	<b>Scope of Work</b>	<b>Generation/ Tutuka Power Station/ C&amp;I Maintenance</b>
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## **1. Introduction**

Tutuka Dirty Water Dam C&I equipment are not operational due to flood damage and deterioration over the years resulting in the plant being run manually directly from the drive's switchgear buckets.

This document lays down the minimum recommended scope of work for the repair and recommissioning of the C&I equipment and to reinstate the original automation, protections and interlocks of the DWD drives and subsystems.

## **2. Supporting Clauses**

### **2.1 Scope**

This document defines the minimum requirements for reinstating the DWD C&I system and automation

The scope includes the following:

- The replacement of all defective field instruments
- Repair and recommissioning of all interfaces to the PLC (field, switchgear and local control desk)
- Recommission and reinstate protections, interlocks and automation of the DWD C&I system.

#### **2.1.1 Purpose**

Reinstate the DWD C&I system and automation.

#### **2.1.2 Applicability**

This document shall apply to Tutuka Power Station C&I Maintenance.

#### **2.1.3 Effective date**

The effective date will be the same as the authorisation date

### **2.2 Normative/Informative References**

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

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### **2.2.1 Normative**

- [1] ISO 9001 Quality Management Systems
- [2] 240-56356396 Earthing and Lightning Protection Standard
- [3] 240-71432150 Plant Labelling Standard
- [4] 240-56227443 Requirement for Control and Power Cables for Power Stations Standard
- [5] 240-56355754 Field Equipment Installation Standard
- [6] SANS 60529 Enclosure IP Rating
- [7] 240-54937450 (Fire Protection & Life Safety Design Standard)

### **2.2.2 Informative**

N/A

## **2.3 Definitions**

### **2.3.1 Local Control Desk**

Operating desk located at the DWD pump house that provided the operator interface for the entire DWD plant for manual or automated operation.

### **2.3.2 Local Control Station**

Operating panel for each drive located in close proximity of the pump or oil skimmer in the plant, providing the operator with local operation of the drive.

## **2.4 Abbreviations**

<b>Abbreviation</b>	<b>Explanation</b>
AKZ	Power Plant Coding System
C&I	Control and Instrumentation
CPU	Central Processing Unit
DC	Direct Current
DWD	Dirty Water Dam
HMI	Human Machine Interface
I/O	Inputs/Outputs
LCD	Local Control Desk
LCS	Local Control Station
PLC	Programmable Logic Controller
SOW	Scope of Work
TOL	Thermal Overload
VAC	Voltage Alternative Current

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## **2.5 Roles and Responsibilities**

Tutuka maintenance shall be responsible for the implementation of the scope of work listed in this document.

## **2.6 Process for Monitoring**

The relevant C&I maintenance supervisor or project manager with the assistance of the relevant C&I Engineer shall assess and monitor the daily work progress.

## **2.7 Related/Supporting Documents**

N/A

# **3. Dirty Water Dam C&I Repair & Recommissioning Scope of Work**

## **3.1 DWD Design Base**

The DWD control system consists of a Siemens S7 300 series PLC with a Local Control Desk at the DWD to provide for operator interface.

The following are the subsystem field drives and instrumentation:

- Five submersible pumps at the dirty water fore-bay elevate the dirty water for gravity feed to the rest of the DWD system. The system includes a dirty water fore-bay Ultrasonic level transmitter for the automation of the pumps.
- Two sedimentation pumps, two flushing pumps and two oil skimmers for the processing of the dirty water for the removal of sedimentation and oil. Each two secondary sedimentation sump levels are monitored by an ultrasonic level transmitter. A turbidity analyser is installed for each of the two flushing lines.

Automation of the sedimentation and flushing pumps operation are regulated by predetermined time intervals. The oil skimmers are continuously in operation while any one submersible pump is in operation. The level and turbidity measurements provide the system interlocks.

- One oil recovery pump which includes an oil storage tank ultrasonic level transmitter.

Only local manual operation of the pump is possible. The level measurement provides the drive interlock.

- Six Clean Water Return pumps. The clean water fore-bay ultrasonic level transmitter provides for the automation of the pumps system.
- One floor sump pump. The floor sump ultrasonic level transmitter and three level switches provide for the automation of the pump system.

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### **3.2 DWD Control System deficiency**

Most of the field equipment (C&I cables, transmitters, flow/level switches, Local Control Stations and local control desk) are not operational due to flood damage and deterioration over the years. The damage also includes the DWD PLC cubicle power supply termination strip and circuit breakers.

### **3.3 Minimum Recommended Work Scope to Reinstate DWD C&I**

The repair and recommissioning SOW includes the following:

- DC power distribution to the PLC cubicle
- Instrument 220VAC supply
- Replacement of all defective field instruments
- Loop check all interfaces to the PLC (field, switchgear and local control desk)
- Recommission and reinstate protections, interlocks and automation of the DWD C&I system.

#### **3.3.1 DC Power Distribution to the PLC Cubicle Repair and Recommissioning**

Replace and recommission flood damaged circuit breakers, terminal strips, wiring and cables in the DWD PLC cubicle.

Test the 24VDC and 48VDC power supply cables from the chargers to the PLC cubicle and ensure the power distribution to the PLC CPU, I/O modules and interface relays are operational and implement any repairs or corrections where required.

When the PLC is powered-up delete the program, restart the CPU and only reload the hardware configuration. Ensure that the CPU green RUN light indicates and that there are no other orange or red error indications.

Replace any PLC CPU module, IM, I/O module or bus connections identified to be faulty by the hardware diagnostic program.

Only load the PLC logic program once the PLC interfaces are loop checked.

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### **3.3.2 220VAC supply to Field Repair and Recommissioning**

The following nine instruments are supplied by 220VAC from the PLC Cubicle:

- 00UH35A001 Turbidity Line 1 Analyser
- 00UH35A002 Turbidity Line 2 Analyser
- 00UH35L001 Dirty Water Level Transmitter
- 00UH35L002 Secondary Sedimentation Tank 2 Level Transmitter
- 00UH35L003 Secondary Sedimentation Tank 2 Level Transmitter
- 00UH35L004 Floor Sump Level Transmitter
- 00UH35L005 Oil Storage Tank Level Transmitter
- 00UH35L006 Clean Water Forebay Level Transmitter
- 10VR10F001 Clean Water Return Flow Transmitter

Test the 220VAC supply cable and replace and commission the following components if identified as faulty during the loop checks:

- 220VAC supply field cable or any faulty wiring or wiring corrections
- PLC cubicle 220VAC circuit breaker
- PLC cubicle terminations and wiring

Repair and restore the common AC supply to the PLC cubicle 220VAC circuit breakers if required.

### **3.3.3 Field Instrument replacement**

The following eighteen instruments shall be replaced:

- 00UH35A001 Turbidity Line 1 Analyser
- 00UH35A002 Turbidity Line 2 Analyser
- 00UH35L001 Dirty Water Level Transmitter
- 00UH35L002 Secondary Sedimentation Tank 2 Level Transmitter
- 00UH35L003 Secondary Sedimentation Tank 2 Level Transmitter
- 00UH35L004 Floor Sump Level Transmitter
- 00UH35L005 Oil Storage Tank Level Transmitter
- 00UH35L006 Clean Water Forebay Level Transmitter
- 10VR10F001 Clean Water Return Flow Transmitter
- 10VR10F002 Clean Water Return Pump 1 Low Flow Switch
- 10VR10F003 Clean Water Return Pump 2 Low Flow Switch
- 10VR10F004 Clean Water Return Pump 3 Low Flow Switch
- 10VR10F005 Clean Water Return Pump 4 Low Flow Switch
- 10VR10F006 Clean Water Return Pump 5 Low Flow Switch
- 10VR10F007 Clean Water Return Pump 6 Low Flow Switch
- 00UH35L004-M01 Floor Sump Low Level Float Switch
- 00UH35L004-M02 Floor Sump High Level Float Switch
- 00UH35L004-M03 Floor Sump Flood Level Float Switch

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The work shall include following:

- Installation, configuring and commissioning of the instrument
- Replace instrument mounting rack and probe brackets for all transmitters that are not inline installations
- Replace turbidity analyser sampling chambers and sampling lines
- Implement any changes required to pipeline and/or fittings to accommodate flow switch in the pipe line

In order to standardise with existing installed instruments on the common plant and minimise the costs of onsite spares holding the replacement instrumentation shall be of the following make and model:

- Level transmitter –
  - Siemens Multiranger 200 7ML50332AB001A 220 VAC
- Turbidity analyser –
  - Analyser – 220VAC. Liquiline CM442-12E7/0
  - Chamber for probe Flowfit CUA252 (CUS52D)
  - Probe CUS52D
- Flow transmitter –
  - Stationary Ultrasonic Flowmeter – 220VAC. MODEL: BOP108205
  - 500 kHz Ultrasonic Transducers. MODEL: BOP108205.

#### **3.3.4 PLC Interfaces Loop Checks Repair and Recommissioning**

The following are the PLC interfaces that will require testing of each loop and repair or replacement of faulty components identified:

- Switchgear buckets for each drive
- Local Control Station for each drive
- The general Local Control Desk
- Field instruments

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### **3.3.4.1 Switchgear Buckets**

The switchgear/PLC interfaces test and repair work shall include as a minimum the following:

- Simulate the relevant Outputs from the PLC logic and test that the relevant switchgear bucket relays or lamp activates.
- Activate the Switchgear bucket selection switches and contactors and test that the relevant Inputs to the PLC logic is received.
- Supply, replace and commission the following components if identified as faulty during the loop check:
  - Instrument cable or any faulty wiring or wiring corrections
  - SG lamps and C&I termination
  - PLC modules
  - PLC cubicle terminations, wiring and interface relays

The SG bucket for each drive shall be function tested with the 380VAC isolator off in order to test that the main contactor operates and the relevant feedback signals are received.

The following are the nineteen switchgear bucket drives:

- 00UH35D009 Sedimentation Pump 1
- 00UH35D010 Oil Skimmer 1
- 00UH35D011 Flushing Pump 1
- 00UH35D012 Sedimentation Pump 2
- 00UH35D013 Oil Skimmer 2
- 00UH35D014 Flushing Pump 2
- 10VR10D015 Floor Sump Pump
- 00UH35D016 Oil Recovery Pump
- 00UH35D005 Submersible Pump 1
- 00UH35D006 Submersible Pump 2
- 00UH35D007 Submersible Pump 3
- 00UH35D008 Submersible Pump 4
- 00UH35D021 Submersible Pump 5
- 10VR10D001 Clean Water Return Pump 1
- 10VR10D002 Clean Water Return Pump 2
- 10VR10D003 Clean Water Return Pump 3
- 10VR10D004 Clean Water Return Pump 4
- 10VR10D005 Clean Water Return Pump 5
- 10VR10D006 Clean Water Return Pump 6

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### **3.3.4.2 Drive Local Control Stations**

Signal loop recommissioning and repair and/or replacement of the Local Control station shall include the following work:

- supply, install and commission the Local Control Station at ground level. The work includes the supply and installation of the following:
  - LCS enclosures (which includes selection switch, display lamps, pushbuttons and termination strip) for LCS requiring replacement.
  - LCS cable to the junction box (reuse cable for Local Control Stations not replaced)
  - LCS mounting rack
- Simulate the relevant Outputs from the PLC logic and test that the relevant lamps activate on the LCS.
- Activate the LCS selection switches and pushbuttons and test that the relevant Inputs to the PLC logic is received.
- Supply, replace and commission the following components if identified as faulty during the loop check:
  - Instrument cable or any faulty wiring or wiring corrections
  - LCS lamps, selection switches/pushbuttons and C&I termination
  - Trunk cable or any faulty wiring or wiring corrections
  - C&I termination
  - PLC modules
  - PLC cubicle terminations, wiring and interface relays

#### **Local Control Stations to be Replaced**

Eleven of the fifteen LCSs and field cables shall be replaced due to flooding damage and deterioration for the following drives:

- Clean Water return pumps (one LCS per three drives)
- Flushing pumps
- Oil recovery pumps
- Floor sump pump
- Submersible pumps

#### **Local Control Stations to be Reused**

The remaining four of the fifteen LCSs shall be reused and recommissioned namely the oil skimmer and sedimentation pump drives.

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### **3.3.4.3 General Local Control Desk**

The Local Control Desk interfaces test and repair work shall include as a minimum the following work:

- Simulate the relevant Outputs from the PLC logic and test that the relevant lamps or audible alarm activates on the desk.
- Activate the LCD selection pushbuttons and test that the relevant Inputs to the PLC logic is received.
- Supply, replace and commission the following components if identified as faulty during the loop checks:
  - Instrument cable or any faulty wiring or wiring corrections
  - LCD lamps, selection pushbuttons and C&I termination
  - PLC modules
  - PLC cubicle terminations, wiring and interface relays
  - Audible alarm unit (one common to all systems)

### **3.3.4.4 Field Instrument PLC Interface**

Test the instrument signal loops and replace and commission the following components if identified as faulty during the loop checks:

- Instrument/trunk cable or any faulty wiring or wiring corrections
- PLC modules
- PLC cubicle terminations, wiring and interface relays

The instrument cables to the junction box shall be replaced for the following instrumentation:

- 00UH35L004 Floor Sump Level Transmitter
- 00UH35L005 Oil Storage Tank Level Transmitter
- 10VR10F001 Clean Water Return Flow Transmitter
- 10VR10F002 Clean Water Return Pump 1 Low Flow Switch
- 10VR10F003 Clean Water Return Pump 2 Low Flow Switch
- 10VR10F004 Clean Water Return Pump 3 Low Flow Switch
- 10VR10F005 Clean Water Return Pump 4 Low Flow Switch
- 10VR10F006 Clean Water Return Pump 5 Low Flow Switch
- 10VR10F007 Clean Water Return Pump 6 Low Flow Switch
- 00UH35L004-M01 Floor Sump Low Level Float Switch
- 00UH35L004-M02 Floor Sump High Level Float Switch
- 00UH35L004-M03 Floor Sump Flood Level Float Switch

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### 3.3.5 Automation & Interlocks Recommissioning

Test and recommission the the automation and interlocks of the following DWD plant sections according to the control philosophy listed:

- Submersible pumps
- Clean water return pumps
- Sedimentation and oil separation plant
- Oil recovery
- Floor sump pump

#### 3.3.5.1 Submersible Pumps

##### Auto Operation Sequence:

When the submersible pump system is selected for auto operation the duty selected 22kW pump (1st pmp) will automatically start when the dirty water fore-bay sump level raises above L (Low Level 0.8M 40%). The pump will continue to run until the level falls below LL (LowLow Level 0.4M 20%) and switch off automatically.

The next two 22kW pumps in the duty selection sequence (2nd & 3rd pmpps) will simultaneously start automatically if the level increases above H (High Level 1.2M 60%). The two pumps including the duty pump will continue to run until the level falls below LL (LowLow Level 0.4M 20%) and then all three pumps will switch off automatically.

The 75kW pump will start automatically if the level increases above HH (HighHigh Level 1.6M 80%). The 75kW pump including the three 75kW pumps will continue to run until the level falls below LL (LowLow Level 0.4M 20%) and then all four pumps will switch off automatically.

Pump	Start Level	Total Flow (Litres/sec)	Stop Level
1 <sup>st</sup> (22kW)	L (0.8M 40%)	66.7	LL (0.4M 20%)
2 <sup>nd</sup> (22kW)	H (1.2M 60%)	133.4	LL (0.4M 20%)
3 <sup>rd</sup> (22kW)	H (1.2M 60%)	200	LL (0.4M 20%)
4 <sup>th</sup> (75kW)	HH (1.6M 80%)	400	LL (0.4M 20%)

##### Drive interlocks, protections and fault conditions:

- Dirty water sump level LL (00UH35L001)
- Drive TOL (Thermal Overload)
- SG panel Local selected
- Contactor feedback discrepancy (ANS+)
- E-stop condition

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### **3.3.5.2 Clean Water Return Pumps**

#### Auto Operation Sequence:

When the clean water pump system is selected for auto operation the duty selected pump (1st pmp) will automatically start when the clean water fore-bay sump level rises above L (Low Level). The pump will continue to run until the level falls below LL (Low-Low) Level and switch off automatically.

The 2nd pump in the duty selection sequence will start automatically if the level increases above M (Medium) Level. The 2nd pump including the duty pump (1st pump) will continue to run until the level falls below LL (Low-Low) Level when both pumps will switch off automatically.

The 3rd pump in the duty selection sequence will start automatically if the level increases above HH (High-High Level. All three pumps will continue to run until the level falls below LL (LowLow Level) when all three pumps will switch off automatically.

The system should never allow the running of 4 or more pumps at the same time.

#### Drive interlocks, protections and fault conditions:

- Clean water sump level LL (00UH35L008)
- Drive TOL (Thermal Overload)
- Drive selected on Test (no remote selection)
- Contactor feedback discrepancy (ANS+)
- LCS Local selection
- Discharge flow low trip – 10VR10F002/3/4/5/6 (flow low for more than 5sec when pumps is started and runs)
- Floor sump level HH (00UH35L004)

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### **3.3.5.3 Sedimentation and Oil Separation Plant**

#### Auto Operation Sequence:

The function of the flushing pumps is to agitate the sediment in the separation unit in order for the sedimentation pumps to transfer the slurry back to the primary sedimentation dams.

The oil skimmers remove the oil from the surface of the separation units and transfer the recovered oil to the oil storage tank.

The line consists of a flushing pump, sedimentation pump and oil skimmer. The line will commence with auto operation if the line is auto selected and an auto start is initiated by the operator.

Once the line auto operation is active the flushing pump will immediately start and 60 seconds later the sedimentation pump will start. The flushing pump will run for a duration of 5 minutes and switch off while the sedimentation pump will run for a duration of 40 minutes and switch off. This cycle will repeat every 6 hours. Refer to example of two cycles below:

First cycle:

- Flushing pumps start at 07:00
- Sedimentation pump Start at 07:01
- Flushing pump stops at 07:05
- Sedimentation pump stops at 07:41

Second cycle (after 6 hours):

- Flushing pumps start at 13:00
- Sedimentation pump Start at 13:01
- Flushing pump stops at 13:05
- Sedimentation pump stops at 13:41

The cycle will not be disrupted if either the flushing pump or sedimentation pump is not available. The remaining drive will continue with the cycle operation.

The line oil skimmer will also immediately start once the line auto operation is active if any submersible pump is in operation at the dirty water sump. The Oil skimmer will stop or not start if no submersible pumps are running.

#### Drive interlocks, protections and fault conditions:

Flushing Pumps:

- o Clean water sump level LL (00UH35L008)
- o Floor sump level HH (00UH35L004)
- o Drive TOL (Thermal Overload)
- o Drive selected on Test (no remote selection)
- o Contactor feedback discrepancy (ANS+)
- o LCS Local selection

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**Sedimentation Pumps:**

- o Separation unit level L (00UH35L002/3)
- o Drive TOL (Thermal Overload)
- o Drive selected on Test (no remote selection)
- o Contactor feedback discrepancy (ANS+)
- o LCS Local selection

**Oil Skimmers:**

- o Oil storage tank level H (00UH35L005)
- o No submersible pump running
- o Drive TOL (Thermal Overload)
- o Drive selected on Test (no remote selection)
- o Contactor feedback discrepancy (ANS+)
- o LCS Local selection

### **3.3.5.4 Oil Recovery**

The oil recovery system consists of an oil storage tank and an oil recovery pump which is periodically started by the operator locally. The pump transfers water that has accumulated in the oil storage tank back to the separation units.

Drive interlocks, protections and fault conditions:

- o Oil Storage Level L (00UH35L005)
- o Drive TOL (Thermal Overload)
- o Drive selected on Test (no remote selection)
- o Contactor feedback discrepancy (ANS+)

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### **3.3.5.5 Floor Sump Pump**

#### Auto Operation Sequence:

When the floor sump pump is selected for auto operation the pump automatically starts when the High level switch is activated. The pump will continue to run until the Low level switch is activated and automatically switch off again.

The HH level limit value of the level transmitter or the HH level switch will cause the PLC to trip all the pumps located in the floor sump pump house and also prevent them from starting. In addition, a HH level audible alarm and indication will be displayed on the local operating desk.

#### Drive interlocks, protections and fault conditions:

- o Floor sump level L (00UH35L004)
- o Drive TOL (Thermal Overload)
- o Drive selected on Test (no remote selection)
- o Contactor feedback discrepancy (ANS+)
- o LCS Local selection

### **3.3.6 Decommissioning and**

the obsolete field equipment shall be decommissioned and removed. Removal only takes place once the new field installations are done.

All removed equipment is transported to an area to be specified by C&I maintenance. All such areas shall be located within the boundaries of Tutuka Power Station.

All equipment and material that is removed is deemed re-usable and remains the property of Eskom.

Where field equipment and/or cabling have been removed, the area needs to be "made good" in accordance with following requirements:

- The removal of all the equipment and components of the old C&I system. These include signal cabling, conduit, trunking, racking, supports and support frames, bolts, transducer racks, local control stations and junction boxes.
- Trunk cabling from the old junction boxes to the equipment room is left on the existing cable racks, but cable ends are pulled back capped and labelled as decommissioned.
- All areas where equipment was removed on the plant are made neat by means of closing of holes, grinding of old anchor points and welding, repainting and resurfacing.

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### **3.4 General requirements**

#### **3.4.1 Cold Commissioning**

Cold commissioning the control system shall be performed by conducting functional system test. This test includes the checking of all interlocks and protections, sequence controls and all components of the whole (from the primary instrument to the HMI and PLC programmer station) loop, which includes the input and output loops for the works to prove plant reliability and safe operation.

The following are additional checks as part of the cold commissioning:

##### Instrument checks:

Calibrate all measuring instruments

All the instrument calibration sheets shall be included in the quality documentation package for the works.

##### Loop checks:

Loop checks on the field devices are required to prove their connection integrity.

Each loop shall be checked to ensure that each input and output circuit functions correctly. This includes all existing field equipment as well as new equipment supplied and installed.

Binary and analogue signals shall be simulated by closing the switching loop or simulating analogue signals on the cable terminals respectively. Such simulated signals shall be checked on the other end of the loop by observing the outgoing signals to the Switchgear, automation unit and Local Control Desk devices, etc.

##### Electrical drive checks

During plant shutdown all electrical drives shall be remotely operated and checked for correct operation. These tests shall be conducted while the Switchgear isolator is off.

#### **3.4.2 Hot Commissioning**

Control components shall be made available for control and monitoring the plant during its re-commissioning.

Cold commissioning would include most of the works namely; all the cable installations and terminations, field equipment installations and termination, commissioning of the PLC, Local Control Desk. These activities will be possible since the plant automation and monitoring is not available due to flood damage.

The flood damage has required the drives to run from the Switchgear local operation and not through the C&I control system and therefore hot commissioning will primarily be the final testing and commissioning of the Switchgear drives into the C&I control system

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### **3.4.3 Performance and Acceptance Testing**

Performance and Acceptance tests shall be performed on all areas of the DWD Plant.

The tests include all analogue controls, interlocks, safety protections, control loops, binary control, sequence control and interfaces.

After satisfactory completion of installation and commissioning of the control and monitoring system it shall be demonstrated that the control and monitoring systems correctly performs in the following modes:

- Verification of related protections is a prerequisite before plant is released to run in a manual or automated mode.
- Plant operated manually from the Local Control Desk as well as Local Control Stations.
- Plant operated automatically (start-up, sequential control and shut-down) with all the remote monitoring / supervisory functions at the Local Control Desk.

The plant shall then run for an unbroken period of 164 hours without a hardware or software malfunction. During this period any and all control modes may be exercised.

### **3.4.4 Cables**

UVG ACV cable types shall be supplied for the works with the following specification and termination standard:

- cable sheath specification shall be Blue Stripe Low halogen, flame retardant Polyvinyl Chloride (LH PVC) all cabling installed outside of building shall be UV resistant (UV stabilised).
- All process cables follow the cable core identification marking and termination sequence shall be as the existing colour coding standard.
- Sizes power cables in terms of the respective load these cables will be carrying.

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### **3.4.5 Junction Boxes and LCS Enclosures**

The junction boxes shall be supplied complete with:

- Mounting plate
- Number of terminals shall be dependent on cable configuration. Terminals shall be on DIN rail with end stops and end plates. All terminals must be numbered top and bottom from left to right.
- Screen bar
- Separate removable gland plate on the bottom.
- Glands
- Cable trunking at the bottom and the top and at least one side.
- Hinges must be of stainless steel.
- Locking device must be of stainless steel.
- Any additional equipment to make a complete assembly.

The junction boxes shall be supplied and glanded to the following specifications:

- Powder coated 3CR12 stainless steel.
- IP65 degree of protection
- Door: Neoprene gasket, lockable with a square key, removable, hinged at the top and open door position holding mechanism. An earth strap from the door to the junction box.
- All cables shall be glanded with compression glands to the back of the gland plate, without affecting the IP65 rating.

Terminals shall be supplied and installed to the following specifications:

- Material: 6.6 Polyamide
- Metal parts: Corrosion proof, high conductivity
- Locking type of conductor clamping to prevent self-loosening of screws due to vibrations.
- Current carrying capacity: = 34 Amps
- Insulation voltage: =750 Volts AC
- Connection: 6 mm<sup>2</sup> single strand or 4 mm<sup>2</sup> fine strand.
- Must clip onto rail
- It shall be possible to mark each terminal with at least three digits. All terminal strip markers, end covers fixed bridged bars and mounting rails shall be included in the supply.

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- Mounting rails: Galvanised steel in accordance with DIN EN 50022 - 35 x 7.5 or DIN EN 50035 - G32, perforated.
- Cables shall be terminated using a screw clamp type technique.
- Termination lugs for standard wire cores for use with screw clamp terminals shall be of wire pin or blade type.
- Not more than one conductor shall be connected to any side of a terminal, except in the case of screen and power supply jumper wires in junction boxes where a maximum of two conductors may be connected to one side.
- The stripping of insulation shall be carried out so that no damage to the conductor occurs and no bare conductor is visible or touchable.
- 20% expansion capability equipped must be provided in all junction boxes, field panels, marshalling racks/panels and on cable racks.

#### **3.4.6 Equipment Labelling**

Labelling of all equipment and documentation supplied shall be part of the works. The relevant AKZ code shall be included on the label according to the required format, together with plant description.

Cabling have labels made of aluminium and the lettering and numbers shall be black and engraved. The cable labels must be installed on both ends of the cable.

Field device labels shall be made of stainless steel. All text on labelling must be engraved. The position of the device also need to be labelled on the stand or supporting structure with a brass plate.

#### **3.4.7 New Instrument, Enclosure and Junction Box Stands**

All measurement transducers and junction boxes supplied shall be mounted on transducer racks or in equipment cabinets supplies as part of the works.

The transducer racks shall be configured out of galvanized carbon steel uni-struts. Standard mild steel components such shall not be accepted.

The racks shall be supplied complete with all necessary holding down bolts and equipment to make a complete assembly. The racks shall be of a sufficiently sturdy structure to accommodate equipment, which is to be mounted thereon.

Transducer racks shall be erected on concrete foundations or steelwork structures and includes the levelling, lining-up, bolting or welding together, bolting or welding down and earthing of the racks.

Transducer racks shall make provision for cable trunking or cable trays where required.

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The transducer racks shall provide protection against the environmental conditions which the transducer racks are exposed to. The transducer racks shall be designed to ensure a lifetime of 20 years.

Swagelok fittings and valves (or equivalent) are to be utilised for the works for the installation of sampling line and measurement tapping point.

#### **3.4.8 Cable Rack and Trays**

Cable trunking shall be used where cables are exposed to areas where damage can occur during normal plant operation. Cable tray roofing is to be provided for cable tray areas outside of buildings.

Galvanised conduit shall be used for all C&I cabling not running on cable trays or cable trunks.

C&I cable trays and power cable racks shall be spaced a minimum of 1000mm apart. Where C&I cable trays and power cable racks cross each other, the crossing shall be at 90° angle to avoid the possibility of electromagnetic induction.

To avoid damage to the sheath of C&I unarmoured cables, appropriate cleats, saddles and clamps shall be used to fix the cables to cable trays. Cables shall be fixed in such a way as to prevent strain on terminals and connectors. Enough slack shall be catered for when making off cables.

C&I cables shall not be stacked higher than the supporting edges of the cable tray or cable trunks.

The installation of all cables shall be installed in such a way that operational and maintenance activities will not cause accidental damage. Control and instrument cables shall be supported on the cable tray along the entire length of the cables.

#### **3.4.9 PLC Program Structure**

PLC Logic program shall be structured to allow efficient and effortless trouble-shooting with regard to identifying, accessing and to cross-reference relevant software variables including I/Os. Standard libraries and function routines shall be used. Every software variable and I/O must have an appropriate abbreviation and description.

Program categories or blocks with their relevant segments must have appropriate descriptions.

#### **3.4.10 Fire Barriers**

Fire barriers are to be installed wherever cables pass through walls, floors and ceilings and comply with Generation standard 240-54937450 (Fire Protection & Life Safety Design Standard) and SANS10142-2.

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#### **4. Acceptance**

This document has been seen and accepted by:

<b>Name</b>	<b>Designation</b>
John Green	Senior Advisor C&I Maintenance
Martin Coetzee	Senior Advisor C&I Maintenance
Nomkhosi Ramonotsi	C&I Maintenance Manager

#### **5. Revisions**

<b>Date</b>	<b>Rev.</b>	<b>Compiler</b>	<b>Remarks</b>
October 2021	0	PF Bosman	First draft for comment
November	1.0	PF Bosman	Final Rev 1.0 Document for Authorisation

#### **6. Development Team**

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

- Martin Coetzee
- Johan Green

#### **7. Acknowledgements**

N/A

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