protection and control scheme/module. The PIUs shall be located within the relevant JB(s). The following PIUs are required:

- Circuit-breaker bay (breaker, isolator and earth switches);
- Transformer; and,
- Tap change control.

The IEDs shall comply with the Generic Standard for Intelligent Electronic Devices (IEDs) Standard, Unique Identifier 240-64685228.

3.7.2 Auxiliary components

The auxiliary components shall comply with the Design Standard for low voltage auxiliary electrical scheme components, Unique Identifier 240-62773019.

3.7.2.1 230V AC Supply MCB - MCB (AC) (10 Amp)

The 230V AC MCB provides for the protection and isolation of the 230V AC voltage (ON or OFF) to the Panel Not Healthy Indication and the JB Not Healthy Indication. Both these indications (red) are located on the Panel/module.

2 pole MCB (selection between OFF and ON)

OFF - Isolate the 230 VAC supply to the panel and JB not healthy indication circuits; and,

ON - Apply the 230 VAC supply to the panel and JB not healthy indication circuits.

3.7.2.2 Main # DC Isolating MCB - DCI (M#) (16 Amp)

This MCB provides for the protection and isolation of the main # DC voltage (ON or OFF) to the main # tripping system.

2 pole MCB (selection between OFF and ON)

OFF - Isolate the main # DC supply to the main # protection system circuits; and,

ON - Apply the main # DC supply to the main # protection system circuits.

3.7.2.3 Main # Secure Supply DC Isolating MCB - DCI (SS)(M#) (16 Amp)

This MCB provides for the protection and isolation of the main # DC voltage (ON or OFF) to the secure supply chop-over circuit. The main 1 DC for the secure supply is connected before the main 1 protection system DC supply and is therefore independent on the position of DCI(M1). The main 2 DC for the secure supply is connected before the main 2 protection system DC supply and is therefore independent on the position of DCI(M2).

2 pole MCB (selection between OFF and ON)

OFF - Isolate the main # DC supply to the secure supply chop-over circuit; and,

ON - Apply the main # DC supply to the secure supply chop-over circuit.

3.7.2.4 Main # Ethernet Switch Main # DC Isolating MCB - DCI (ETHSW)(M#) (6 Amp)

This MCB provides for the protection and isolation of the main # DC voltage (ON or OFF) to the Ethernet Switch (ETHSW). The main # DC for the ethernet switch is connected after the main # protection system DC supply MCB (DCI (M#)) and is therefore also dependent on the position of DCI(M#).

2 pole MCB (selection between OFF and ON)

OFF - Isolate the main # DC supply to the ethernet switch; and,

ON - Apply the main # DC supply to the ethernet switch.

3.7.2.5 Main # Teleprotection DC Isolating MCB - DCI (TPE)(M#) (10 Amp)

This MCB provides for the protection and isolation of the main # DC voltage (ON or OFF) to the teleprotection device and circuits. The main # teleprotection DC for the teleprotection circuits are connected after the main # protection system DC supply MCB (DCI (M#)) and is therefore also dependent on the position of DCI(M#).

2 pole MCB (selection between OFF and ON)

OFF - Isolate the main # DC supply to the main # teleprotection circuits; and,

ON - Apply the main # DC supply to the main # teleprotection circuits.

3.7.2.6 Circuit-breaker Closing DC Isolating MCB - DCI (CL) (16 Amp)

This MCB provides for the protection and isolation of the closing DC voltage (ON or OFF) to the circuit-breaker closing circuits. The closing DC supply is connected to the secure supply.

2 pole MCB (selection between OFF and ON)

OFF - Isolate the closing DC supply to the closing circuits; and,

ON - Apply the closing DC supply to the closing circuits.

3.7.2.7 Indication DC Isolating MCB - DCI (IND) (6 Amp)

This MCB provides for the protection and isolation of the indication DC voltage (ON or OFF) to the indications circuits. The indication DC supply is also connected to the main # DC supply and is independent of the position of DCI (M#).

2 pole MCB (selection between OFF and ON)

OFF - Isolate the indication DC supply to the indication circuits; and,

ON - Apply the indication DC supply to the indication circuits.

3.7.2.8 Circuit-breaker Spring Rewind DC Isolating MCB - DCI (SR) (32 Amp)

This MCB provides for the protection and isolation of the spring rewind DC voltage (ON or OFF) to the circuit-breaker spring rewind DC circuits. The circuit-breaker spring rewind DC supply is also connected to the motorised isolators DC supply and is independent of the position of DCI(MI).

2 pole MCB (selection between OFF and ON)

OFF - Isolate the spring rewind DC supply to the circuit-breaker spring rewind circuits; and,

ON - Apply the spring rewind DC supply to the circuit-breaker spring rewind circuits.

3.7.2.9 Motorised Isolator DC Isolating MCB - DCI (MI) (32 Amp)

This MCB provides for the protection and isolation of the motorised isolator DC voltage (ON or OFF) to the motorised isolators DC circuits. The motorised isolators DC supply is also connected to the circuit-breaker spring rewind DC supply and is independent of the position of DCI(SR).

2 pole MCB (selection between OFF and ON)

OFF - Isolate the motorised isolator DC supply to the motorised isolators circuits; and,

ON - Apply the motorised isolator DC supply to the motorised isolator circuits.

3.7.2.10 IED DC Isolating MCB - DCI (IED) (6 Amp)

This MCB provides for the protection and isolation of the DC voltage (ON or OFF) to the IED. This MCB provides for the ability to isolate DC supply to the IED without affecting the availability of any one of the other functions located within the same supply. This MCB will be required for the following:

- Standalone bay control device (BCD);
- Point-on-wave switching device;
- Phasor measurement unit; and,
- Etc.

2 pole MCB (selection between OFF and ON)

OFF - Isolate the relevant DC supply to the IED; and,

ON - Apply the relevant DC supply to the IED.

3.7.2.11 VT Main - MCB (VT) (6 Amp)

This MCB provides for the protection and isolation of the Main VT supply (ON or OFF) to the Main IED. This MCB is only necessary when the Main IED VT inputs are not directly connected to the VT JB.

2 pole MCB (selection between OFF and ON)

OFF - Isolate the VT supply to the IED; and,

ON - Apply the VT supply to the IED.

3.7.2.12 VT Synch - MCB (SYNC) (6 Amp)

This MCB provides for the protection and isolation of the Synchronising VT supply (ON or OFF) to the IED. This MCB is only necessary when the IED VT inputs are not directly connected to the VT JB. Three MCBs are required: Line VT, Busbar 1 VT and Busbar 2 VT. Normally closed auxiliary contacts are required per MCB to block synchronism check (internal to the IED) when the MCB(s) is in the trip position.

2 pole MCB (selection between OFF and ON)

OFF - Isolate the connected busbar VT supply to the synchronism check function; and,

ON - Apply the connected busbar VT supply to the synchronism check function.

3.7.3 Ethernet switches and communications architecture

Each protection and control scheme/module shall include an ethernet switch with 100 Megabit Multi-mode fibre ports for bay IED connections and two Gigabit ports for connection to the station backbone Gigabit ethernet switches. All the IEDs (including the PIUs) within a specific bay shall connect to the ethernet switch in a star topology. The connections between the ethernet switch, IEDs and PIUs shall be multi-mode fibre. The IEDs and PIUs fibre connection requirements shall comply with the Generic Standard for Intelligent Electronic Devices (IEDs) Standard, Unique Identifier 240-64685228. The ethernet switch, per bay, shall interface with the substation automation network topology as per the Substation Automation Network Architecture Standard, Unique Identifier TST 41-1077.

The panel/module shall include fibre patch panels to interface between the ethernet switch and the fibre cable entering the panel/module. The fibre patch panels shall be fitted FC fibre connections and shall include pigtails and midcouplers. The fibre patch panel shall make provision for the required number of fibre connections including 2 spares

The ethernet switch design and requirements shall comply with the Standard Networking Devices for the Substation Environment Specification, Unique Identifier TST 474-242.

3.7.4 Equipment compliance

The solution(s) shall be manufactured using only equipment that is compliant with this standard and the relevant specified standards.

3.7.5 Serial, hardware and firmware version numbers

Each functional unit of each scheme (e.g. rack, sub-rack and auxiliary relay) shall contain a unique, indelible and easily identifiable serial number and where applicable, the hardware and firmware version number. A list of all items (with associated serial numbers, hardware version numbers and firmware version numbers) shall be provided with each production scheme. The successful tenderer shall maintain a comprehensive record of all transactions involving serialised items.

3.8 Physical construction

3.8.1 Safety and regulatory requirements

No approval given or implied by Eskom shall relieve the supplier of any statutory obligations regarding safety.

3.8.2 Scheme housing and mounting

The required scheme shall comprise of a main protection system and the bay control system. The main protection system and bay control system shall be housed in a single module/panel.

The panel design for EHV/HV Main Transmission substations shall be fixed front-rear access panels and for HV/MV Distribution substations swing frame panels.

The dimensions of the fixed front-rear access panel shall be 800mm x 600mm x 2400mm (WxDxH), with rear access to the scheme wiring, relay terminals, rail-mounted scheme terminals, etc., by means of a hinged door per panel. Access to the front of the panel shall also be by way of a hinged door. The fixed front-rear access panels shall have the terminals positioned vertically on the inside rear of the panel with access from the rear door. The panels shall be designed so that the front faces line up correctly to within ± 2 mm.

The swing frame schemes shall consist of a front panel module and a terminal back plate coupled by wiring tails. It shall be possible to mount the module in an 800mm x 600mm x 2400mm (WxDxH) swing frame panel specified to DSP 34-464. The depth of the front panel module shall be a maximum of 350 mm. Tails shall be made long enough to allow free movement of the swing frame (door). Easy access shall be provided to the back of all IEDs. No plug-in system (except for the connector terminal rails provided on IEDs and auxiliary components) will be allowed.

3.8.3 Panel design

Where the scheme fills a complete panel (more than half) then the full panel is considered a module, whereas if the scheme fills less than half of a panel it shall be considered for modular design. A module should be easily transportable and shall be designed to be easily removed.

Where the module is constructed in a box-form, the rear of the module shall be open to ease access to the internal components and to improve heat dissipation.

Rack mountable IEDs shall be firmly attached to the chassis of the front panel module, independently of the 19 inch rack securing bolts. The IED shall be positioned at an acceptable working height, but not lower than 500mm off ground level. The IED with HMI used for local control execution and local measurements display shall be at an acceptable height for ease of access and readability.

All A.C and D.C. isolation MCBs shall be located at the front of the panel/module. The MCB's shall be fitted in the following order: DC, AC, VT Main and VT Synch.

The design of a scheme shall be such that, when fitted in a swing frame panel to DSP 34-464 or a fixed front-rear access panel, with all doors closed and covers in place and with all internal equipment correctly mounted and fully operational, the temperature rise at any free air point shall not exceed 10 °C. Forced cooling shall not be used.

The front of the panels shall be compatible with a flush mount 19 inch rack system in accordance with IEC 60297-1. Nineteen inch (19") rack mounting hole arrangements shall be as per the IEC 60297-1. Only closed holes shall be permitted.

The classification of enclosures shall be in accordance with SANS 60529. The minimum degree of protection provided shall be IP 41 for the front panel, and IP 1X for the rear of the module and back plate.

The channel base frame of each panel enclosure shall be drilled and fitted with holding down bolts to suit pockets to be provided by Eskom. The bolts shall be delivered with the panels.

Suitable means of lifting shall be provided for.

3.8.4 Panel finishing

After fabrication is complete the metal surfaces shall be finished in accordance with Eskom Standard OPS 2366/11—3 Corrosion Protection Specification. The paint colour of the interior and exterior of the housing shall be to SANS 1091 colour code G29: Medium Grey. The base channels, base backplate and checker plate support angle shall be gloss black. The interior side plates and terminal back plate shall be smooth powder coated to SANS 1091 colour white.

3.8.5 Component mounting and fixing

Lock washers shall be used with all screwed fittings except where the use of self-locking nuts or fasteners, make their use unnecessary. Permanent fixings such as rivets shall only be used for fixed mechanical parts, and not for electrical or electronic components. Self-tapping screws shall not have sharp points and shall not be used for fixing items such as cover plates which may have to be removed and replaced.

Components shall be located, secured and disposed with respect to each other and the structural members so that they, together with all connecting wires, can be inspected, removed and replaced without damage to, or undue disturbance of, other parts of the equipment or wiring.

Components shall be mounted inside the scheme or module. Where mounted on the back plate, it is preferred that a dedicated rail be provided for this purpose. Components shall not be mounted on the back plate or on the side of the panel which shall be reserved for terminal blocks only.

Test blocks shall be located in the lower region of the 19" rack panel/module and shall be easily accessible from the front of the panel with the cover door open. Cables hanging from test plugs inserted in the blocks shall not obscure or in any way interfere with any test or operational feature of any equipment mounted in the 19" rack. The minimum height of such test blocks above floor level shall be 150 mm. The input circuits from the outside plant shall always be connected to the lower terminals of the test blocks and the panel circuits shall always be connected to the upper terminals of the test blocks. When observed from the front of the panel the phase order of the connections to both the upper and lower terminals shall be (from left to right) Red, White, Blue, Neutral.

3.8.6 Terminals

Terminals for connection to external circuits shall be to approval. Not more than two conductors shall be connected to any side of a terminal. Terminals shall be suitable for use with crimped or compression type terminations.

Terminals to which external cabling is to be connected (boundary terminals) shall be permanently and indelibly marked in an approved manner. Each terminal shall be clearly and unambiguously identifiable by suitable marking which is on or adjacent to it.

3.8.7 Terminal strips

The terminal strips shall be legibly numbered: X1, X2, etc. To improve visibility, the label shall be placed on the right side of each terminal strip for the swing frame panels and above each terminal strip for the fixed front-rear entry panels. The terminal strips shall be positioned horizontally top to bottom on the back plate of the swing frame panels: X1,X2, etc. The terminal strips shall be positioned vertically at the rear of the fixed front-rear entry panels starting from the bottom right hand side: X1, X3, etc., and the bottom left hand side X2, X4, etc.

The design shall cater for the termination for all used cores within a common cable on one terminal strip only. Terminal strip functionality shall be divided according to the following table:

Terminal Strip number	Functionality (in recommended order)
X1	Power terminals: • DC supplies; and, • AC supplies.
X2	CT terminals
X3	VT terminals
X4	Trip interface terminals: • Trip signals to circuit-breaker; • Breaker fail signals to the buszone scheme; • Reactor interfacing; • Series capacitor bank interfacing; • External trip interfacing; and,
X5	Inter scheme/module interfacing; • Trip signals between object protection schemes.
X6	JB interface terminals (signals between the scheme/module and the JB).
X7	Teleprotection interface

Terminal Strip number	Functionality (in recommended order)
X8	Protection equipment interface (internal to the scheme/module)
X9	External disturbance recorder interface
X10	Interface with third party equipment

3.8.8 Vertical and horizontal wiring trunking

Wiring trunking shall be provided for all vertical (fix frame panel design) and horizontal wires (swing frame panel design). Each trunking shall be fitted with a cover of insulating material. These covers shall be designed so that they can be fixed in position, and removed without the use of tools. Trunking shall be adequately dimensioned to accommodate the maximum number of cables especially where the cables enter the trough.

For the swing frame panels, a horizontal plastic trunking strip shall be provided above and below each terminal strip to accommodate wiring. For the fixed front-rear entry panels, a vertical plastic trunking strip shall be provided to the left and right of each terminal strip to accommodate wiring. Where space permits, the wiring for the top and bottom or left and right of each terminal strip shall be accommodated in separate trunking strips of minimum dimensions 60mm (h) x 25mm (w). This means that double rows of trunking will be provided between all terminal strips.

Where there is insufficient space on the terminal back plate or terminal rear side to accommodate double rows of trunking, a single trunking strip of minimum dimensions of 60mm (h) x 40mm (w) may be provided between terminal strips.

Trunking shall be of the 'fine' tooth type (tooth width 6.1 mm as opposed to 12.0 mm).

In order to facilitate easy access to all terminals and wires, a minimum gap of 30mm shall be provided between trunking and the top and bottom or left and right of the terminal blocks. To further improve accessibility, the terminal attachment rail may be mounted on posts or an angle iron such that the rail is raised from the back plate by 70mm. The number of terminal strips required will depend on the terminal requirements per individual scheme.

Proprietary brands of PVC or equivalent material trunking shall be used, but regardless of the type of construction, the design and sizing of the trunking with cover shall be subject to Eskom approval before manufacture commences.

3.8.9 Wiring supports

Vertical lacing supports of non-magnetic material shall be provided for securing cable tails. Joints or splices in any wiring are not acceptable. Any support for wiring must be of a non-conductive material. Vertical lacing supports of non-magnetic material shall be provided for securing cable tails. Wiring and cabling shall be adequately supported and clamped. Where wiring is routed from the inside of a panel to a panel door, its' wiring shall be routed through a protective wiring sock. Grommets or bushes shall be used where wires or cables pass through metalwork. Wiring and cabling shall be routed such that its insulation is not subject to injurious temperatures or stresses.

In the case of vertical terminal rows, panel wiring shall be connected to the side of the terminal strip which is nearest the front of the panel, and cable tails shall be connected to the side nearest to the panel rear. In the case of horizontal terminal rows the panel wiring shall be connected to the lower side of the terminals and the cables shall be connected to the upper side.

3.8.10 Wiring terminations

The selection of specific terminal block types for application in a scheme shall take cognisance of the typical wire size to be applied at the scheme interface. Link type terminals, for applications Distribution applications, shall be used in the following applications:

- CT and VT Circuits that are not routed via test blocks

- Tripping and Closing Circuits that are not fed via local remote switches – LOR switches.

The terminals of all relays and other panel components shall be readily accessible when the panel is fully wired. Any difficulties experienced, either with layouts or terminal accessibility shall be referred to Eskom prior to the commencement of the wiring.

Not more than two conductors shall be connected to any side of a terminal and where two conductors are connected to a terminal, care shall be taken to ensure that lugs and ferrules are fitted to the conductors so as to allow the wires to approach the terminal as near parallel as possible.

The stripping of insulation shall be carried out so that no damage to conductors occurs. Any nicked wiring will be rejected. The stripping tools used shall be of the type which permits the length of strip to be pre-set.

All wires and cables less than 6 mm² in the panel shall be terminated with pre-insulated crimped connectors of approved types. Other types of lug which are to Eskom's approval may be considered.

Schemes shall include at least two spares of each terminal block type used.

The scheme back plate shall include horizontal terminal strips for the swing frame panels and vertical terminal strips for the fixed front-rear entry panels.

For the swing frame panels with horizontal terminal strips, internal scheme wiring to terminal strips on the terminal back plate shall be connected to the lower side of the terminals and the cables shall be connected to the upper side. The input circuits from the outside plant shall always be connected to the lower terminals of test blocks and the panel circuits shall always be connected to the upper terminal. When observed from the front of the panel the phase order of the connections shall be (from left to right) red, white, blue, neutral.

For the fixed front-rear entry panels with vertical terminal strips, internal scheme wiring to terminal strips on the inside of the panel, for the left terminal strip shall be connected to the right side of the terminals and the cables shall be connected to the left side. For the right terminal strip, internal scheme wiring to terminal strips on the inside of the panel shall be connected to the left side of the terminals and the cables shall be connected to the right side.

Wiring terminations shall be of such a length and executed in such a manner that the conductors are not subject to injurious tensile stresses or flexing which might cause fatigue failure, whether as a result of vibration or otherwise.

All terminations shall be made with the tool recommended by the manufacturer of the lugs. Crimping tools shall be of the type which will not release the termination during normal operation until the crimp has been correctly formed. A double die crimping tool shall be used in order to effect both the lug and insulation support crimp simultaneously.

All wires and cables larger than 6 mm² shall be terminated with an approved lug. The lug shall be crimped with a hydraulically actuated hexagonal die tool as recommended by the manufacturer of the lug.

There shall be no bare wire exposed between a lug and the insulation of the wire to which it is crimped.

All tools used shall be regularly inspected and tested with approved gauges, and maintained or repaired as necessary. Tools shall be inspected and tested initially at weekly intervals, but this period may be extended in the light of experience. A log of inspections shall be maintained for Eskom's inspection.

The lugs selected shall be the correct barrel size for the size of wire or cable with which they are to be used, and the dimensions of the tongue shall match the stud, screw or aperture of the terminal to which they will be connected.

A sample of each type of lug, wire, tool and finished connection if not previously approved shall be submitted to Eskom for approval before wiring is commenced.

The size, current and voltage rating shall match the wire and cable used.

3.8.11 Wiring identification

Wiring leads connected to the boundary terminals shall be permanently marked with an approved type of marking device, with black letters impressed on a white background or black letters on a yellow background provided that the colour selected is consistent throughout the panel and/or suite of panels and is to Eskom's approval.

Interlocking slip-on types of ferrules or one piece ferrules may be used and shall match the size of wire onto which they will be fitted.

For heavy conductors and very light telephone type wiring where the preferred type of marking ferrule is not available, other methods will be subject to Eskom's prior approval.

All wiring shall be identified using numbers, at each end, following the alphanumeric wire identification conventions stated in the generic equipment standard for wiring, wire marking and cable numbering, Unique Identifier 240-64636794.

3.8.12 Wiring sizing and practices

The wiring sizing and practices shall be as per the wiring standard 240-64636794.

The overload rating of the scheme/module wiring shall be higher than the protected MCB rating. (ensure this statement is within the wiring standard)

3.8.13 Earthing

All earthing shall be done in accordance with the Standard for Earthing of Protection Equipment, Unique Identifier 240-64100247.

3.8.14 Labelling

All labelling shall be done in accordance with the Standard for Panel Labelling, Unique Identifier 240-62629353.

3.8.15 Packaging for transport

The schemes/panels/modules shall be securely packed before transporting by road to site or store, as specified per batch order. If the Supplier is required to deliver and off-load, he must ensure that he uses transport with proper off-loading facilities.

The Supplier shall pack the schemes/panels/modules in a manner that is designed to prevent damage or deterioration during transit to the final destination.

The Supplier shall pack the schemes/panels/modules taking account of rough handling, exposure to extreme temperatures, salt, precipitation during transit, open storage, the final destination and the absence of heavy handling facilities at certain points in transit or on arrival.

Acceptance of the schemes/panels/modules or any other equipment by the Eskom representative at the time of delivery is also subject to inspection by the Eskom representative for loss and damage. Unless instructed otherwise by the Eskom representative, the Supplier shall promptly replaces loss of and repairs damage to the schemes/panels/modules arising from the inspection.

4. Tests

The applicable type and routine tests required by Eskom shall constitute the type and routine tests acceptable on all devices, relays and the complete protection scheme/module. The successful tenderer(s) are responsible for the implementation of the required tests and the production of the necessary report documentation. The successful tenderer(s) shall compile a detailed test plan, and shall be agreed between the supplier and the Eskom representative prior to the commencement of any of the required tests. It shall be noted that an Eskom representative shall witness all of the tests.

4.1 Prototype tests

The purchaser's engineers will carry out type and functional tests once the prototype scheme is completed.

4.1.1 Environmental testing

Type tests shall be carried out by the successful tenderers (possibly with the involvement of a third party test organisation) and shall be witnessed by Eskom's representative. These tests may be destructive in nature and as such, any product or device, which has undergone any of these tests, shall not be used in any production scheme.

Unless specified to the contrary, type testing shall consist of performing the required tests on at least one sample of the design. Tests shall be performed on equipment which has not been the subject of previous type testing or, at Eskom's discretion on equipment which has been the subject of any modification which could affect the performance of the equipment.

Normal performance tests shall be performed before any type tests for comparison to determine damage.

Subject to Eskom's approval, evidence of equivalent tests performed on substantially similar equipment may be accepted provided that the test results are available in the form of a fully detailed certified test report.

When relevant, a check shall be made before the commencement of type testing, to ascertain that the equipment as supplied, inspected and adjusted from the production line, is correctly set up. Any differences found between the equipment as supplied and as required by its standard shall be recorded. The measurements taken to establish this shall also be recorded.

If during testing any further adjustments are required, such adjustment shall only be made with Eskom's approval and repetition of some of the previous tests may be required.

The supplier shall submit a detailed schedule of the proposed tests for approval before the commencement of the tests. This schedule shall be complete and include the following information:

- Date and place of test;
    - Details of the equipment to be tested, such as standard, type and serial numbers, contract reference and all relevant drawings and documentation;
    - A list of all test equipment which may be used, and performance standards of each test equipment listed, clearly showing that the stability, resolution, accuracy range, capacity, etc. ratings of the chosen equipment are more than adequate for the test performance requirement. When such information is not known, for instance when test equipment has to be specially manufactured, it shall be demonstrated that such equipment performs in the way intended so that its use is acceptable to those witnessing the tests;
- Details of usage and test equipment and the test methods, together with the connection diagrams and other related data;
- Description of measurements and observations to be made together with their intended number, frequency, sequence and time duration for each test; and,
- Documentation to be used for the recording of all results of testing and also the format of the certifying test documents.

If during the tests any failure occurs, any adjustments are made, or the equipment design is changed, Eskom shall be informed and may require the previous tests to be carried out again.

Where equipment is designed to be connected to other equipment at remote sites where different environmental conditions such as temperature and supply voltage can prevail, tests may be required to demonstrate that these differences do not adversely affect the compatibility of the equipment.

4.1.1.1 Insulation resistance (across isolating barrier) test

When a barrier is used to provide isolation from external circuits, its insulation resistance shall be measured. If the barrier is required to withstand high voltage stresses, then it shall be stressed at the specified voltage to demonstrate its withstand capability and a further insulation resistance test shall be made to ascertain that it has not been significantly degraded as a result of the stress being applied. The tests shall be performed in accordance with IEC 60255-5. Test details are given below.

The insulation of all circuits which include contacts of switches, relays or contactors for isolation functions shall be tested for insulation resistance. This shall be not less than 20 MΩ when measured at d.c. 500 V.

For circuits intended for connection to a.c. 100 V or d.c. 100 V and above, 2 kV r.m.s. shall be applied for 1 min and this shall be followed by a further insulation resistance test.

For circuits intended to provide isolation against large differences in earth potential as in class IV electrical environment, the barrier shall, after the initial resistance measurement, be stressed to the design voltage and this shall be followed by a further insulation resistance test.

NOTES:

a) Resistance measured at a potential of d.c. 500 V applied across the isolating barrier.
   - o R = R1 > 20 MΩ

b) For switches, relays and contactors 500 V is to be applied between
   - o The opposite ends of each circuit with contacts in open position.
   - o Both ends of each circuit to earth with contacts in closed position.

c) Circuits intended for connection to 100 V (a.c. or d.c). and above to be stressed to a.c. 2 kV for 1 min after initial resistance measurements. Stress to be applied between:
   - o The individual circuits of this type
   - o Each circuit of this type and all other circuits including earth. These other circuits can be strapped together electrically for the purpose of this test.

d) Final insulation resistance shall be such that
   - o R = R2 > 20 MΩ; or,
   - o R2/R1 > 0,7.

e) Barriers to provide protection against large rises in earth potentials to be stressed across barrier at design voltage for 1 min after initial isolation resistance measurement. Final insulation resistance test as above.

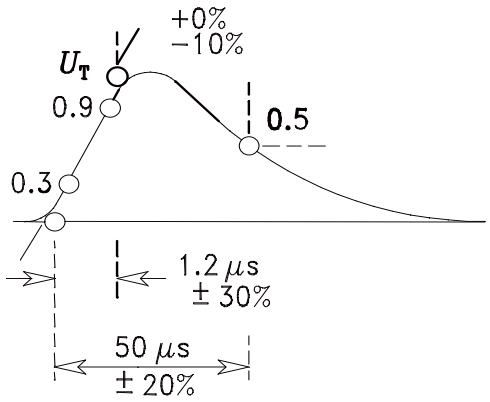
4.1.1.2 Electrical impulse test 1, 2/50 μs

This test is to demonstrate that the equipment has been correctly designed to withstand, without damage, the electrical stresses to which it might be subjected in practice.

The test to be applied is based upon IEC 60255-5. The impulse wave form is an aperiodic transient voltage without appreciable oscillations having a 1,2 μs rise time and an exponential decay to half amplitude in 50 μs.

When a large number of identical interface circuits are used, this test may be restricted to a representative sample, the proportion being to Eskom's approval.

A suggested circuit for the production and application of the test waveform is given in IEC 60255-5.



NOTES:

a) Source energy 1/2 joule for 1,0 kV to 5,0 kV.

b) Source energy 1/8 joule for 0,5 kV.

c) Source energy 1/12 joule for 0,25 kV.

d) Source impedance 500 Ω.

No less than 3 positive and 3 negative pulse each applied at intervals of not less than 5 s.

Application Method	Test voltage 'V' (kV)		
	Class II	Class III	Class IV
a)	-	1,0	5,0
b)	-	1,0	5,0
c)	0,25	0,5	1,0
d)	1,0	1,0	1,0

NOTES

Method of application - Test voltage 'V' shall be applied between:

a) Each terminal and the safety earth (common mode).

Note: Where practicable all terminals may be connected together.

b) Individual terminals of all independent circuits (including power supplies). Where practicable the terminals of each independent circuit may be connected together (common mode between separate circuits).

c) Signal terminals of the same circuit (series mode).

d) Power supply terminals of battery powered equipment (external supply) (series mode).

Note: A terminal is defined as any connection to or from the equipment including those to power supplies.

4.1.2 Functional testing

The purchaser's engineers will carry out functional tests to verify the scheme wiring, relay configurations and overall scheme functionality. These tests shall be performed on the deemed prototype scheme, devices and shall include, but not be limited to, the following:

- Secondary injection tests to prove correct functional operation and to check the functional accuracy and calibration of the units;
- Type testing of scheme and devices;
- Model Power System simulator testing at the tenderer's principal works; and,

Any specific test which shall prove, to the purchaser's satisfaction, the required performance aspects of the protection scheme and devices which may be impacted by minor equipment modifications, refinements or development work.

The supplier(s) shall develop and verify the required test routine prior completion of the proto-type testing. The test routine shall be for the test equipment being utilised by Eskom.

4.1.2.1 Initial visual inspection

The initial visual inspection shall be performed to ensure that the equipment is of sound construction and, so far as can be ascertained, meets the requirements of this standard, schedule A of the enquiry document and the offered equipment within the tender submission documentation.

4.1.2.2 Initial performance test

The initial performance test shall carried out on the completed proto-type scheme and prior any type testing and shall consist of a comprehensive series of measurements of the characteristics of the equipment to demonstrate that its performance is in accordance with its functional requirements, including the detailed requirements of schedule A of the enquiry document and with this standard. This test shall normally be performed at an ambient temperature of 20 °C ± 5 °C while supplied at 120% of the normal DC voltage.

4.1.2.3 Final performance test

The final performance test shall be carried out after completion of type testing and shall consist of a comprehensive series of measurements and observations of the characteristics and performance of the equipment to demonstrate that no unacceptable deterioration has occurred as a result of previous tests. The test shall normally be performed at an ambient temperature of 20 °C ± 5 °C. The equipment shall be tested while supplied at normal supply voltages and subsequently with worst case combinations of supply voltages (80% and 120% nominal DC voltage).

4.1.2.4 Final visual inspection

The final visual inspection shall be performed to check whether any damage exists or deterioration has occurred as a result of any of the previous tests or activities. Eskom will determine the action which is necessary as a result of any findings of the inspection, which shall be made known as soon as possible.

4.1.3 Model power system simulator testing

In order to prove the operation of the protection scheme it is required that extensive model power system simulator testing of the protection and closing devices be done. The tests shall be carried out by the tenderers in conjunction with the Purchaser's engineers at the tenderers 's principal works on their model power system simulator. The simulator testing required will be based on the contents of the document "Eskom's certification testing requirements for EHV numerical transmission line protection relays" Cigre paper 313-PS3, 1999 SC34 Colloquium, Italy. The purchaser will supply source and line data for the simulations as well as a list of the required tests and test scenarios. The protection equipment must not only be subjected to the list of required tests provided by the purchaser. The successful tenderers shall be responsible for the provision of all the equipment and protection/closing devices required, to conduct the MPS tests. All preparation shall be finalised before arrival of the purchaser's project engineers. The device settings shall be the responsibility of the tenderers, and shall be submitted to the identified purchaser's settings engineer for sanctioning prior commencement of the model power system simulator testing.

It is expected that any failures/shortcomings in the devices, identified during the above tests, shall immediately be noted and resolved by the tenderers's design engineers. The tenderers shall provide solution(s) to the identified failure(s)/shortcoming(s). The solution(s) shall be implemented to the device(s) in question and the tests that have highlighted the failure(s)/shortcoming(s) shall be repeated to confirm the solution(s). In the event that fundamental solution(s) are implemented, all the specified tests shall be repeated. The nature of the failure(s)/shortcoming(s) shall dictate whether or not the remainder of the tests shall be concluded before implementation of the solution(s). Should a further round of simulator testing be necessary this shall be at the supplier's cost. Additional and/or different tests/test scenarios may be prescribed for any subsequent rounds of testing.

The tenderers are required to provide full details of his "power system simulator", including its ranges of simulation and capabilities, with the offer.

4.2 Testing of production schemes

4.2.1 Routine testing

The successful tenderers shall, in conjunction with the purchaser, compile the required routine tests. These tests constitute the minimum routine tests acceptable on all devices, relays and the complete protection scheme. The successful tenderers are responsible for the production of the routine test report. The successful tenderers shall compile a detailed functional test report template for approval by Eskom's representative. These tests shall be done on each production unit and produced during QA inspection. The required tests can be modified by the Eskom representative, if deemed necessary; to ensure that only the required site tests are outstanding prior delivery to site.

Routine testing shall comprise a series of tests to confirm that individual production equipment has been correctly manufactured and set up. The quality assurance shall be subject to Eskom's approval and Eskom reserves the right to witness any or all of the tests. An inspection of manufacturing processes such as plating, encapsulation, welding, etc., and separate checks and proof of adequate quality control may be required.

The details of routine testing shall be agreed between the supplier and Eskom prior to the commencement of manufacture of the equipment concerned. If the production equipment differs in any respect from the equipment upon which the type testing was performed, Eskom shall be informed and may require a repetition of those tests which might have been made invalid by the changes in the design of the equipment.

The successful tenderers shall, in conjunction with the purchaser, compile a test certificate, indicating clearly the successful completion of all the required routine factory tests. As part of the QA requirements, a copy of the completed certificate shall accompany each production unit.

4.2.1.1 Visual inspection

The visual inspection shall be performed to ensure that equipment complies with the requirements of this standard and the approved bill of material (equipment type and versions), and the equipment is properly installed.

Eskom will determine the action necessary as a result of any adverse finding of the inspection, which shall be made known as soon as possible.

4.2.1.2 Performance test

This test shall be performed to check that the equipment is capable of performing all its specified functions and is still within calibration. The calculated site specific settings shall be applied and tested (with test routine).

4.2.2 Site testing

Where site testing related to interfacing is required, it shall be performed unless otherwise approved, with the equipment correctly installed in its final location.

4.2.2.1 Visual inspection

Inspections will be performed by Eskom to establish that the equipment has been delivered to site and installed correctly and without damage. Such inspections shall be called for by the installation contractor before another contractor is allowed access to the equipment. This practice shall be enforced whenever two or more contractors require access to equipment to carry out their contract work.

4.2.2.2 Performance test

- The performance test shall be done with the equipment fully installed and supplied from the specified sources and correctly interfaced with all its associated plant and equipment. It shall be established that all associated plant and equipment has undergone separate tests before conducting the final system tests.

- The following sequence is required as it ensures the availability of specific functions at appropriate times:
- Deliver, erect and install scheme at substation;
- Cable contractor installs and terminates all cabling as per application drawings. For refurbishment projects the cable termination's must be coordinated with outage of existing scheme;
- Verify all scheme and external cable wiring as per application drawings and energise external power supplies to scheme;
- Verify and commission all interfaces to the primary equipment and to other scheme/modules, this include GOOSE data verification.
- Complete commissioning tests for protection equipment, apply and verify all subsequent setting changes. Protection personnel that are trained on the applicable equipment items must conduct these tests;
- Verify and commission all interfaces between the various disciplines. These tests will be conducted jointly by protection, telecommunications, measurements and control personnel that are trained on the applicable equipment;
- Verify and commission with higher level devices. Personnel that are trained on the SCADA equipment must conduct these tests. All measurement quantities, plant status, scheme/module selections, alarms and controls shall be tested to all clients;
- End-end verification of binary and analogue quantities; and,
- On energising of the relevant bay equipment, final commissioning and on-load checks must be conducted by the various responsible personnel.

The detailed testing requirements will be within the detailed functional standards

5. Tender requirements

5.1 Tender completion requirements

The tenderers are to take cognisance of the following:

- An incomplete tender submission will be deemed as non-compliant.
- An alternative offer shall only be considered if the main offer is compliant.
- Technical schedule A: The Purchaser's Requirements.
- Technical schedule B: Guarantees and Technical Particulars (to be completed by tenderers).
- The tenderers shall not change the content of this document.
- The tenderers shall clearly, for each clause that requires a statement of compliance in the A/B schedules, respond by either stating "Comply" or "Do not Comply" and state deviation details.
- If a clause in the A/B schedule requires a statement of compliance and additional information, the tenderers shall state clearly "Comply" and shall provide detail information or state "Do not Comply" and shall provide detail information.
- If a clause in the A/B schedule requires information only, the tenderers shall provide the necessary information.
- All additional options shall be detailed.

5.2 Tender evaluation criteria

The tender evaluation will take the form of a:

- Desktop review of submitted documentation (A/B schedules); and,
- Hands-on demonstration of the offered products by the vendors. The hands-on demonstration will include, but not be limited to:
  - All IEDs offered are successfully demonstrated to meet Eskom's minimum IEC 61850 function and interoperability requirements (as per the Eskom standard; and,
  - The IED interface software user friendly and operates on Eskom-standard laptop computers (Windows XP, Windows 7 and Windows 8), and all IEDs are demonstrated to be accessible via such a computers/software to upload, download and compare settings and configuration files and to retrieve event records and waveform recordings (comtrade export capability).

5.3 Product development process

The project shall comprise two phases; and engineering/development phase and a production phase. The purchaser will sign a development contracts for the engineering/development phase with the successful vendors. The engineering/development phase ends with the awarding of production contracts for the required scheme solutions and spare items. Vendors who have been awarded development contracts shall be accountable for producing deliverables according to the project schedule.

The product development phase is the detailed engineering phase in which:

- Proto-type scheme design diagrams, based on Eskom's design standards and formats, is finalised;
- Proto-type scheme is developed and built;
  - The prototype scheme is tested for compliance against this standard document;
- Type testing requirements verified and done (if so required);
- Model power system simulator testing (witnessed by the purchaser's representatives) is completed and results accepted and approved by the purchaser;
- IED configurations finalised and verified;
- IED and relay Eskom default settings and settings templates finalised;
- IEC61850 configuration finalised and verified;
- Scheme permutations and complete list of scheme spares including pricing finalised;
- Specialised training; and,
- The technical and SHEQ documentation is finalised and approved by the purchaser.

All relevant information regarding the configuration/marshalling of the protection devices shall be supplied to the purchaser one month after contract award. The purchaser reserves the right to call for further information at any time during the development of the prototype scheme.

The purchaser will be an active participant during this phase. The purchaser has the option to either purchase the proto-type scheme or the first production unit.

5.3.1 Proto-type scheme design diagrams

During the initial part of the engineering development phase, only drawings shall be produced and no panel manufacturing shall take place. The tenderers shall provide in-depth details of their equipment's interfaces with applicable substation equipment, for the purpose of producing the prototype drawings. The drawings shall be produced on the purchaser's CAD system, standard drawing symbols and standard layouts. Thereafter, preliminary drawings will be supplied bearing the label "PROTOTYPE". Only drawings so sourced, and bearing the prototype label will be regarded as valid. The purchaser shall assume overall responsibility for the production of scheme drawings.

The prototype design freeze follows the approval, by the responsible Eskom representative, of the prototype drawings as per the development program. The approval of the drawings shall take place before the scheduled design freeze date.

The product development phase shall last for a period of no more than 2 years from product development contract award. The purchaser shall be an active participant during this phase. During this phase, the scheme design shall be completed, the documentation and drawings shall be finalised and approved, all type testing, functional testing and Model Power System simulator testing shall be completed to the purchaser's approval, the specialised training requirements shall be fulfilled and the first production unit (prototype scheme – including primary plant simulator) shall be completed. The prototype scheme shall consist of the following main devices:

- Main 1 impedance based protection device;
- Two current differential protection devices;
- Bay control device;
- Ethernet switch; and,
- Primary plant simulator.

The successful tenderers shall, within one month of contract award, supply the purchaser with a set of comprehensive equipment documentation, setting guidelines and the operating/analysis software. Each device shall be equipped with the hardware and firmware version that will be supplied during the production phase. The operating and analysis software version shall be the version that will be required to communicate with the production phase devices.

5.3.2 Proto-type scheme development and built

The first production scheme, as determined by the purchaser, shall constitute the prototype. The purchaser will determine the exact composition of the prototype. The prototype scheme shall include a primary plant simulator. The simulator shall provide for the all the required scheme inputs and outputs to and from the circuit-breaker (phase segregated) and isolators (busbar 1, busbar 2, line and transfer) for the main 1, main 2, closing, spring rewind, motorised isolators, indication and secure supply circuits. The proto-type scheme shall include analogue and binary merger units for the main 1 and main 2 protection systems.

Eskom technical staff will interact directly with the contracted vendors in the development of detailed designs, prototypes and associated tests. This is different to the tender stage where all correspondence with vendors is channelled via the purchaser's representative. Any correspondence relating to contract pricing will still be communicated with the vendor by the purchaser's representative.

The Eskom technical team will:

- Act as moderators between vendors, endeavouring to ensure that competing products are equally flexible and user friendly, thereby reducing the possibility of strong user preferences for one product over the other during the production phase of the contracts;
    - o Ensure that standard gaps identified during the product development stage are addressed. They will document such decisions for incorporation into a future revision of the standard;
- Compile a buyer's guide drawing for codification of items on SAP;
- Develop the buyer's guide drawing into a scheme ordering schedule;
- Convert the vendor's scheme Master drawings into the standard Eskom format, with application detail as applicable;
- Develop IED-specific settings philosophies;
- Sign off all project deliverables including scheme manuals and procedures; and,
- Conduct and sign off all scheme prototype tests.

5.3.3 Design freeze for the production phase

Once the product development phase is completed, a design freeze shall come into effect. No further changes shall be permitted to the scheme, the scheme components or the scheme drawings.

5.3.4 Production phase

During the production phase, the schemes is ordered, manufactured, tested, QA inspected, delivered, offloaded and erected in position at site.

The successful tenderers shall, in conjunction with the purchaser, compile a test plan with QA inspection holding points.

5.3.5 Production scheme delivery

The production schemes shall be delivered to site with:

- As build scheme diagrams;
- QA inspection report;
- All IEDs and relays shall have the purchaser's (Eskom) default settings applied. The settings, as set by the supplier prior to shipment of the scheme, shall also be provided to the purchaser;
- All IEDs shall be fitted with the final IED configuration;
- All IEDs shall be configured with the IEC61850 SCD and SED (where applicable);
- IED project file that include the Eskom default settings, configuration/marshalling and IEC61850 engineering (station final SCD file imported to the IED and GOOSE receive signals configured),
- Ethernet switch(s) configured; and,
- Production unit routine test report.

5.4 Price schedule categories

The main scheme components (typically imported IEDs or custom components) shall be included as separate price schedule items in a product standard. Vendors shall tender spares prices against these items for inclusion in the overall evaluated price of the offer. The detail per product will be provided in Annexure B.

During the product development phase, the detail of these items (main and spare) shall be finalised for codification on SAP and will be available for order via the contract.

5.5 Engineering fees and provision of prototypes

For products for which the vendors will be paid engineering fees and/or prototypes purchased, this will be done under a signed development contract. The vendor engineering fees shall include:

- Engineering services for the development of Eskom-specific intellectual property: master drawings, IED configuration settings, documentation. These shall be quoted for as a number of hours per type of resource (Chief Engineer, Engineer, etc) and stated hourly rates.
- Costing for simulator testing of the prototype (where required). This shall exclude expenses for Eskom staff to witness such testing.
- Costs for advanced/expert engineering software for Eskom product custodians as recommended by the vendor for the development or management of the products.

Eskom will review the submissions from the vendors and shall propose a reasonable capped amount for vendor engineering fees to be used in the upcoming tender. This decision will take cognisance of historical development costs paid for similar commodities. Vendors may tender engineering fees at any amount up to the capped value. Should a vendor require additional engineering fees, these shall be re-couped by them via a component in the product pricing.

The following vendor expenses (where applicable) will be absorbed into the product pricing:

- Costs relating to the development of product production facilities.
- A corporate licence for IED interface software meeting Eskom's minimum requirements.

Prototype schemes shall be purchased by Eskom at the tendered price of a production scheme (plus applicable optional items). The vendor will undertake any re-engineering of the prototype as may be required (at his cost) such that it has identical wiring and functionality of a production unit.

5.6 Warrantees, spares and support

5.6.1 Warrantees

The supplier shall provide a minimum of a 10 year warrantee on the protective IEDs provided in the scheme. The warranty shall include the repair of all failures due to latent defects (i.e. excluding failure due to mishandling or misuse of the equipment by Eskom or Eskom appointed representatives). Any charges associated with the repair/replacements and shipping of the defective equipment from the local supplier's office to and from the works of the overseas principal shall be for the supplier's expense.

The supplier of IEDs for protection schemes shall undertake, in writing, to support each product for a minimum period of 15 years from the date of contract signature. Product support shall include services to repair or replace any damaged or failed IED that falls outside the terms of the abovementioned warrantee. Eskom shall be liable for all costs associated with these services. Replacement IEDs shall preferably be of the same type, model number and firmware as the failed IED, but alternative products of substantially similar physical dimensions and terminal layouts offering the same or increased functionality shall be accepted in fulfilment of this requirement.

The supplier shall notify Eskom of the planned discontinuation of any IED used in a current or previous national contract.

5.6.2 Spares

The Supplier shall supply a comprehensive list of spares that shall, at minimum, include one of the devices/relays used, as well as MCB's, switches, lamps, empty sub-racks and any consumable items. The Supplier shall also include on the list of spares any other recommended spares necessary for the proper maintenance of the protection scheme. The spares items shall be priced individually and the list shall include a description of the item, a reference number, the pricing details and the guaranteed delivery time. All spares shall be delivered in approved cases suitable for storing such parts over a period of 10 years without damage or deterioration.

Spare devices shall be available from the tenderers for a period of at least 10 years subsequent to the expiry of the contract. Spares shall be carried at the tenderers's local works according to the following amount of schemes in service:

Table 1: Spares requirements

Number of schemes in service	Available immediately (within 24 hours of order)	Additionally available on demand within 72 hours
1 to 20 schemes	1 spare of each device	A maximum of 2 spares of each device
21 schemes and more	2 spares of each device	A maximum of 3 spares of each device

The successful tenderers shall maintain an up-to-date register of at least three contact persons who may be contacted regarding spares. This information shall be communicated to the purchaser when any of the details contained therein are altered.

The purchaser shall annually audit the spares holding as per the requirements of this standard.

5.6.3 Repairs

The tenderers shall provide a schedule detailing the guaranteed turnaround time for the repair of faulty equipment. The turnaround time shall include any international transport and customs clearance times as applicable. If the turnaround times differ for different equipment, the schedule shall include these details. The tenderers shall also state the extent to which repairs can be effected at the tenderers's local works, including the capability and equipment that the tenderers possesses in order to effect such repairs. The tenderers shall, for all repair work, inform the purchaser of the exact nature of the failure, how such failure was remedied and how these failures, and other similar failures, can be prevented. The solutions to the identified failures/deficiencies shall also be implemented to all the in-service and spare devices and shall be for the cost of the tenderers. The implementation will be governed by the availability of the devices due to power network constraints.

5.6.4 Support

The purchaser requires a maximum transfer of technology from the supplier's principals to enhance the local support capabilities. The tenderers shall indicate in his offer how he intends committing to this requirement.

The transfer of technology shall include, but not be limited to:

- Operating and analysis software;
- IED functions (detailed description and explanations); and,
- Compilation of standard IED (Eskom) templates that also include the IEC61850 engineering.

5.7 In-service experience requirements

The tenderers shall provide details of their device's operating record and installation details with their offers. The tenderers shall also provide details on all offered IEDs, the firmware upgrades made in the past 3 years. The Purchaser will use protection devices that satisfy the following conditions:

- Available 'off-the-shelf';
- Have a proven track record in terms of an acceptable in-service record on networks of greater than 200kV in utilities world-wide. The tenderers shall provide proof of track record by documentation and reference to buyers and/or utilities world-wide;
- Have a minimum in-service experience of 50 equipment-years, at time of tender closure, with at least 25 devices/relays having an in-service record of more than 6 months. This shall apply to the same or similar production unit version of device/relay that the Purchaser would employ;
- Successfully pass required model power system simulator testing;
- Successfully pass all functional testing; and,
- Successfully pass all specified environmental type tests.

Cumulative years of service are only based on an in-service period of identical hardware and firmware versions.

6. Documentation

6.1 Scheme manual requirements

The required documentation shall include a full description of the scheme including the detailed information/manuals on all scheme components and devices. Also required are the complete drawings for each of the scheme permutations. The scheme manual shall include the product configuration and a hard copy of the scheme drawings. All documentation called for shall be finalised and approved before the engineering/development phase ends and awarding of production contract phase.

The documentation shall be clear, concise and to the point. The supplier shall compile all documentation and a complete documentation set (printed and bounded and in electronic format *.doc(x)) shall be submitted to the purchaser on conclusion of the engineering/development phase.

The scheme manual shall have as a minimum the following chapters:

Chapter 1 General Description

1.1 Basic description of the scheme and devices

1.2 Intended area of application

1.3 Brief description of the protection and closing functions

1.4 Contract/agreement data

1.5 Device configuration (logic diagrams)

1.6 Drawing set (scheme)

Chapter 2 Mechanical Construction

2.1 Mechanical drawings

2.2 Construction details

Chapter 3 Controls, Indications and Test Facilities

3.1 List of controls and indications

3.2 Detailed description of functions

3.3 General operational data

3.4 Test facilities

Chapter 4 Protection Functionality

4.1 Detailed description of protection functions

4.2 Scheme protection philosophy

4.3 Scheme logic

4.4 Application guidance

4.5 Burdens

Chapter 5 Substation automation integration

5.1 MMS data sets with data attributes (also the subscribers to the data)

5.2 GOOSE data sets with data attributes (also the subscribers to the data)

6.2 Settings guide

The settings guide shall include a comprehensive set of blank and example setting details to cover all user settable functions in the scheme and devices shall be provided. A list of the settings, as set by the supplier prior to shipment of the scheme, shall also be provided to the purchaser. The supplier shall provide the recommended setting limits to ensure that the required protection performance is obtained. A list of settings (including the Eskom default settings) and settings guidelines shall be provided for all functional elements and shall indicate any setting limitation and any possible conflict with any other setting.

The settings guide (printed and bounded and in electronic format *.doc(x)) shall be finalised, approved and submitted to the purchaser before the engineering/development phase ends and awarding of production contract phase.

6.3 Scheme selection and application guide

The scheme selection and application guide shall include a complete description of the different scheme permutations and selection thereof for specific applications. The application section of the guide shall include a full description and the physical interfacing of the scheme with components external to the scheme (e.g. DC board, CTs, VTs, JB, substation automation, etc.).

The scheme selection and guide (printed and bounded and in electronic format *.doc(x)) shall be finalised, approved and submitted to the purchaser before the engineering/development phase ends and awarding of production contract phase.

6.4 Scheme drawings

The scheme drawings shall be as per the drawing standard. The supplier shall be accountable for the compilation of drawing for all scheme/module permutations.

7. Training

The tenderer shall include proposals for the training of Eskom personnel. The following item shall be quoted:

- The local specialised training of selected Purchaser protection engineers (not more than 6) by an expert(s) from the tenderer's principal works. The price shall be quoted on a per week basis. Details of the specialised training will be negotiated during the development phase of the contract. The required training shall include, but not be limited to, an in-depth working knowledge of all devices and products (hardware, firmware and software functionality), the relay operating and analysis software, setting and application, commissioning, maintenance and first-line fault finding.
- The Grid staff training at the tenderer's local works. The price shall be quoted on a per week basis. Details of the training will be negotiated during the development phase of the contract. The required training shall include, but not be limited to, a working knowledge of all devices and products (hardware, firmware and software functionality), the relay operating and analysis software, setting and application, commissioning, maintenance and first-line fault finding.

8. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Prince Moyo	Power Delivery Engineering GM
Richard McCurrach	PTM&C CoE Manager
Prince Kara	PTM&C Protection Manager
Graeme Topham	SCOT Protection and Automation Study Committee (SC) Chairperson

9. Revisions

Date	Rev.	Compiler	Remarks
April 2014	1	T Bower	New document based on TST 41-1062.

10. Development team

The following people were involved in the development of this document:

This document was developed by Thys Bower.

11. Acknowledgements

Not applicable

Annex A – Impact assessment

(Normative – for Eskom internal use only)

A.1 Guidelines

- All comments must be completed.
- Motivate why items are not applicable (n/a).
- Indicate actions to be taken, persons or organizations responsible for actions and deadline for action.
- Change control committees to discuss the impact assessment and, if necessary, give feedback to the compiler regarding any omissions or errors.

A.2 Critical points

A.2.1 Importance of this document, e.g. is implementation required due to safety deficiencies, statutory requirements, technology changes, document revisions, improved service quality, improved service performance, optimized costs.

Comment: This standard is required to document the generic requirements for Transmission and Distribution protection & control schemes.

A.2.2 If the document to be released impacts on statutory or legal compliance, this needs to be very clearly stated and so highlighted.

Comment: No statutory or legal compliance required.

A.2.3 Impact on stock holding and depletion of existing stock prior to switch over.

Comment: No impact.

A.2.4 When will new stock be available?

Comment: Not applicable.

A.2.5 Has the interchangeability of the product or item been verified, i.e. when it fails, is a straight swap possible with a competitor's product?

Comment: Not interchangeable.

A.2.6 Identify and provide details of other critical (items required for the successful implementation of this document) points to be considered in the implementation of this document.

Comment: This document must be used as reference when compiling the bay specific protection & control scheme standards for application to Transmission and Distribution stations:

A.2.7 Provide details of any comments made by the Regions regarding the implementation of this document.

Comment: (n/a during commenting phase).

A.3 Implementation time frame

A.3.1 Time period for implementation of requirements.

Comment: The requirements within this standard will be implemented during the compilation of the detailed protection scheme solution standards:

A.3.2 Deadline for changeover to new item and personnel to be informed of DX wide changeover.

Comment: No changeover required, new standard.

A.4 Buyer's guide and power office

A.4.1 Does the Buyer's Guide or Buyer's List need updating?

Comment: No.

A.4.2 What Buyer's Guides or items have been created?

Comment: N/A.

A.4.3 List all assembly drawing changes that have been revised in conjunction with this document.

Comment: N/A.

A.4.4 If the implementation of this document requires assessment by CAP, provide details under A.5.

A.4.5 Which Power Office packages have been created, modified or removed?

Comment: N/A.

A.5 CAP/LAP pre-qualification process-related impacts

A.5.1 Is an ad hoc re-evaluation of all currently accepted suppliers required as a result of implementation of this document?

Comment: N/A.

A.5.2 If NO, provide motivation for issuing this specification before Acceptance Cycle Expiry date.

Comment: N/A.

A.5.3 Are ALL suppliers (currently accepted per LAP) aware of the nature of changes contained in this document?

Comment: N/A.

A.5.4 Is implementation of the provisions of this document required during the current supplier qualification period?

Comment: N/A.

A.5.5 If Yes to A.5.4, what date has been set for all currently accepted suppliers to comply fully?

Comment: N/A.

A.5.6 If Yes to A.5.4, have all currently accepted suppliers been sent a prior formal notification informing them of Eskom's expectations, including the implementation date deadline?

Comment: N/A.

A.5.7 Can the changes made, potentially impact upon the purchase price of the material/equipment?

Comment: N/A.

A.5.8 Material group(s) affected by specification (refer to Pre-qualification invitation schedule for list of material groups).

Comment: N/A.

A.6 Training or communication

A.6.1 Is training required?

Comment: No.

A.6.2 State the level of training required to implement this document (e.g. awareness training, practical/on job, module).

Comment: N/A.

A.6.3 State designations of personnel that will require training.

Comment: N/A.

A.6.4 Is the training material available? Identify person responsible for the development of training material.

Comment: N/A.

A.6.5 If applicable, provide details of training that will take place (e.g. sponsor, costs, trainer, schedule of training, course material availability, training in erection/use of new equipment, maintenance training).

Comment: N/A.

A.6.6 Was Technical Training Section consulted regarding module development process?

Comment: N/A.

A.6.7 State communications channels to be used to inform target audience.

Comment: N/A.

A.7 Special tools, equipment, software

A.7.1 What special tools, equipment, software, etc. will need to be purchased by the Region to effectively implement?

Comment: N/A.

A.7.2 Are stock numbers available for the new equipment?

Comment: N/A.

A.7.3 What will be the cost of these special tools, equipment, software?

Comment: N/A.

A.8 Finances

A.8.1 What total costs would the Regions be required to incur in implementing this document? Identify all cost activities associated with implementation, e.g. labour, training, tooling, stock, obsolescence.

Comment: N/A.

Impact assessment completed by:

Name: Thys Bower

Designation: Senior Consultant

Annex B – Price Schedule Items

(Normative)

The scheme/module permutations will be within the detailed functional standards. Listed are typical price schedule items, the items shall be independently priced:

Item	Description
1.1	Scheme Engineering
1.2	Test equipment – test routine
1.3	Scheme/module permutations (independently priced)
1.4	Breaker bay process interface unit (PIU)
1.5	Model Power System Simulator Testing (price per week), where applicable
1.6	Specialised training (per week)
1.7	Grid staff training (per week for 12 people)
1.8	Scheme documentation
1.9	Application guide
1.10	Settings guide
1.12	Main scheme components (IEDs etc. independently priced)
1.13	Site commissioning per scheme/module

Annex C – Performance Questions

(Normative)

Tenderers are required to submit in writing, with their offer, answers to performance questions. Any technical documentation which might assist the answers must be provided. The answers to the questions will be taken into account in evaluating the offers. The performance questions, as applicable, shall be answered for each protection device offered. Actual performance to be stated and not general information on a product range, but specific to the offered product. Performance questions will be within each detailed functional standards.

Annex D – Drawing set

(Normative)

A typical drawing set shall be included, per permutation, within the detailed functional standard