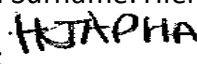
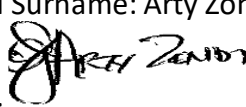




**Site Specific Health and Safety Specification in terms of 2014
Construction Regulations 5.1(b)**

Document Title	Site Specific Health and Safety Specification
Client	eThekweni Municipality – Water and Sanitation
Project Name	Tongaat Water Treatment Works Functional Upgrade
Contract Number	WS7382
Compiled by (Safety Officer)	Name and Surname: Hlengiwe Njapha Signature:  Date: 30/01/2025
Approved by (Safety and Risk Manager)	Name and Surname: Arty Zondi Signature:  Date: 30/01/2025
Revision Number	SSHSS 267/02/2025

PROJECT LOCALITY



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1. PROJECT DESCRIPTION

Tongaat Water Treatment Works Functional Upgrade

2. LIMITATIONS OF LIABILITY

The Principal Contractor shall enter into a Mandatory Agreement with the Client, as defined in Section 37(2) of the Occupational Health and Safety ACT.

The Principal Contractor shall ensure that each contractor appointed by the Principal Contractor and each sub-contractor appointed by a contractor also into a Mandatory Agreement with the Principal Contractor, as defined in Section 37(2) of the Occupational Health and Safety ACT. These agreements shall be included in the Principal Contractor's H&S File on site and be valid for the duration of the contractors' work on the construction site.

3. PURPOSE OF THE CONSTRUCTION H&S SPECIFICATION

This document defines the minimum management requirement that is to be implemented by the Principal Contractor/Contractor for the management of Health and Safety on any eThekweni Municipality project.

The aim of this document is to present the health and safety aspects that need to be controlled and managed on the project.

This Health and Safety specification identifies and encompasses the working behaviours and safe work practices that are expected of all employees, Vendors and Contractors, Sub-Contractors and Visitors, engaged on construction site.

Providing a guideline to comply with best Health & Safety practices and the Occupational Health and Safety Act 85/1993 as amended, including reference to applicable legislative requirement.

4. PROJECT HEALTH AND SAFETY COST

The Client must ensure that potential Principal Contractor submitting tenders have made adequate provision for the cost of health and safety measures.

The Principal Contractor shall allow in their cost provision for complying with the requirements of this Client Health and Safety Specification; resources for the following H&S controls shall be in place.

	H&S cost item	Description
1.	Full time safety officer	Full time attendance on site of a SACPCMP registered safety officer from the start of construction until the end of project handover

2.	First Aiders	First Aid training
3.	Competent inspectors (trained, certified, competent)	Statutory inspections of excavation, temporary works, fire extinguishers, lifting equipment, lifting machinery, construction vehicles and mobile plant, portable electrical equipment, Electrical Installation Controller etc.
4	Medical certificate of fitness	Medical examination of all employees and certification of fitness by an Occupational Medicine Practitioner Pre- employment and annual
5	PPE	Standards set for all employees Including community and environment
6	Dust mitigation	To reduce dust exposure to the employees and the public
7	Employee facilities	Refer to the Facilities Regulations (drinking water, change facility, personal lockers, and wash facilities, eating facilities, ablution toilets)
8	Public Protection and Barricading	Barricading, shoring and notices
9	Traffic Management	Traffic Controllers training and traffic signages
10	Signage	All construction safety signage required for the project
11	Other	

5. SCOPE OF WORK

The scope of works to be carried out under this Contract is shown on the drawings and described in the specifications and may be described as comprising but not limited to the following (detailed scope defined in the specifications and the BOQ):

New Head of Works

- Isolating valve
- Flow metering
- Flow rate control
- Automated screening
- A manual screen bypass that enables maintenance of the automated screen and additionally provides an emergency overflow in the event of a malfunction of the automated screen
- Backup flow measurement at V-notch weir
- Automated coagulant dosing facility with gravity flash mixing

immediately upstream of the flocculation tanks

- Pre-chlorination dosing facility
- Turbidity, pH, and conductivity monitoring

New Dual Flocculation Channels

- Construction of new dual flocculation channels, each equipped with 4 mechanical mixers to ensure optimal mixing and flocculation

Existing Dortmund Clarifiers (6No)

- Refurbishment of the 6 existing Dortmund clarifiers
- Automation of sludge removal to enhance efficiency and reliability

Existing Rapid Gravity Filters (6No)

- Refurbishment of the 6 existing rapid gravity filters
- Automation of the backwash sequence to improve operational efficiency
- Upstream monitoring of chlorine concentration to ensure water quality

Potable Water Reservoir

- Incorporation of upstream post-chlorination
- Continuous monitoring of:
 - Water level
 - Turbidity
 - pH
 - Chlorine concentration

Backwash Pumps

- Installation of backwash pumps in a Duty: Duty: Standby configuration
- Installation of blowers in a Duty: Duty: Standby configuration

Backwash Recovery System

- Implementation of a system to recover and reuse backwash water

Sludge Disposal System

- Establishment of a system for the efficient disposal of sludge

Metering

- Installation of metering systems to monitor various parameters and ensure accurate data collection

Cross Connection

- Creation of a cross-connection between the residue disposal system and the backwash recovery system to enhance operational flexibility and efficiency

Electrical and Instrumentation

- Disconnection and removal of existing equipment, including actuated valves, flow meters, control panels, and transformers
- Installation of a new 200kVA 400V transformer and new MCCs for mixers, screens, conveyors, clarifiers, filters, and sludge pumps

- New control panels for automatic backwash and air blower sequencing
- Automation of chemical and chlorine dosing systems with integration to the new SCADA system
- Installation of new electrical actuators for inlet flow control, clarifier de-sludge valves, and filter backwash valves
- New ultrasonic flow meters and level sensors for various applications
- Relocation and integration of existing telemetry and PLC/HMI systems to the new control room
- Comprehensive earthing and lightning protection systems for all new structures and buildings
- New site lighting and power installations for the administration building and guard house
- Testing, commissioning, and certification of the entire electrical and instrumentation installation

C3.1.3 TEMPORARY WORKS

The Contractor shall carry out such temporary work, including the necessary access and construction roads, shoring of trenches and excavations etc., as he may require enabling the permanent work to be constructed. He shall allow for the cost of all temporary works, including design and their removal, in his tendered rates.

Temporary works are expected to include:

- Necessary site access and deviations for traffic where the proposed works will disrupt traffic.
- Shoring, dewatering and related temporary works required during excavation of trenches and excavations as required to enable the permanent works to be constructed. The design of the lateral support is to be undertaken by the Contractors Professional Engineer and included in the tendered rate. The design of the lateral support solution will be dependent on the technique used by the contractor to perform the excavation, as well as programmed to fit into the Contractors construction programme. The Contractor is to submit the detailed design for the approval and acceptance of the project geotechnical engineer.
- Any temporary support structures required to protect and maintain services.

- Any temporary pipe specials and fittings.
- The pipework to the clarifiers will have to be temporarily supported during the filling of the structure for the drop test. Backfilling around the structure will only take place after successful completion of the drop test.

6. COMPENSATION FOR OCCUPATIONAL INJURIES AND DISEASES ACT

The Principal Contractor, each contractor and each sub-contractor shall submit proof of Good Standing with COIDA Commissioner, or a Mutual Association licensed in terms of Section 30 of COIDA, prior to starting any work on site.

A copy of the Letter of Good Standing with COIDA Commissioner must be included in the H&S Plan of each contractor working on the site and must remain updated for the duration of the construction work.

7. APPLICATION FOR CONSTRUCTION WORK PERMIT

The Principal Contractor shall assist the Client in compiling the evidence required by the Department of Labour for the issuing of the Construction Work Permit.

The Principal Contractor shall ensure that the H&S Plan presented for approvals includes:

- Evidence that the Principal Contractor made adequate provision for the cost of H&S measures
- Evidence that the Principal Contractor has the necessary competencies and resources to carry out the construction work safely.
- A copy of the Letter of appointment of the Construction Manager in terms of CR 8(1) + proof of his qualification, competence and registration where applicable.
- Proof of the registration of the Principal Contractors Health & Safety officer with the SACPCMP.

The Principal Contractor shall display the work permit number at the main site entrance. This display must be conspicuous to the satisfaction of the Department of Labor. The permit must be noticeable.

The construction works can only commence once the construction work permit is issued by the Department of Labor.

8. MANAGEMENT AND SUPERVISION OF CONSTRUCTION WORK

8.1 Construction Manager

The Principal Contractor shall appoint a full-time competent person as the construction manager with the duty of managing all construction on the site including the duty of ensuring occupational health and safety compliance.

The Construction Manager must demonstrate competency in relation to work being performed and the ability to manage construction work which may include making all statutory appointments in terms of health and safety.

8.2 Construction Health and Safety Officer

The Principal Contractor shall appoint a full-time competent Construction health and Safety Officer for the construction work. The Construction Safety Officer shall be full on the construction site for this project.

The Safety Officer shall be registered with the South African Council for the Projects and Construction Management Professions. Proof of competence and registration of the appointed Construction Safety Officer must be included in the H&S Plan.

8.3 Construction Supervisor

A Construction Manager must in writing appoint construction supervisors responsible for construction activities and ensuring occupational health and safety compliance on the construction site. A contractor must, upon having considered the size of the project, in writing appoint one or more competent employees for different sections thereof to assist the construction supervisor contemplated in sub regulation (7), and every such employee has, to the extent clearly defined by the contractor in the letter of appointment, the same duties as the construction supervisor: Provided that the designation of any such employee does not relieve the construction supervisor of any personal accountability for failing in his or her supervisory duties in terms of this regulation.

9. PRINCIPAL CONTRACTOR'S HEALTH AND SAFETY PLAN

The Principal Contractor shall submit a suitable, sufficiently documented and coherent specific health and safety plan based on the Client documented Health and Safety Specification. The health and safety plan shall include but not limited to the following

- Objectives
- Scope of work
- Management of construction and supervision
- Monitoring and review plan
- Sub-contractor management
- Risk Assessment & Written Safe Working Procedures
- Roof work planning/ methodology
- Incident Management & First Aid
- Fall Protection Plan
- Emergency procedures/ plan
- Fire Prevention & Protection
- Public Health and Safety
- PPE Provision
- Health & Safety Signage
- Excavations
- Site establishment
- Existing services
- Construction Vehicles and Mobile Plants
- Hand & Electrical Tool Management
- Construction Employees Facilities
- Health & Safety Policies
- Health and Safety Training & Competencies
- Housekeeping
- Hazardous Chemicals
- Inductions
- Medicals
- Site Security
- Stacking and Storage
- Internal and external Audit
- Inspection Registers
- Toolbox Talks
- Site Establishment

- Concrete Works
- Removal of Rubble and Large Trees
- Demolition work/Replacement

10. HAZARD IDENTIFICATION AND RISK ASSESSMENT

The Principal Contractor shall before commencement of any construction and during such construction works have risk assessments performed by appointed competent person in writing which forms part of the health and safety plan to be applied.

The provisions of Regulation 9 of the Construction Regulations shall be followed in every detail.

11. HEALTH AND SAFETY FILE

The Client must discuss and negotiate with a Principal Contractor the content of the Health and Safety Plan and thereafter finally approve the Health and Safety plan for implementation. The recommended Health and Safety file shall include the following:

- Client Health & Safety Specification
- Principal Contractor Health & Safety Plan
- Letter of good standing
- Section 37.2 Mandatory Agreement
- Contractor appointment letter in terms of CR 5.1(k)
- Legal appointments and competencies (Site manager, Site supervisor, Safety officer, Risk assessor, Incident investigator, Fall protection planner, Temporary work designer, Temporary work supervisor, Electrical installation supervisor)
- Risk Assessments as per scope of work
- Written Safe Working Procedures as per risk assessment
- Incident/Accident Management Procedures
- Award letter from SCM
- Organogram as per appointments
- Copy of OHS Act and COID Act
- Environmental Management Procedures (Dumpsite, Water provision, Ablution, Waste management, Concrete works, Refuelling and spillage management, Hazardous chemicals storage and disposal, Environmental awareness training, No Go Areas, Protection of animals, Site demarcation ect.)
- Health and Safety Induction programme
- Emergency Procedures/ Plan
- Medical Fitness Certificate (Safety Officer, Site manager and Supervisor)
- Toolbox Talks Programme/ Plan
- Fall Protection Plan
- Roof work methodology

- SHE Policy

12. HEALTH AND SAFETY REPRESENTATIVES AND COMMITTEE

Health and Safety Representatives

- The Principal Contractor shall ensure that Health and Safety Representatives are appointed in writing and exercise their functions as defined in OHSA.
- The Principal Contractor shall elect and appoint a health and safety representative regardless of the number of employees on the site.
- The H&S representative shall at all times be on site and report to the Health and Safety Officer and Construction Manager.

Health and Safety Committee

- The Principal Contractor shall ensure that the H&S committee meets on a monthly basis
- The Principal Contractor's management and each contractor shall be represented at the H&S committee meeting; contractors with more than 20 employees shall have an H&S representative at each committee meeting and each contractor shall have a management member attending each H&S committee meeting.

13. CLOSE- OUT CONSOLIDATED HEALTH AND SAFETY FILE

The Principal Contractor shall compile a consolidated H&S file and hand over to OHS Unit –Rennies House Durban for att: Hlengiwe Njapha. OHS Unit will conduct a project close out using the appropriate checklist before the completion of the project.

14. HEALTH AND SAFETY TRAINING

The Principal Contractor shall ensure that employees are trained on health and safety measures this shall include but not limited to:

- Written Safe Working Procedures
- Risk Assessments
- Health and Safety Plan
- Emergency Management Plan
- Induction
- Toolbox Talks
- MSDS

15. INCIDENTS MANAGEMENT & FIRST AID

All incidents and accidents as per Section of the Act must be reported, recorded and investigated as per General Administration Regulation 8 & 9

Where a fatality or permanent disabling injury or incident occurs on the Construction site, the Client must ensure that the Principal Contractor provides the Provincial Director with a report contemplated in Section 24 of the Act and the report includes the measures that the Principal Contractor intends to implement to ensure a safe construction site.

16. HEALTH AND SAFETY AUDITS

The Client must ensure that periodic health and safety audits are conducted at intervals mutually agreed upon between the Principal Contractor and the Client at least every 30 days, the copy of the health and safety audit report must be provided to the Principal Contractor within seven days after the audit.

17. FIRE PRECAUTIONS ON CONSTRUCTION SITE

The Principal Contractor shall provide suitable fire extinguishers which shall be serviced regularly in accordance with the manufacture's recommendations.

Safety signage shall be prominently displayed in all areas where fire extinguishers are located. The Principal Contractor shall arrange for training of the relevant personnel, in the use of fire extinguishers.

The provisions of Regulation 29 of the Construction Regulations as well as Regulation 9 of Environmental Regulation for Workplaces shall be followed in every detail.

18. ELECTRICAL INSTALLATIONS AND MACHINERY ON CONSTRUCTION SITE.

The Principal Contractor shall designate a competent electrician in writing who shall control all electrical installations.

All temporary electrical installations used by the contractor are inspected at least once a week by a competent person and the inspection findings are recorded in a register kept on the construction site.

All Electrical machinery is inspected by the authorized operator or user on daily basis using a relevant checklist prior to use and the inspection findings are recorded in a register kept on the construction site.

The provisions of Regulation 5, 6 & 9 of the Electrical Installation Regulations shall be followed in every detail.

19. PERSONAL PROTECTIVE EQUIPMENT AND CLOTHING.

The Principal Contractor shall ensure that every employee is issued with, and wears SANS-approved P.P.E. as per the conducted risk assessment.

Failure to use protective equipment as per the risk assessment shall require disciplinary intervention and this process shall be documented in the induction.

No employer shall in respect of anything which he is in terms of this Act required to provide or to do in the interest of health or safety of an employee make any deductions from any employee's remuneration or require or permit any employee to make any payment to him or to any other person.

The provisions of Regulation 2 of the General Safety Regulations shall be followed in every detail.

20. OCCUPATIONAL HEALTH AND SAFETY SIGNAGE

The Principal Contractor shall erect and maintain quality safety signage

The signage shall include but is not limited to:

- The construction work permit number displayed at the entrance
- Access restrictions
- A sign indicating that all visitors must report to the site office and must be accompanied by the Principal Contractor when accessing the site
- The name and telephone number of the responsible person(s)
- Emergency telephone number(s)
- PPE to be worn at the particular site
- When falling objects may occur, relevant barricading and warning signs must be erected
- Excavations, heights structures, temporary structures and all risk areas must be indicated as per the specific methods defined in the H&S Plan.

21. DUTIES OF PRINCIPAL CONTRACTORS AND CONTRACTORS

Contractors and sub-contractors must be given a copy of the H&S specification and any additional specification issued by the Client and shall comply with these specifications integrally. All employers working on the site shall conform to the standard in the CHSS. All the duties of the Principal Contractor in this CHSS equally apply, in full, to contractors of such Principal Contractor and to sub-contractors of such contractors.

The Principal Contractor shall ensure that the comprehensive and updated list of all the contractors and sub-contractors on site includes:

- A reference to the agreements between the parties, including all contractors Section 37(2) agreements with the Principal Contractor
- The type of work being done
- The date of the approval of the H&S Plan
- The date of expiry of the COIDA certificate of good standing
- The date of the last monthly audit

The provisions of Regulation 7 of the Construction Regulations shall be followed in every detail.

22. FALL PROTECTION AND WORKING IN FALL RISK POSITIONS

The Principal Contractor shall ensure that the fall protection plan include a risk assessment for all work carried out from the fall risk position and the safe work procedures.

All employees working from fall risk position are subject to medical examination. The Training Programme must be in place for employees working from a fall risk position. The procedures addressing the inspection, testing and maintenance of all fall risk protection equipment. The rescue plan detailing procedure, personnel and suitable equipment to be used to rescue a person. The Principal Contractor must that a competent person is designated to be responsible for the preparation of the fall protection plan.

The provisions of Regulation 10 of the Construction Regulations shall be followed in every detail.

23. EXCAVATION

The Principal Contractor must ensure that all excavation work is carried out under the supervision of a competent person who has been appointed in writing for that purpose.

The Principal Contractor shall take cognizance of the geotechnical study pertaining to the conditions of the construction site and must plan all excavation work in accordance with the recommendations of the professional engineer.

The Principal Contractor must ensure that every excavation, including all bracing and shoring, is inspected daily, prior to the commencement of each shift and that no person enters the excavation or works in a risk zone until the excavation is assessed and declared safe.

All excavations must be left open for the minimum of time required and those that are left open on the site must be protected by a barrier or a fence of at least one meter in height as close to the excavation as is practicable. The protective barrier or fence must adequately prevent persons from falling into the excavation and barrier taping is not sufficient for this purpose

Excavation shoring and bracing, if required shall be designed by a designer appointed in writing who shall inspect and approve the installed shoring and bracing

Where persons work, inspect or test excavations, warning signs must be in place next to an excavation

The provisions of Regulation 13 of the Construction Regulations shall be followed in every detail.

24. PUBLIC HEALTH AND SAFETY

The site shall at all times be secured to prevent the unauthorized access of persons to construction risk areas.

Appropriate health and safety signage shall be posted and access control to site must be exercised via a single access point.

All members entering the site must indicate in what capacity they are visiting the site.

The access point must be designed and constructed to allow for temporary parking, entry of construction vehicles, entry of personnel transport vehicles and entry of individual workers and other persons.

The principal Contractor shall ensure that each person visiting the site shall be inducted to the site and such abridged induction shall outline the hazards from on-site activities and the precautions to be observed to avoid or minimize those risks

Visitors must only enter when accompanied by a responsible person designated by the Principal Contractor.

25. NIGHT; WEEK –END WORK

No night or weekend work shall be performed unless authorized by the Principal Agent or Lead Engineers

Where week end work is planned the Principal Contractor shall ensure that its construction supervisor is on site, this applies even if only contractors or sub-contractors are working on the site

Where weekend work is planned each contractor or sub-contractor shall ensure that its construction supervisor is on site, this applies even if the Principal Contractor's manager or supervisor is on the site.

26. CONSTRUCTION EMPLOYEES FACILITIES

The Principal Contractor shall provide at or within reasonable access of every construction site, the following clean, hygienic and maintained facilities:

- (a) Shower facilities after consultation with the employees or employees representatives, or at least one shower facility for every 15 persons;
- (b) at least one sanitary facility for each sex and for every 30 workers;
- (c) changing facilities for each sex; and
- (d) sheltered eating areas.

The provisions of Regulation 2, 3, 4, 6, 7, 9 of the Facilities Regulations shall be followed in every detail.

27. CRANES AND LIFTING OPERATIONS

The Principal Contractor must ensure the cranes used are:

Are designed and erected under the supervision of a competent person;

A relevant risk assessment and method statement are developed and applied; The effects of wind forces on the crane are taken into consideration and that a wind speed device is fitted that provides the operator with an audible warning when the wind speed exceeds the design engineer's specification; The bases for tracks for rail-mounted tower cranes are firm, level and secured; The tower crane operators are competent to carry out the work safely; and The tower crane operators have a medical certificate of fitness to work in such an environment, issued by an occupational health practitioner in the form of Annexure 3

28. STORAGE AND USE OF FLAMMABLE LIQUIDS

No flammable substances must be stored on site unless these are stored in a flammable store or cabinet approved by the Municipal Chief Fire Officer, no other materials shall be stored in the flammable store or cabinet

Where required the H&S Plan shall include a method statement detailing the safe use, storage, decanting and spill controls for all flammable liquids used and stored on site.

The provisions of Regulation 25 of the Construction Regulations shall be followed in every detail.

29. HAZARDOUS CHEMICAL SUBSTANCE

With respect to hazardous chemical substances used, the contractor shall ensure that:

- All MSDS are included in the H&S File
- A HCS risk assessment is included in the H&S Plan
- The safe use, storage, emergency procedures and safe disposal of hazardous substances are addressed in a method statement(s) included in the H&S Plan.
- Proof of competency and signed letters of appointment of the person responsible for chemical handling is included in the H&S File.

Any hazardous chemical substance intended to be applied on site during the project (i.e. after approval of the H&S Plan) shall be subject to an issue-based risk assessment and method statement which must be presented to the Client Agent prior to the substance being introduced on site.

The provisions of Regulation 3, 5, 7, 8, 9, 9A, 10, 11, 14, 15 of the Hazardous Chemical Substances Regulations shall be followed in every detail.

30. HOUSEKEEPING AND GENERAL SAFEGUARDING ON CONSTRUCTION SITE

The Principal Contractor shall appoint a person responsible for general housekeeping and stacking and storage of materials and equipment on the entire site.

The provisions of Regulation 27 of the Construction Regulations shall be followed in every detail.

31. DEMOLITION WORK/REPLACEMENT

The Principal Contractor contractor must appoint a competent person in writing to supervise and control all demolition work on site.

A contractor must ensure that before any demolition work is carried out, and in order to ascertain the method of demolition to be used, a detailed structural engineering survey of the structure to be demolished is carried out by a competent person and that a method statement on the procedure to be followed in demolishing the structure is developed by that person

During a demolition, the competent person contemplated in sub regulation (1) must check

the structural integrity of the structure at intervals determined in the method statement contemplated in sub regulation (2), in order to avoid any premature collapses

The provisions of Regulation 14 of the Construction Regulations shall be followed in every detail.

32. CONSTRUCTION MEDICALS

A Principal Contractor must ensure that all his or her employees have a valid medical certificate of fitness specific to the construction work to be performed and issued by an Occupational Health Practitioner in the form of Annexure 3.

33. STACKING AND STORAGE ON CONSTRUCTION SITE

A Principal Contractor must, in addition to compliance with the provisions for the stacking of articles in the General Safety Regulations, 2003, ensure that—

A competent person is appointed in writing with the duty of supervising all stacking and storage on a construction site; Adequate storage areas are provided; There are demarcated storage areas; and storage areas are kept neat and under control.

34. INDUCTION AND TOOLBOX PROGRAMME

No contractor may allow or permit any employee or person to enter any site, unless that employee or person has undergone health and safety induction training pertaining to the hazards prevalent on the site at the time of entry.

A contractor must ensure that all visitors to a construction site undergo health and safety

induction pertaining to the hazards prevalent on the site and must ensure that such visitors have

the necessary personal protective equipment.

A contractor must at all times keep on his or her construction site records of the health and safety induction training contemplated in sub-regulation (6) and such records must be made

available on request to an inspector, the client, the client's agent or the principal

contractor. The Principal Contractor must ensure that the toolbox talks are conducted

on weekly basis and the training records kept on the safety file

DESIGNER COMMENTS ON HEALTH AND SAFETY SPECIFICATION

Designer's Health and Safety Checklist

Name and address of Project _____

Item and Legal Reference	Y/N	Comment
CR 6(1) (a) Has the designer familiarized himself with the Construction Regulations 2014 (particularly Regulation 6) and the Safety Standards incorporated into these Regulations?		
CR 6(1) (b) During the design stage, was the Client's Health and Safety Specifications given due consideration?		
The structural design aspects that could have an effect on the pricing of construction work?		
The geotechnical-science aspects?		
The weight which the structure is designed to safely withstand?		
CR 6(1)(d) Has the designer communicated all known and anticipated hazards and risks associated with the construction of the designed structure? Furthermore, has the safe method statement been developed to ensure that construction work is safely executed?		
CR 6 (1) (e) As far as is reasonably practicable, are the dangerous processes and materials been eliminated or replaced		

in the design?		
CR 6(1) (f) Has due consideration been taken during the design stage, for the safe maintenance of the structure after its completion?		
CR 6 (g-i) Is the designer aware of his/her responsibility to carry out periodic site inspections to ensure that the structure is constructed correctly in accordance with the design?		
CR 6(1) (j) Have all ergonomic hazards been considered for the lifecycle of the structure (i.e. during construction and after completion)?		

(Please ensure that the checklist is completed in full particularly the comments column)

Name of Designer_____

Designer's Title (e.g. Engineer, Architect)_____

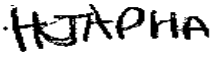
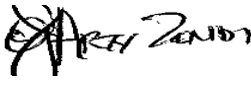
Signature_____

Date_____



ETHEKWINI MUNICIPALITY Occupational Health & Safety Unit

BASELINE RISK ASSESSMENT

Document Title	Baseline Risk Assessment
Client	eThekwini Municipality –Water and Sanitation
Project	Tongaat Water Treatment Works Functional Upgrade
Contract Number	WS7382
Compiled by (Safety Officer)	Name and Surname: Hlengiwe Njapha Signature:  Date: 03/02/2025
Approved by (Safety and Risk Manager)	Name and Surname: Arty Zondi Signature:  Date: 03/02/2025
Revision Number	BRA 267/02/2025

BASELINE RISK ASSESSMENT

1. INTRODUCTION: In accordance with the Occupational Health and Safety Act, (Act 85 of 1993) the Legislator places specific requirements on an Employer. One of these is prescribed in Section 8(i) of the Act where it requires the Employer to ascertain the risks and dangers which may occur within the workplace or section of the workplace and then goes on to establish working procedures or practices.

2. PURPOSE: This is conducted to create a benchmark of the potential risks that apply to the whole project or business operation.

3. SCOPE: This assessment could be approached on a site, regional or national level concerning any facet of the business operation or process or activity.

4. REVIEW AND MONITORING PLAN

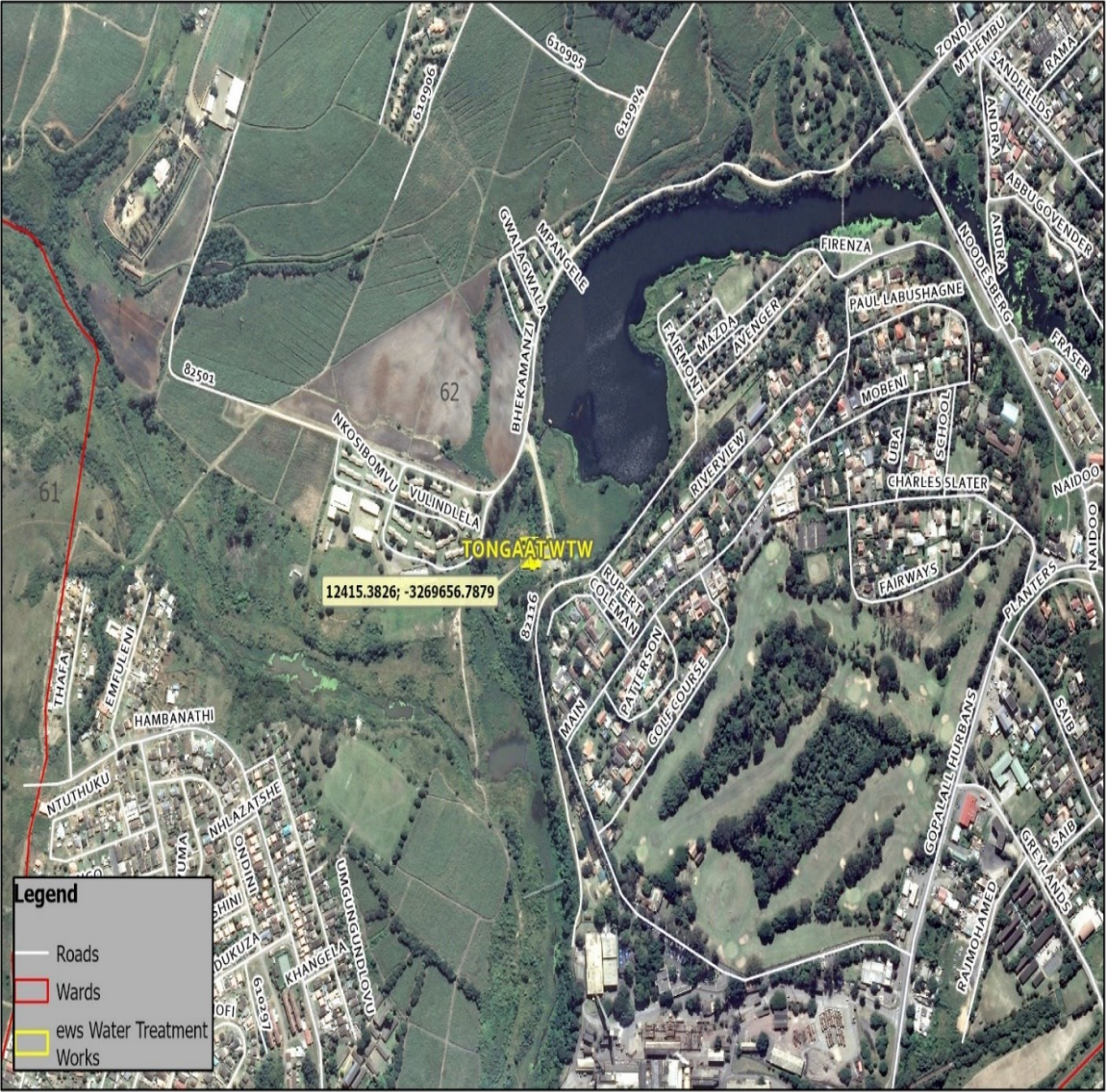
The risk assessment form part of the health and safety plan to be applied on the site and must include the following:

- (a) The identification of the risk and hazards to which to which persons may be exposed.
- (b) An analysis and evaluation of the risks and hazards identified based on a documented method

5. REFERENCES

- (a) Tender document WS7382
- (b) Occupational Health & Safety Act and its Regulation

6.LOCALITY PLAN



7.SCOPE OF WORKS

The scope of works to be carried out under this Contract is shown on the drawings and described in the specifications and may be described as comprising but not limited to the following (detailed scope defined in the specifications and the BOQ):

New Head of Works

- Isolating valve
- Flow metering
- Flow rate control
- Automated screening
- A manual screen bypass that enables maintenance of the automated screen and additionally provides an emergency overflow in the event of a malfunction of the automated screen
- Backup flow measurement at V-notch weir
- Automated coagulant dosing facility with gravity flash mixing immediately upstream of the flocculation tanks
- Pre-chlorination dosing facility
- Turbidity, pH, and conductivity monitoring

New Dual Flocculation Channels

- Construction of new dual flocculation channels, each equipped with 4 mechanical mixers to ensure optimal mixing and flocculation

Existing Dortmund Clarifiers (6No)

- Refurbishment of the 6 existing Dortmund clarifiers
- Automation of sludge removal to enhance efficiency and reliability

Existing Rapid Gravity Filters (6No)

- Refurbishment of the 6 existing rapid gravity filters
- Automation of the backwash sequence to improve operational efficiency
- Upstream monitoring of chlorine concentration to ensure water quality

Potable Water Reservoir

- Incorporation of upstream post-chlorination
- Continuous monitoring of:
 - Water level
 - Turbidity
 - pH
 - Chlorine concentration

Backwash Pumps

- Installation of backwash pumps in a Duty: Duty: Standby configuration

- Installation of blowers in a Duty: Duty: Standby configuration

Backwash Recovery System

- Implementation of a system to recover and reuse backwash water

Sludge Disposal System

- Establishment of a system for the efficient disposal of sludge

Metering

- Installation of metering systems to monitor various parameters and ensure accurate data collection

Cross Connection

- Creation of a cross-connection between the residue disposal system and the backwash recovery system to enhance operational flexibility and efficiency

Electrical and Instrumentation

- Disconnection and removal of existing equipment, including actuated valves, flow meters, control panels, and transformers
- Installation of a new 200kVA 400V transformer and new MCCs for mixers, screens, conveyors, clarifiers, filters, and sludge pumps
- New control panels for automatic backwash and air blower sequencing
- Automation of chemical and chlorine dosing systems with integration to the new SCADA system
- Installation of new electrical actuators for inlet flow control, clarifier de-sludge valves, and filter backwash valves
- New ultrasonic flow meters and level sensors for various applications
- Relocation and integration of existing telemetry and PLC/HMI systems to the new control room
- Comprehensive earthing and lightning protection systems for all new structures and buildings
- New site lighting and power installations for the administration building and guard house
- Testing, commissioning, and certification of the entire electrical and instrumentation installation

C3.1.3

TEMPORARY WORKS

The Contractor shall carry out such temporary work, including the necessary access and construction roads, shoring of trenches and excavations etc., as he may require enabling the permanent work to be constructed. He shall allow for the cost of all temporary works, including design and their removal, in his tendered rates.

Temporary works are expected to include:

- Necessary site access and deviations for traffic where the proposed works will disrupt traffic.
- Shoring, dewatering and related temporary works required during excavation of trenches and excavations as required to enable the permanent works to be constructed. The design of the lateral support is to be undertaken by the Contractors Professional Engineer and included in the tendered rate. The design of the lateral support solution will be dependent on the technique used by the contractor to perform the excavation, as well as programmed to fit into the Contractors construction programme. The Contractor is to submit the detailed design for the approval and acceptance of the project geotechnical engineer.
- Any temporary support structures required to protect and maintain services.
- Any temporary pipe specials and fittings.
- The pipework to the clarifiers will have to be temporarily supported during the filling of the structure for the drop test. Backfilling around the structure will only take place after successful completion of the drop test.

1. RISK ESTIMATION AND EVALUATION

RISK CLASSIFICATION USING A RISK SCORE TECHNIQUE

Exposure (E) How frequently does the hazardous event occur		Risk classification
Continuously		10
Frequently (daily)		6
Occasionally (weekly)		3
Unusually (monthly)		2
Rarely (few a year)		1
Probability (P) The probability of a loss when the hazardous event does occur		Risk classification
Frequent (happens often)		10
Probable (quite possible)		6
Occasional (unusual, but possible)		3
Remotely possible (has happened somewhere)		1
Improbable (practically impossible)		0.5
Severity (S) Consequences of the hazardous event		Risk classification
Catastrophic many fatalities; or interruption of longer than 2 weeks; or asset or environmental damage (or both) exceeding R100m		100
Disaster (few fatalities; or interruption between one and 2 weeks; or asset or environmental damage (or both) exceeding R10m)		40
Very serious (one fatality; or interruption of 6 days; or asset or environmental damage (or both) exceeding R100,000		7
Important (temporary disability; or interruption between 6 and 24 hours; or damage exceeding R10,000		3
Noticeable (first aid needed; or interruption of less than 6 hours; damage exceeding R1000)		1
Risk classification (Risk score = E x P x S)		
Risk score	Risk classification	
Over 400-----5	Very high risk – discontinue operation or activity	
200 to 400 ----- 4	High risk – immediate correction needed	
70 to 200----- 3	Substantial risk – correction needed	
20 to 70----- 2	Possible risk – attention needed	
Under 20 ----- 1	Risk accepted	

BASELINE RISK ASSESSMENT WORKSHEET: IDENTIFYING EXISTING & POTENTIAL RISKS

1	Site Access								
	Activity	Hazard	Risk	Risk Evaluation			Risk Score	Risk level	Risk Rank
				E	P	S			
	Accessing the site using construction vehicles or walking to site. Delivering of equipment and material to the site	Excessive speed, head on collusion, employees knocked by moving vehicles. Road blocked off due to community protest. Manual Handling and excessive lifting.	Accidents, damage to equipment or severe injuries or death. Back injuries,	6	6	7	252		4
2	Site Establishment								
	Manual and mechanical clearing of the land. Off-loading and positioning of offices by mobile crane. Fencing. Installation of temporary water supply, electricity, ablution facilities,	Dust, Snakes, Bees & Wasps. Incompetent operator. Poor connection of temporary services.	Poisoned and death. Collision/impacts of mobile lifting equipment, loads and dropped loads with process plant, pipe work, electrical cables and people. Water leaks, Electrocution, improper connection	6	6	7	252		4
3	Drainage/Sewage								

	Lay, bed and joint of pipes	Unsafe access to excavation Manual handling of pipes Possible pinch of fingers Engulfment of excavation	Personal injuries. Possible pinch Death/ body injury	6	6	3	108		3
4	Excavation Work & Back Filling								
	Mechanical and manual excavation. Back filling mechanical and manual	Incompetent operator. Machine running out of control. Open excavation. Dust. Operating mobile plant next to open excavation. Unsafe tools, damage of pipes by stone Back fill material.	Personal injury/possible disabling injuries. Property to damage Respiratory problem.	6	6	3	252		4
5	Existing Services								
	Identify the existing services	Snakes Unforeseen hazards	Poisoned and death. Personal injuries.	6	6	7	252		4
6	Removal of rubble								
	Mechanical and manual loading of rubble Removal of rubble	Dust, Mobile plant came into contact with trucks. Incompetent operator and lack of planning.	Respiratory problem. Damage to equipment. Damage to property. Motor Vehicle Accident.	3	6	7	126		3

		Reckless driving.							
7	Compaction								
	Operating a Bomag roller, wacker etc.	Incompetent operator. Noise. Vibration.	Personal injuries and damage to property. Noise Induce. Hearing loss. Kidney problem. Body pain.	6	6	3	108		3
8	Construction Mobile Plant and Equipment								
	Use of Plant & Equipment on site	Incompetent operator Unsafe plant & equipment. Collusion with other vehicles. Petrol and oil spillages.	Personal injuries. Motor vehicle accident. Environmental contamination.	6	6	7	252		4
9	Emergency Management								
	Development and Implementation of an Emergency Management Plan	Failure to have a basic, site specific emergency management plan. Workers not trained in the Emergency Plan. Insufficient or no emergency equipment or personnel.	Injury or damage to property. Inability to respond to emergencies. Insufficient or no emergency equipment.	6	6	3	108		3

10	Community Risk Management								
	Managing community risk	Failure to adequately monitor and manage the multi-faced social issues.	Violent protests. Injury to employees and property damage.	6	6	3	108		3
11	Subcontractor Management								
	Managing subcontractors	Failure to adequately assess subcontractors S.H.E Management System before work commences and at regular intervals. Inadequate Supervision. Utilizing incompetent Subcontractors.	Injury and non-compliance to legislation. High level of employee unsafe behavior. Accidents and property damage.	6	6	3	108		3
12	Block work and Brick work								
	Block work and mixing mortar.	Manual handling of blocks. Mortar inhalation. Mortar contact with body.	Injury to hands. Respiratory problem. Skin problems.	6	6	7	252		4
13	Working in elevated positions and scaffolding works								

	Working in elevated positions. Erection and dismantling of scaffolding.	Falling from elevated positions. Poor/ no edge protection. Unsafe scaffolding. Incompetent erectors.	Broken borne, death, disability and amputation. Broken borne, death, disability and amputation. Broken borne, death, disability and amputation.	6	6	7	252		4
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PEM: ENVIRONMENTAL MANAGEMENT SPECIFICATION

PEM1 PURPOSE

The purpose of the EMP is to encourage good management practices through planning and commitment with respect to environmental issues, and to provide rational and practical environmental guidelines to minimise disturbance of the natural environment.

PEM2 RESPONSIBILITIES FOR ENVIRONMENTAL MANAGEMENT

The contractor will be responsible for environmental control on site during construction and the maintenance period. The construction activities will be monitored by an independent environmental specialist and audited against the EMP.

PEM3 TRAINING AND INDUCTION OF EMPLOYEES

The contractor has a responsibility to ensure that all those people involved in the project are aware of and familiar with the environmental requirements for the project (this includes sub-contractors, casual labour, etc.).

PEM4 COMPLAINTS REGISTER AND ENVIRONMENTAL INCIDENT BOOK

Any complaints received by the project team from the community will be recorded. The complaint will be brought to the attention of the site manager.

All complaints received will be investigated and a response given to the complainant within 28 days.

All environmental incidents occurring on the site will also be recorded.

PEM 5 ENVIRONMENTAL SAFETY

The management of impacts associated with various categories of concern is discussed as separate topics, indicated below.

PEM 5.1 Soil

- (a) Topsoil should be temporarily stockpiled, separately from (clay) subsoil and rocky material, when areas are cleared. If mixed with clay sub-soil the usefulness of the topsoil for rehabilitation of the site will be lost.
- (b) Stockpiled topsoil should not be compacted and should be replaced as the final soil layer. No vehicles are allowed access onto the stockpiles after they have been placed.
- (c) Stockpiled soil should be protected by erosion-control berms if exposed for a period of greater than 14 days during the wet season. The need for such measures will be indicated in the site-specific report.
- (d) Topsoil stripped from different sites must be stockpiled separately and clearly identified as such. Topsoil obtained from sites with different soil types must not be mixed.
- (e) Topsoil stockpiles must not be contaminated with oil, diesel, petrol, waste or any other foreign matter, which may inhibit the later growth of vegetation and micro-organisms in the soil.
- (f) Soil must not be stockpiled on drainage lines or near watercourses without prior consent from the Project Manager.
- (g) Soil should be exposed for the minimum time possible once cleared of invasive

vegetation, that is the timing of clearing and grubbing should be co-ordinated as much as possible to avoid prolonged exposure of soils to wind and water erosion. Stockpiled topsoil must be either vegetated with indigenous grasses or covered with a suitable fabric to prevent erosion and invasion by weeds.

- (h) Limited vehicular access is allowed across rocky outcrops and ridges.
- (i) All cut and fill surfaces need to be stabilized with appropriate material or measures when major civil works are complete.
- (j) Erosion and donga crossings must be dealt with as river crossings. Appropriate soil erosion and control procedures must be applied to all embankments that are disturbed and destabilized.
- (k) All equipment must be inspected regularly for oil or fuel leaks before it is operated. Leakages must be repaired on mobile equipment or containment trays placed underneath immobile equipment until such leakage has been repaired.
- (l) Soil contaminated with oil must be appropriately treated and disposed of at a permitted landfill site or the soil can be regenerated using bio-remediation methods.
- (m) Runoff must be reduced by channelling water into existing surface drainage system.

PEM5.2 Water

- (a) Adequate sedimentation control measures must be instituted at any river crossings when excavations or disturbance of a riverbanks or riverbeds takes place.
- (b) Adequate sedimentation control measures must be implemented where excavations or disturbance of drainage lines of a wetland may take place.
- (c) All fuel, chemical, oil, etc spills must be confined to areas where the drainage of water can be controlled. Use appropriate structures and methods to confine spillages such as the construction of berms and pans, or through the application of surface treatments that neutralise the toxic effects prior to the entry into a water course.
- (d) Oil absorbent fibres must be used to contain oil spilt in water.
- (e) During construction through a wetland, the majority of the flow of the wetland should be allowed to pass down stream.
- (f) Vehicular traffic across wetland areas must be avoided.
- (g) No dumping of foreign material in streams, rivers and/or wetland areas is allowed.
- (h) The wetland area and/or river must not be drained, filled or altered in any way including alteration of a bed and/or, banks, without prior consent from the DWAF. The necessary licenses must be obtained in terms of Section 21 and 22 of the National Water Act, 36 of 1998 from DWAF.
- (i) No fires or open flames are allowed in the vicinity of the wetland, especially during the dry season.
- (j) No swimming, washing (including vehicles and equipment), fishing or related activity is permitted in a wetland or river without written permission from the Project Manager.
- (k) Disturbances to nesting, breeding and roaming sites of animals in or adjacent to wetland areas must be minimized.

PEM5.3 Air

- (a) Speed limits must be implemented in all areas, including public roads and private property to limit the levels of dust pollution.

- (b) Dust must be suppressed on access roads and construction sites during dry periods by the regular application of water or a biodegradable soil stabilisation agent. Water used for this purpose must be used in quantities that must not result in the generation of run-off.
- (c) The site-specific investigation will quantify the impact of dust on nearby wetlands, rivers and dams in terms of sedimentation. Mitigation measures identified during the site specific study must be implemented.
- (d) The Contractor must notify the Principal of all schools within 50m of the site of proposed activities. The Principal must in turn ensure that children with allergies and respiratory ailments take the necessary precautionary measures during the construction period. The Contractor must ensure that construction activities do not disturb school activities e.g. dust clouds may reduce visibility affecting sports activities.
- (e) Waste must be disposed of, as soon as possible at a municipal transfer station, skip or on a permitted landfill site. Waste must not be allowed to stand on site to decay, resulting in malodours.
- (f) Noise control measures must be implemented. All noise levels must be controlled at the source. All employees must be given the necessary ear protection gear. IAP's must be informed of the excessive noise factors.
- (g) The Contractor must inform all adjacent landowners of any after-hour construction activities and any other activity that could cause a nuisance e.g. the application of chemicals to the work surface. Normal working hours must be clearly indicated to adjacent land owners.
- (h) No loud music is allowed on site and in construction camps.
- (i) No fires are allowed if smoke from such fires will cause a nuisance to IAP's.

PEM5.4 Social and Cultural

- (a) Access by non-construction people onto any construction sites must be restricted. The Contractors activities and movement of staff must be restricted to designated construction areas only.
- (b) The Contractors crew must be easily identifiable due to clothing, identification cards or other methods.
- (c) Rapid migration of job seekers could lead to squatting and social conflict with resident communities and increase in social pathologies if not properly addressed. The Contractor must ensure that signs indicating the availability of jobs are installed.
- (d) Criteria for selection and appointment (by the Contractor) of construction labour must be established to allow for preferential employment of local communities. The Local Authority must be actively involved in the process of appointing temporary labourers.
- (e) Sub-Contractors and their employees must comply with all the requirements of this document and supporting documents e.g. the Contract document that applies to the Contractor. Absence of specific reference to the sub-contractor in any specification does not imply that the sub-contractor is not bound by this document.
- (f) No member of the construction workforce is allowed to wander around private property, except within the immediate surrounding of the site.
- (g) The Contractor must provide suitable sanitation facilities for site staff. Sanitation provided during the construction phase should be managed so that it does not cause

environmental health problems. The use of the surrounding veld for toilet purposes is not permitted under any circumstance.

- (h) The Contractor must arrange for all his employees and those of his sub-contractors to be informed of the findings of the environmental report before the commencement of construction to ensure:
 - A basic understanding of the key environmental features of the work site and environments, and
 - Familiarity with the requirements of this document and the site specific report.
- (i) Supervisory staff of the Contractor or his sub-contractors must not direct any person to undertake any activities which would place such person in contravention of the specifications of this document, endanger his/her life or cause him/her to damage the environment.
- (j) The demand for construction materials and supplies will have an effect on the local economy. This impact can be optimised by sourcing and purchasing materials locally and regionally wherever possible, insofar as the material complies with the design specification.
- (k) The Contractor must maintain a detailed complaints register. This must be forwarded, together with solutions, to the authorities when requested.

PEM5.5 Aesthetics

- (a) Scenic Quality

Damage to the natural environment must be minimized.

Trees and tall woody shrubs must be protected from damage to provide a natural visual shield. Excavated material must not be placed on such plants and movement across them must not be allowed, as far as practical.

The clearing of all sites must be kept to a minimum and surrounding vegetation must, as far as possible, be left intact as a natural shield.

No painting or marking of natural features must be allowed.

- (b) All above ground structures could be treated or painted to blend in with the natural environment.
- (c) Cut and fill areas, river and stream crossings and other soil stabilisation works must be constructed to blend in with the natural environment.
- (d) Natural outcrops, rocky ridges and other natural linear features, must not be bisected. Vegetation on such features must, as far as possible, not be cut unless absolutely necessary for construction.
- (e) Excavated material must be flattened (not compacted) or removed from site. No heaps of spoil material must be left on site once the Contractor has moved to a new construction site.
- (f) Any complaints from interest groups regarding the appearance of the construction site must be recorded and addressed promptly by the Contractor.

PEM5.6 Archaeology and Cultural Sites

- (a) All finds of human remains must be reported to the nearest police station.

- (b) Human remains from the graves of victims of conflict, or any burial ground or part thereof which contains such graves and any other graves that are deemed to be of cultural significance may not be destroyed, damaged, altered, exhumed or removed from their original positions without a permit from the South African Heritage and Resource Agency (SAHRA).
- (c) Work in areas where artefacts are found must cease immediately.
- (d) Under no circumstances must the Contractor, his/her employees, his/her sub-contractors or his/her sub-contractors' employees remove, destroy or interfere with archaeological artefacts. Any person who causes intentional damage to archaeological or historical sites and/or artefacts could be penalised or legally prosecuted in terms of the National Heritage Resources Act, 25 of 1999.
- (e) A fence at least 2 m outside the extremities of the site must be erected to protect archaeological sites.
- (f) All known and identified archaeological and historical sites must be left untouched.
- (g) Work in the area can only be resumed once the site has been completely investigated. The Project Manager will inform the Contractor when work can resume.

PEM5.7 Flora

- (a) All suitable and rare flora and seeds must be rescued and removed from the site. They must be suitably stored, for future use in rehabilitation.
- (b) The felling and/or cutting of trees and clearing of bush must be minimised.
- (c) Bush must only be cleared to provide essential access for construction purposes.
- (d) The spread of alien vegetation must be minimized.
- (e) Any incident of unauthorised removal of plant material, as well as accidental damage to priority plants, must be documented by the Contractor.
- (f) Woody vegetative matter stripped during construction must either be spread randomly throughout the surrounding veld so as to provide biomass for other micro-organisms and habitats for small mammals and birds, or it may be stockpiled for later redistribution over the reinstated topsoiled surface. No vegetative matter must be burnt or removed for firewood other than those removed during the grubbing and clearing phase. Such vegetation can be made available to the local inhabitants to be used as firewood.
- (g) No tree outside the footprint of the Works area must be damaged.

PEM5.8 Fauna

- (a) No species of animal may be poached, snared, hunted, captured or willfully damaged or destroyed.
- (b) Snakes and other reptiles that may be encountered on the construction site must not be killed unless the animal endangers the life of an employee.
- (c) Anthills and/or termite nests that occur must not be disturbed unless it is unavoidable for construction purposes.
- (d) Disturbances to nesting sites of birds must be minimized.
- (e) The Contractor must ensure that the work site is kept clean and free from rubbish, which could attract pests.

PEM5.9 Infrastructure

(a) The relevant authorities must be notified of any interruptions of services, especially the Local Municipality, National Road Agency, Spoornet, TELKOM and ESKOM. In addition, care must be taken to avoid damaging major and minor pipelines and other services.

(b) The integrity of property fences must be maintained.

(c) No telephone lines must be dropped during the construction operations, except where prior agreement by relevant parties is obtained. All crossings must be protected, raised or relocated as necessary.

(d) All complaints and/or problems related to impacts on man-made facilities and activities must be promptly addressed by the Contractor and documented.

(e) Storage Facilities

- Proper storage facilities should be provided for the storage of oils, grease, fuels, chemicals and hazardous materials.
- The Contractor must ensure that accidental spillage does not pollute soil and water resources.
- Fuel stock reconciliation must be done on all underground tanks to ensure no loss of oil, which could pollute groundwater resources.
- Cement must be stored and mixed on an impermeable substratum.

(f) Traffic Control

All reasonable precautions must be taken during construction to avoid severely interrupting the traffic flow on existing roads, especially during peak periods.

Before any work can start the Local Traffic Department must be consulted about measures to be taken regarding pedestrian and vehicular traffic control.

(g) Access Roads

The Contractor and the affected landowner must collaborate on the planning and construction of new access routes and the repair or upgrading of existing routes.

Access to the site must be controlled such that only vehicles and persons directly associated with the work gains access to the site.

Temporary access roads must not be opened until required and must be restored to its former state as soon as the road is no longer needed.

(h) Batching Plants

Concrete must be mixed only in an area demarcated for this purpose. All concrete spilled outside this area, must be promptly removed by the Contractor and taken to a permitted waste disposal site. After all concrete mixing is complete, all waste concrete must be removed from the batching area and disposed of at an approved dumpsite. Stormwater must not be allowed to flow through the batching area. Water laden with cement must be collected in a retention area for evaporation and not allowed to escape the batching area. Operators must wear suitable safety clothing.

(i) Chemical toilet facilities should be managed and serviced by a qualified company. No disposal or leakage of sewerage should occur on or near the site.

(j) **Blasting**

Blasting must not endanger public or private property.

Noise mufflers and/or soft explosives must be used to minimize the impact on animals.

All the provisions of the Explosives Act, 26 of 1956 and the Minerals Act, 50 of 1991 must be complied with.

The Contractor must take measures to limit flyrock.

PEM5.10 Safety

- (a) Measures must be taken to prevent any interference that could result in flashover of power lines due to breaching of clearances or the collapse of power lines due to collisions by vehicles and equipment.
- (b) Measures must be taken during thunderstorms to protect workers and equipment from lightning strikes.
- (c) All tall structures must be properly earthed and protected against lightning strikes.
- (d) The process of excavation and back filling must be carried out as a sequential process following one another as quickly as possible. Excavations must only remain open for a minimum period of time and during this time they must be clearly demarcated. If excavations place the public at risk these sites must be fenced.
- (e) The residents directly affected by open trenches must be notified of the dangers. This will be done during the site-specific phase.

PEM5.11 Waste

Solid Waste

- (a) Littering on site and the surrounding areas is prohibited.
- (b) Clearly marked litterbins must be provided on site. The Contractor must monitor the presence of litter on the work sites as well as the construction campsite.
- (c) All bins must be cleaned of litter regularly.
- (d) All waste removed from site must be disposed at a municipal/permitted waste disposal site.
- (e) Excess concrete, building rubble or other material must be disposed of in areas designated specifically for this purpose and not indiscriminately over
- (f) the construction site.
- (g) The entire works area and all construction sites must be swept of all pieces of wire, metal, wood or other material foreign to the natural environment.
- (h) Contaminated soil must be treated and disposed of at a permitted waste disposal site, or be removed and the area rehabilitated immediately.
- (i) Waste must be recycled wherever possible.

Liquid Waste

- (a) The Contractor must maintain mobile toilets on site.
- (b) The Contractor must provide adequate and approved facilities for the storage and recycling of used oil and contaminated hydrocarbons. Such facilities must be designed and sited with the intention of preventing pollution of the surrounding area and environment.

- (c) All vehicles must be regularly serviced in designated area within the Contractors camp such that they do not drip oil.
- (d) All chemical spills must be contained and cleaned up by the supplier or professional pollution control personnel. Run-off from wash bays must be intercepted.

Hazardous Waste

- (a) No hazardous materials must be disposed of in the veld or anyplace other than a registered landfill for hazardous material. Hazardous waste must be stored in containers with tight lids that must be sealed and must be disposed at an appropriately permitted hazardous waste disposal site. Such containers must not be used for purposes other than those originally designed for.
- (b) The Contractor must maintain a hazardous material register.

PEM5.12 Rehabilitation and Site clearance

- (a) When all major construction activities are completed, the site must be inspected to determine site-specific rehabilitation measures. This may be considered as unplanned work e.g. soil rehabilitation due to oil spills.
- (b) All temporary buildings and foundations, equipment, lumber, refuse, surplus materials, waste, construction rubble fencing and other materials foreign to the area must be removed.
- (c) If waste products cannot be recycled they must be disposed of at a permitted landfill site.
- (d) All drainage deficiencies including abandoned pit latrines and waste pits must be corrected.
- (e) Cut and fill areas must be restored and re-shaped.
- (f) The area must be restored to its natural vegetation condition using indigenous trees, shrubs and grasses as directed by a grassland and/or rehabilitation expert.
- (g) Borrow pits must be re-shaped into even slopes and surfaces to blend with the natural terrain and topsoil must be replaced.
- (h) The grass mix, shrubs and trees used for rehabilitation must be compatible with the species identified in the site-specific investigation.
- (i) Areas compacted by vehicles during construction must be scarified to allow penetration of plant roots and the regrowth of natural vegetation.

(a) PEM6 MEASUREMENT AND PAYMENT

An item has been included in the Bill of Quantities to comply with the above actions.



ETHEKWINI MUNICIPALITY

ETHEKWINI WATER AND SANITATION PARTICULAR SPECIFICATIONS FOR DAYWORK SCHEDULE

PAA.1 GENERAL

In cases where the Engineer orders any variation in the form, quality or quantity of the work or any extra work to such an extent that the tendered rates for specific items are no longer applicable, or where a combination of tendered rates cannot be applied to compensate for such work, the Engineer may, in terms of the General Conditions of Contract, order that the amended or extra work be carried out as daywork at the cost of labour, plant and materials. For that purpose provision is made for the Contractor to tender his rates for labour and plant in the Daywork Schedule which forms part of this contract.

No work will be measured as daywork unless:

- (a) the Engineer agrees that the varied work is not in accordance with the specification or scope of a measured item in the contract;
- (b) the Engineer has issued an order in writing for the execution of such varied work; and
- (c) statements of plant and labour are submitted daily to the Engineer for his consideration and approval.

All work valued at the tendered rates in the Daywork Schedule will be subject to contract price adjustment as applicable to the Contract.

PAA.2 SALARIES AND WAGES OF WORKMEN

The amount to be paid for labour will be based on the rates tendered in the Daywork Schedule for the workers executing the work. The tendered rates shall be all-inclusive and shall be held to cover all charges for the Contractor's profits, timekeeping, clerical work, insurance, establishment, superintendence, the use of hand tools, etc, and no additional surcharge over and above the tendered rates will be applicable.

PAA.3 CONSTRUCTIONAL PLANT

The rates for constructional plant as tendered in the Daywork Schedule shall cover all costs, overheads and profit for the contractor and no further surcharge will be payable on the tendered rates. The cost of operators shall be included in the tendered rates except where otherwise specified in Clause PAA-5 (Measurement and Payment) hereafter.

Where plant or equipment for which no rates exist in the Daywork schedule are employed, the cost thereof shall be determined as agreed with the Engineer in terms of the General Conditions of Contract. In such case contract price adjustment will only be applicable if the agreed cost is based on rental rates at the time of the base month before closing of tenders, or if the ruling rates current at the time of the execution of the work are de-escalated to the base month.

The Contractor will be paid for the transport to and from the site of constructional plant not on site and specially ordered by the Engineer to be brought on site. No payment

will be made for transport of equipment listed in the Contractor's Schedule of Constructional Plant in the tender document, or for equipment which has been removed from the site on request of the Contractor, or for equipment already on site, regardless of whether it appears on the Schedule of Constructional plant or not.

PAA.4 MATERIALS

Materials required for daywork items which cannot be compensated under existing rates and have to be purchased, will be paid for at cost, excluding VAT, plus a surcharge of 15%. The cost of materials provided for daywork at current rates at the time when the work is executed, will not be subject to contract price adjustment unless the prices of the materials are de-escalated to the base month for escalation.

PAA.5 MEASUREMENT AND PAYMENT

<u>Item</u>	<u>Unit</u>
-------------	-------------

PAA.5.1 Labour

- | | | |
|-----|---|----------|
| (a) | Unskilled workers | hour (h) |
| (b) | Skilled workers (Artisans) | hour (h) |
| (c) | Operators and drivers (where measured separately) | hour (h) |
| (d) | Foremen | hour (h) |
| (e) | Others (specify) | hour (h) |

The unit of measurement is the hour or part thereof during which workers were engaged in daywork.

The tendered rate shall include full compensation for all salaries, wages, bonuses, pension, insurance, medical aid and other benefits as well as overheads arising from administrative personnel, site agents, supervisors, tools and profit. No surcharge will be paid on the tendered rates

The cost of operators included in the rates for constructional plant, will not be measured again under Labour.

<u>Item</u>	<u>Unit</u>
-------------	-------------

PAA.5.2 Constructional Plant

- | | | |
|-----|---|----------------------|
| (a) | Lowbed transport of plant to and from the site..... | ton-kilometre (t.km) |
| (b) | Bulldozer and ripper | |
| | (i) (Specify power and mass) | hour (h) |
| | (ii) etc (for other bulldozers) | hour (h) |
| (c) | Grader | |
| | (i) (Specify power and mass) | hour (h) |
| | (ii) etc (for other graders) | hour (h) |
| (d) | Front-end loaders | |
| | (i) (Specify type, power and mass) | hour (h) |
| | (ii) etc (for other front-end loaders) | hour (h) |
| (e) | Back-acting excavators | |

- (i) (Specify type, power and mass)..... hour (h)
 - (ii) etc (for other back-acting excavators) hour (h)
- (f) Tractors and drawn rollers and trailers
 - (i) Tractor (Specify type, power and mass)..... hour (h)
 - (ii) Roller (Specify types, masses) hour (h)
 - (iii) Tractor with trailer, complete (Specify tractor, and type and capacity of trailer) hour (h)
- (g) Compactors
 - (i) (Specify type and mass) hour (h)
 - (ii) etc (for other types and masses)..... hour (h)
- (h) Compressors
 - (i) (Specify capacity and number of tools)..... hour (h)
 - (ii) etc (for other compressors and tools)..... hour (h)
- (i) Trucks
 - (i) (Specify type, and capacity) hour (h)
 - (ii) etc (for other trucks)..... hour (h)
- (j) Light delivery vehicles
 - (i) (Specify load capacity)..... kilometre (km)
 - (ii) etc (for other)..... kilometre (km)

Item

Unit

PAA.5.3 Cost of materials delivered tosite (specify) P-Sum or as scheduled

The unit of measurement for subitem 5.2(a) is the ton constructional equipment multiplied by the kilometre distance over which the plant has been transported with a lowbed transporter as ordered by the Engineer.

The unit of measurement for subitems 5.2(b) to (i) is the hour or part thereof during which the item of plant had been in active use for the daywork operation, including stopping time of less than five minutes.

Where applicable travel time to and from the normal parking position on site, or the position of the most recent non-daywork activity, as well as stopping time exceeding five minutes shall be multiplied by a factor of 0,6. Time shall be measured by means of a vibrating clock card.

The unit of measurement for subitem 5.2(j) is the kilometre travelled to collect or transport small quantities of materials. Kilometres travelled in light delivery vehicles by supervisors in the execution of normal supervisional duties, shall not be measured for payment.

The tendered rates shall include full compensation for the supply, maintenance, service, repairs, depreciation as well as fuel, lubricants, licensing, insurance, overheads and profit. It shall also include the cost of drivers and operators except in the case of subitem PAA-5.2(h) where the operators of tools are paid for under labour.



ETHEKWINI MUNICIPALITY

ETHEKWINI WATER AND SANITATION PARTICULAR SPECIFICATIONS FOR COMMUNITY LIAISON OFFICER (CLO)

PCL.1 COMMUNITY LIAISON OFFICER & LOCAL LABOUR

A Provisional Sum has been provided in the document for the employment of a community Liaison Officer (CLO) for the duration of the contract. The primary role of the CLO shall be liaison and facilitation of communication which shall include inter alia:

-

- assist in all aspects related to the recruitment of local labour, and advise them of their rights
- act as a source of information for the community and Councillors on issues related to the contract
- keeping the contractor advised on community issues
- keeping the contractor advised on any issues pertaining to local security
- assisting in setting up any meetings/ negotiations with affected parties
- keeping a site diary and recording details of any labour/community issues that may arise
- monitoring and reporting on general Health & Safety issues on site
- assisting in HIV/AIDS awareness programmes
- it must be noted that the CLO has no authority to issue any instructions to the Contractor

The CLO needs to be seen as neutral by all parties, and therefore should endeavour not to take sides should conflict arise

The minimum skills for a CLO shall include: -

- An ability to work with others
- An ability to communicate in Zulu and English
- An ability to communicate in writing
- Sound interpersonal skills

The Ward Councillor shall be responsible for the selection of the CLO, however the selected CLO shall be accountable to the Contractor. Where a project traverses several different wards, the respective Ward Councillors shall collectively identify a single CLO. The Ward Councillor should consult with the local community and other affected Councillors when identifying the CLO.

The CLO shall be employed on a full day basis, for the duration of the contract, and shall be paid at a rate based on 200% of the Civil Engineering Industry minimum wage. In addition to this, all statutory conditions of employment in respect of UIF, Workmen's Compensation etc should be met.

Responsibility for the identification of a pool of suitable labour shall rest with the CLO, although the contractor shall have the right to choose from that pool. The contractor and sub contractors shall have the right to determine the total number of labourers required at any time, and this will vary through the duration of the contract.

The contractor shall have the right to replace labour that is not performing adequately. The contractor should ensure that the replacement of any labour due to inadequate performance is done so in conjunction with the CLO.

Local labour shall be paid in accordance with the Civil Engineering Industry minimum wage, and all statutory conditions of employment shall be met.

ETHEKWINI MUNICIPALITY

EMC : CODE OF CONDUCT

Applicable to the Procurement of Goods, Services, Engineering and Construction Works

1. INTRODUCTION

- a) Section 217.(1) of the Constitution of the Republic of South Africa reads as follows:
“When an organ of state in the national, provincial or local sphere of governments, or any other institution identified in national legislation, contracts for goods or services, it must do so in accordance with a system which is fair, equitable, transparent, competitive and cost-effective”.
- b) It goes without saying that, in addition to the foregoing requirements, it is essential that the procurement of goods and services, including engineering and construction works, by eThekwin Municipality should not be affected, or tainted, by illegal action, or default, at any stage of the process, by any party involved.
- c) The foregoing serves to establish the broad framework within which an action, or default, by any party to the procurement process should be judged. Any action, or default, which conflicts with the objectives of section 217.(1) of the Constitution, or which is illegal, is unacceptable.
- d) A party to the procurement process, who wittingly, commits an unacceptable action, or default, renders itself liable to the appropriate sanction, or even, in the case of an illegal action, or default, to prosecution.
- e) This document contains examples of actions, or defaults, by parties to the public procurement process, which are unacceptable. The lists of examples are, however, not exhaustive and each party must, itself, assess whether an action, or default, would be unacceptable in the light of section 217.(1) of the Constitution, or be illegal.

2. INVOLVEMENT OF PARTIES IN THE PROCUREMENT PROCESS

- a) The various parties that could be involved in the procurement of goods, services and engineering and construction works by a public process are the following, which are denoted by capital initial letters in this document.

Employer: Any Output Unit or Department within eThekwin Municipality procuring goods, services or engineering and construction works, including other public bodies/ partners assisting in, or exercising control over, the procurement process e.g. Procurement and Tenders Sub-Committee etc.

Official: An employee of the Employer.

Agent: One who acts on behalf of the Employer.

Consultant: A professional service provider engaged by the Employer.

Tenderer: One who submits a competitive bid for the supply of goods, services, or engineering and construction works to the Employer.

Contractor: The successful Tenderer to whom the Employer awards the contract for the supply of goods, services, engineering or construction works.

Subcontractor: One who contracts to a Contractor to assist the latter in the execution of his/her contract by supplying certain goods, services, or works.

Representative: A political, or other, representative of the public, or of the private sector, who serves on the Procurement and Tenders Sub-committee responsible for policy, oversight of the appointment process or approving any aspect of procurement by eThekweni Municipality.

3. UNACCEPTABLE ACTIONS AND ESSENTIAL PRACTICES

- a) Examples of actions which are unacceptable and essential practices, which would constitute unacceptable defaults if not observed, are given below. The schedules are not exhaustive, but serve to highlight unacceptable actions and defaults which are more commonly encountered.

3.1 The Employer

The Employer should, himself, or through his officials, or agents:

- 3.1.1 Not invite tenders without having a firm intention to proceed with the procurement.
- 3.1.2 Ensure that the basis on which tenders will be adjudicated is clearly set out in the tender documents and that tenders are adjudicated and awarded accordingly.
- 3.1.3 Ensure that the tender documents are clear and comprehensive and set out the rights and obligation of all parties.
- 3.1.4 Not breach the confidentiality of information, particularly intellectual property, provided by Tenderers in support of their tenders.
- 3.1.5 Not attempt to "trade off" Tenderers against each other in an attempt to obtain better offers.
- 3.1.6 Ensure that all Tenderers are fairly treated and that tenders are adjudicated without bias.
- 3.1.7 Ensure that, except when extra ordinary circumstances dictate otherwise, transparency is maintained in the tendering process. This implies, *inter alia*, inviting tenders as widely and publicly as possible, opening tenders in public and reading out/ making available key information, such as tender prices, basic award criteria and times required for completion, and, in due course, making known to unsuccessful Tenderers the outcome of the adjudication process.
- 3.1.8 Ensure that his/her obligations in terms of contracts with Contractors and Consultants are scrupulously and timeously met, particularly in regard to making payments and giving decisions.

3.2 Officials

An Official should:-

- 3.2.1 Strictly observe all code of conduct laid down by the Employer.
- 3.2.2 Ensure that he is not responsible for an unacceptable action, or default, being attributed to the Employer.
- 3.2.3 Not allow himself/herself to be influenced in the execution of his/her duties by any consideration other than the legitimate and reasonable interests of the Employer.
- 3.2.4 Not accept any gifts, favours or other considerations, of anything more than token value from any other party to the procurement process.
- 3.2.5 Administer contracts in an even-handed manner.
- 3.2.6 Disclose any circumstance which may possibly be construed as constituting a conflict of interest and excuse himself/herself from deliberations in such matters

3.3 Agents

An Agent should, insofar as is relevant, act in the same way as the Official is expected to act in terms of Section 3.2.

3.4 Consultants

A Consultant should:

- 3.4.1 Strictly observe the code of conduct laid down by the body governing his/her profession.
- 3.4.2 Act in an impartial manner towards all other parties in the procurement process and take account of the legitimate and reasonable interests of them all.
- 3.4.3 Not accept gifts, favours or other considerations, of anything more than token value from any other party to the procurement process.
- 3.4.4 Not undermine the development objectives of the Employer through tokenism, fronting or any other misrepresentation.
- 3.4.5 Disclose any circumstance which may possibly be construed as constituting a conflict of interest and excuse himself/herself from deliberations in such matters.

3.5 Tenderers

A Tenderer should:

- 3.5.1 Not, except for the purpose of joint venture formation, become involved in collusion with other Tenderers, or potential Tenderers.
- 3.5.2 Not exchange information regarding tenders with any other Tenderer prior to the closing date for tenders.
- 3.5.3 Not knowingly price his/her tender in such a way as to gain an unfair advantage from an obvious error, or oversight, in the tender documents.
- 3.5.4 Not attempt, in any way, to influence the tender adjudication process.
- 3.5.5 Not approach any Representative or Official directly in connection with a tender, subsequent to the closing of all tenders.
- 3.5.6 Tenders only on projects for which they are capable of executing with the resources they are able to marshal in accordance with the terms and conditions of contracts.

3.6 The Contractor

The Contractor should:

- 3.6.1 Undertake the contract with the objective of fulfilling it in accordance with the needs of and in the best interests of the Employer and, in pursuit of this objective, co-operate with all other parties in the procurement process.
- 3.6.2 Aim to meet all statutory and contractual obligations fully and timeously in regard to, inter alia, conditions of employment, occupational safety, training, employment of subcontractors and fiscal matters.
- 3.6.3 Not attempt to influence the judgement, or actions, of Consultants, Officials/Agents, or Representatives by inducements of any sort.
- 3.6.4 Employ Subcontractors only on the basis of fair, unbiased, written subcontracts.
- 3.6.5 Not engage in unfair, or unethical, practices in order to drive subcontract prices down.
- 3.6.6 Not make unwarranted claims for additional payment, or time, in the belief that "nothing venture, nothing gain".
- 3.6.7 Not approach any Representative directly in connection with a contract.
- 3.6.8 Not undermine the development objectives of the Employer through tokenism, fronting or any other misrepresentation.

3.7 Subcontractors

A Subcontractor should, insofar as is relevant, act in the same way as the Contractor is expected to act in terms of Section 3.6.

3.8 Representatives

A Representative should:

- 3.8.1 Perform his duties in an unbiased and conscientious manner, bearing in mind the legitimate interest of all parties to the procurement process and the public.
- 3.8.2 Not entertain representations, except through the Employer or such person as may be delegated by the Employer, from any Consultant, Tenderer, Contractor, or Subcontractor, in regard to a tender, or contract.
- 3.8.3 Not allow himself to be unduly influenced by, or accept any gifts, favours or other considerations from any party which might have an interest in the procurement process.
- 3.8.4 Disclose any circumstance which may possibly be construed as constituting a conflict of interest and excuse himself/herself from deliberations in such matters.

3.9 Penalties

Where there is non-compliance with this code of conduct, sanctions and/penalties will be applied as follows:

3.9.1 Officials and Representatives

Reference to the Multi-Disciplinary Team in the first instance and thereafter, appropriate action by Management, if applicable.

3.9.2 Contractors/suppliers

Depending on the severity of the non-compliance, a contractor/supplier may be disqualified as a registered contractor/supplier for a period of not less than six months. Over and above that financial penalties may be imposed in terms of the Conditions of Contract.

ETHEKWINI MUNICIPALITY

ETHEKWINI WATER AND SANITATION

DEPARTMENTAL SPECIFICATION

FOR STEEL PIPES

100mm TO 2 000mm NOMINAL DIAMETER

STPIPE v13: DATED 2017-04-28

REVISIONS

Version No.	Section(s)	Clause(s)	Information
STPIPEv13	Rigid Polyurethane Coating	Table PCS5.2	Item 4: Corrected Frequency
	2 Layer PE Coating	PSC7 PSC7.2 Table 7.2	Amended Title Amended incorrect table reference Item 2: Corrected Requirement & Test Method
	2 Layer GRE Coating	PSC8	Added section "PSC8: Two Layer Glass-fibre Reinforced Epoxy (GRE)/Visco-elastic Polyisobutene Coating System"
STPIPEv12	Plant	A.4.3	Corrections to Repair of damage to coating/lining references
	2 Layer PE Coating	PSC7	Visco-elastic Polyisobutene (2LPE) Coating added
STPIPE v11	Tolerances & Testing	A6, A7	Updates SANS references
STPIPE v10	Rigid Polyurethane	PSC5.3	Mixing ratio of 1:1 added

INDEX TO PART A : STEEL PIPES 100MM TO 2 000MM NOMINAL DIAMETER
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PART A : STEEL PIPES 100mm TO 2 000mm NOMINAL DIAMETER

A.1 SCOPE

This specification covers the material and manufacturing requirements for electric welded low carbon steel pipes in sizes 100mm to 2 000 mm nominal diameter to be buried in soil and to be used for the conveyance of potable water. The pipes shall be internally lined and externally coated with systems selected from Appendices A to D. The requirements of SANS 1217 'Guidelines for internal and external organic coating protection for buried pipelines' shall apply to all coating and lining activities. Where there is conflict between this document and the SANS specification, the requirements of this document will prevail.

A.2 INTERPRETATIONS

A.2.1 Supporting Specifications

Reference to Standard Specifications and Codes of Practice shall be deemed to be references to the latest issues or amendments of the relevant Specifications and Codes at the time of tender.

Any reference to a South African Standard shall be deemed to include approved equivalent International Standards. Copies of the South African National Standards specifications (S.A.N.S.) can be obtained from:

S A Bureau of Standards
Private Bag X191
PRETORIA 0001
SOUTH AFRICA

- S.A.N.S.62-1 Steel Pipes Part 1: Pipes suitable for threading and of nominal size not exceeding 150 mm.
- S.A.N.S.62-2 Steel Pipes Part 2: Screwed pieces and pipe fittings of nominal size not exceeding 150 mm.
- S.A.N.S.719 Electric welded low carbon steel pipes for aqueous fluids (large bore)
- S.A.N.S.1083 Aggregate from natural sources – Aggregate for concrete
- S.A.N.S.1117 Plastic wrappings for the protection of steel pipelines.
- S.A.N.S.1217 Guidelines for internal and external organic coating protection for buried pipelines.
- S.A.N.S.1224 Polish stripper.
- S.A.N.S.1365 Solvent degreaser that contain chlorinated hydrocarbons.
- S.A.N.S.2808 Paints and Varnishes – Determination of film thickness
- S.A.N.S.5767 Cleanliness of blast-cleaned steel surfaces for painting (assessed by pictorial standards)
- S.A.N.S.5769 Cleanliness of blast-cleaned steel surfaces for painting (assessed by freedom from dust and debris)

S.A.N.S.5772 Profile of blast cleaned steel surfaces for painting (determined by micrometer profile gauge)

S.A.N.S.5863 Concrete Tests – Compressive strength of hardened concrete.

S.A.N.S.10129 Plastic tape wrapping of steel pipelines.

A.S. 4321 (Australian Standard) Fusion-bonded medium-density polyethylene coating and lining for pipes and fittings – 1995

ASTM D2370-82 Tensile Properties of Organic Coatings.

ASTM D2240 Standard Test Method for Rubber Property (Durometer Hardness)

ASTM D4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

ASTM D5162 Standard practice for discontinuity (holiday) testing of nonconductive protective coating on metallic substrates

ASTM G8 Standard Test Methods for Cathodic Disbonding of Pipeline coatings.

ASTM G14 Direct and Reverse Impact

BS 3900 Part F3 Resistance to artificial weathering (enclosed carbon arc)

BS 3900 Part F4 Resistance to continuous salt spray.

CAN/CSA-Z245.20-02 (National Standards of Canada) External Fusion Bond Epoxy Coating for Steel Pipe.

CAN/CSA-Z245.21-02 (National Standards of Canada) External Polyethylene Coating for Pipe.

GBE/CW6: Part 1 (British Gas) Requirements for Coating Materials and Methods of Test

ISO 4624 Paints and varnishes – Pull off test for adhesion

ISO 8501-1 Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness.

NACE RP0394 Application, Performance, and Quality Control of Plant-applied, Fusion-Bonded Epoxy External Pipe Coating

A.2.2 Application

The pipes supplied are to be used for the transportation of potable water and shall be internally lined and externally coated with systems selected from Appendices A and B respectively. The length, size, wall thickness, grade of steel and type of lining and coating required shall be as detailed in the schedule of technical requirements which forms part of these tender documents.

A.2.3 Terminology

For the purposes of this contract the client is defined as being eThekwini Water and Sanitation.

Reference made to the "Head: eThekwini Water and Sanitation " shall also imply any official appointed by eThekwini Water and Sanitation.

Whenever the terminology "approved by eThekwini Water and Sanitation", "to the satisfaction of eThekwini Water and Sanitation", etc., is used, it shall also imply that such work is to the satisfaction and approval of an independent inspectorate body appointed by the eThekwini Water and Sanitation to carry out Quality Assurance on any materials and goods covered by this contract.

A.3 MATERIALS

A.3.1 Steel

Steel from which the pipes are to be manufactured shall comply with clause 3 of S.A.N.S. 719, API Line Pipe Specification or an equivalent International Standard and shall be one of the following grades:

- i) Grade X -42
- ii) Grade X -52
- iii) Grade X -65

The Contractor shall, if required by the Head: Water and Sanitation, provide certificates covering the chemical analysis and physical properties of the steel used in the manufacture of the pipes.

A.3.2 Internal Linings

Appendix A lists the approved internal lining systems. Appendix B contains the specification details for each system.

A.3.3 External Coatings

Appendix C lists the approved external coating systems. Appendix D contains the specification details for each system.

A.4 PLANT

A.4.1 General

As this contract includes not only the manufacture of the pipes but also their delivery, off-loading and stacking, it is of prime importance that the pipes and the protective systems are not damaged. Any damaged pipes may be rejected or acceptance by eThekwini Water and Sanitation may be withheld until such damages are reinstated to the full satisfaction of the Head: eThekwini Water and Sanitation.

A.4.2 Handling

Coated pipes shall be moved with the use of padded slings of width sufficient to prevent damage to the coating. Chain slings, hooks, wire ropes, rope slings without canvas covers, composition belt slings with protruding rivets, and any other equipment liable to damage the coating shall not be used. Lifting centres shall not be less than 6m apart. To ensure that coated pipes do not bear against each other whilst being transported, use shall be made of a resilient material as dunnage

which shall not disintegrate or deteriorate when exposed to the elements for prolonged periods. The pipes shall be stacked with a minimum clearance of 50mm between adjacent pipe walls.

The pipes shall be stacked in a manner that limits the loading on the lower layer of pipes. Any pipe showing permanent ovality due to surcharge loading shall be rejected. Stacking of smaller diameter pipes within larger diameter pipes will be accepted for unlined/uncoated pipes. This method of stacking will not be accepted for pipes which are lined and coated unless adequate dunnage is provided to prevent damage to the coating and lining. All ropes used for fastening shall be so padded as to prevent damage to the coating.

A.4.3 Off-Loading

The Contractor shall be responsible for off-loading the pipes at the pipe yard and shall ensure that the plant used shall be such that no pipe shell is over-stressed. Any pipes showing signs of damage to the coating are to be repaired as specified in the relevant lining/coating specification, where applicable - and such repaired surfaces "Holiday" tested prior to stacking.

All pipes are to be lifted with the aid of a "spreader" lifting beam and special care is to be taken to ensure that no damages occur to the pipe coatings by preventing the pipes from sliding on or hitting adjacent pipes.

Slings as specified in clause A.4.2 above shall be suitably rated for the loads to be handled and in good condition. The use of deteriorating and frayed slings is prohibited.

A.4.4 Storage

Dunnage as specified in clause A.4.2 shall also be used in the stacking of the pipes at the pipe yard on delivery, and the Contractor shall provide sufficient bags so that the pipes can be stacked a minimum of 300mm clear of the ground and do not touch each other. Pipes in 6m lengths shall be stacked with a minimum of 2 dunnage supports. Pipes in 9m and 12m lengths shall be stacked with a minimum of 3 dunnage supports (i.e. one support at each pipe end and one at midspan). Pipes in 18m lengths shall be stacked with a minimum of 4 dunnage supports (i.e. one support at each pipe end and one 6m from each pipe end). Stacked pipes shall have a minimum clearance of 50mm between adjacent pipe walls.

A.5 CONSTRUCTION

A.5.1 Steel Pipe

A.5.1.1 General

All pipes shall be manufactured in accordance with S.A.N.S. 719 (for pipes larger than 150mm nominal diameter) and in accordance with S.A.N.S. 62 (for pipes 150mm nominal diameter and smaller), and shall be coated and lined as detailed in the schedule of technical requirements and in accordance with the technical specification of the product manufacturer and the attached technical specification.

Wherever there is conflict of requirements of the eThekweni Water and Sanitation specification shall prevail.

A.5.1.2 Grade of Steel

All pipes larger than 150mm nominal diameter shall be manufactured from the grade of steel specified in the Schedule of Technical requirements and in accordance with S.A.N.S. 719 and all pipes 150mm nominal diameter and smaller in accordance with S.A.N.S. 62 and shall be medium class unless otherwise specified in the Schedule of Technical requirements.

A.5.1.3 Outside Diameter of Pipes

The following standard outside diameter of pipes shall be used:

Nominal Internal Diameter (mm)	Standard Outside Diameter (mm)
100	114
150	165
200	219
250	273
300	324
400	406
500	508
600	610
700	711
800	813
900	914
1 000	1 016
1 200	1 220
1 400	1 420
1 800	1 820
2 000	2 020

In order to match existing pipes, non-standard outside diameter pipes may be required as detailed in the schedule of technical requirements which forms part of this tender document.

A.5.1.4 Weld Reinforcement

The shape of welds shall be gently convex and the height of the weld reinforcement shall not exceed 1mm internally and 3mm externally. Undercuts, sharp protrusions, blowholes and discontinuity of reinforcement are not permitted.

All pipes of 200mm nominal diameter or less shall be scarfed.

A.5.1.5 End Preparation

All pipes up to and including 250mm nominal diameter shall have plain ends free from indentations and projections for a length of 150mm.

All pipes from 300mm nominal diameter up to and including 600mm nominal diameter shall have one end plain and one end belled as indicated in Fig.1 attached hereto. The inside diameter of the bell shall be 3mm larger than the outside diameter of the pipe.

All pipes over 600mm nominal diameter shall have their ends finished for butt welding with a width of root face 1,6mm (+ 0,8mm) and bevelled at an angle of 30° (+5 ° - 0 °).The ends shall be free of indentations and projections for a length of 50mm.

All pipe ends shall conform with the tolerances specified in clause A.6 of this specification.

A.5.1.6 Preparation of Pipes for Coating

The fabricator of the pipes shall ensure that each pipe complies with the following requirements:

- i) Weld splatter shall have been removed by chipping or grinding to a smooth surface flush with the surrounding steel.
- ii) Weld seams shall have a smooth contour, free from sharp edges, protrusions and undercuts.
- iii) Sharp edges and protrusions shall have been removed by grinding to a smooth radius of curvature of not less than 3mm.
- iv) The pipe shall have been approved for compliance with all the requirements for the pipe specification after completion of work required to comply with clauses (a) to (c) above.

A.5.1.7 Condition of Pipes

All pipes to be coated shall be in Rust Condition A to C of ISO 8501-1. Pipes in rust condition D will be rejected.

A.5.1.8 Length of Pipes

Pipes shall be 6m, 9m, 12m or 18m long as specified in the Schedule of Technical requirements. Should pipes be supplied in lengths which differ from those specified above, the total length to be ordered will be adjusted to a multiple of the nearest whole pipe length.

A.5.1.9 Marking

All pipes shall be clearly marked in characters not less than 40mm in height (for pipes 500 mm NB or larger) or not less than 25 mm in height (for pipes up to and including 450 mm NB), with the contract number, the nominal diameter and the plate thickness in durable yellow paint on a durable black background.

Steel pipes fabricated from material other than Grade B steel are to be marked externally with 50mm wide bands of enamel paint, (traffic yellow), both at the quarter and mid points of the pipe as follows:

- Grade X42 steel - one band
- Grade X52 steel - two bands
- Grade X65 steel - three bands

In addition to the above each pipe shall be marked, by hard stamping the contract number, the relevant item number and the pipe number onto the external face of each pipe. The information shall be stamped within 50mm of the pipe end and adjacent to the weld seam. On pipes from

300mm nominal diameter up to and including 600mm nominal diameter the information shall be stamped on the belled end.

e.g. WS.5482/ (Item Number)/(Pipe Number)

The characters shall not be less than 5mm in height.

A.5.2 Internal Linings

The internal linings shall be applied in strict accordance with the requirements specified for each generic system in Appendix B.

A.5.3 External Coatings

The external coatings shall be applied in strict accordance with the requirements specified for each generic system in Appendix D.

A.6 TOLERANCES

The required tolerance and method of measurement shall be as described in Sections 5 and 6 of S.A.N.S 719. The natural sagging of the pipe shall be calculated using the empirical Mannesmann formula:

$$\text{Natural sagging (h)} = \frac{Dm^4}{t^2} \times 1,312 \times 10^{-6}$$

where Dm = mean diameter

t = wall thickness

A.7 TESTING

A.7.1 Steel Pipe

The steel pipe shall be subject to all tests specified in terms of:

- i) clause 6 of S.A.N.S. 719 for pipes 200mm nominal bore and greater
- ii) clause 5 of S.A.N.S. 62 for pipe 150mm nominal bore and smaller.

All pipes shall be hydraulically tested in accordance with:

- i) clause 7.3 of S.A.N.S. 719 for pipes 200mm nominal bore and greater
- ii) clause 5.2 of S.A.N.S. 62 for pipes 150mm nominal bore and smaller

The hydraulic test pressure shall be in accordance with:

- i) clause 5.2.4 of S.A.N.S. 719 for pipes 200mm nominal bore and greater
- ii) clause 5.2 of S.A.N.S. 62 for pipes 150mm nominal bore and smaller

Hydraulic test certificates shall be provided for each pipe, the pipe number being indicated on the test certificates.

A.7.2 Internal Linings

The performance criteria and frequency of testing shall be as specified for each generic system in Appendix B.

A.7.3 External Coatings

The performance criteria and frequency of testing shall be as specified for each generic system in Appendix D.

A.7.4 Inspection of Manufacture and Material Delivery

A.7.4.1 Quality Control

The Contractor shall ensure that all materials used in the execution of the contract comply with the technical requirements specified.

The Contractor shall maintain accurate and up to date records of all materials, processes, process parameters and measurements necessary to ensure compliance with this specification.

A.7.4.2 Quality Surveillance

eThekwini Water and Sanitation may appoint an independent body to carry out Quality Surveillance on its behalf. The Contractor shall provide all facilities and access to premises at all reasonable times as may be necessary for the independent inspectorate to carry out its function. The cost of Quality Surveillance shall be borne by eThekwini Water and Sanitation, except for surveillance resulting in rejection or a fruitless call when the cost incurred will be back charged to the Contractor.

Advance notice of a minimum of 24 hours shall be given by the Contractor to the appointed inspectorate body when requesting inspection of any portion of the goods for acceptance, and a minimum of 3 working days before commencement of the contract.

The Contractor's quality control records shall be available for inspection at all times. Copies of these records shall be made available on request.

Notwithstanding any surveillance carried out by eThekwini Water and Sanitation or its appointed representative, the Contractor shall retain full responsibility for the quality of the goods supplied under the contract.

All pipes shall be inspected on delivery to eThekwini Water and Sanitation stores and all defects shall be made good by the Contractor at his expense.

A.8 MEASUREMENT AND PAYMENT

No payment shall be made until satisfactory test certificates have been provided. Such certificates shall be posted under separate cover and not dispatched with the deliveries of pipes.

APPENDIX A: **APPROVED INTERNAL LINING SYSTEMS**

Specification Number	Lining Type	Page No
PLS 1	Solvent free liquid epoxy lining	13
PLS 2	Cement mortar lining	20

APPENDIX B: SPECIFICATION DETAILS FOR INTERNAL LININGS

PLS 1: Solvent Free Epoxy Lining System

PLS1.1 Approval of Supplier

The epoxy lining shall be a solvent free liquid epoxy, Copon Hycote 162 PW, Sigmalining SF23 (7623), Pipecoat SF or a similar approved liquid epoxy lining. The approved supplier shall be S.A.N.S. 9001 certificated.

The brand type or grade, and the supplier of the solvent free liquid epoxy to be used shall be approved in writing by eThekwini Water and Sanitation. To obtain approval, the supplier shall:

- i) provide independent test results in writing that demonstrate that the proposed lining material is capable of meeting the requirements specified in Table PLS1.1.
- ii) provide an Infrared Scan fingerprint for the material to be retained as a standard for comparison for all subsequent batches supplied to eThekwini Water and Sanitation.

To maintain their approved status, suppliers will carry out the above tests on an annual basis and submit their results to eThekwini Water and Sanitation for approval.

PLS1.2 Approval of Batches

Each batch of epoxy paint to be used by the applicator shall be approved by eThekwini Water and Sanitation before use. No change in formulation of the liquid epoxy is permitted without prior approval of eThekwini Water and Sanitation. Such approval shall not exonerate the Contractor from the due performance of the paint systems in terms of this specification.

The manufacturer shall supply Quality Control Certificates and Infrared Scan fingerprints for each batch of material supplied. The Quality Control Certificates shall include results of tests carried out in accordance with the manufacturer's approved procedures. The number of epoxy paint batches shall be kept to a minimum so as to avoid excessive costs being incurred with the Quality Control testing required prior to application of the products.

Pipes lined with epoxy paint products that have not been approved by eThekwini Water and Sanitation may be rejected.

PLS1.3 Preparation and Cleaning of Pipe

i) Degreasing

Pipes shall be degreased internally (and externally) by the use of an approved water rinsable solvent degreaser or by passing the pipes over gas burners to carbonise contaminants.

Abrasive used for blast cleaning shall be free from oil or grease, as shall be the compressed air used in air blast cleaning.

ii) Blast Cleaning

The interior surface of the pipe shall be blast cleaned by centrifugal or air blast cleaning methods, then vacuum cleaned or blown off to achieve the following standards:

- a) Cleanliness shall be equal to Sa3 of ISO 8501-1 when tested in accordance with S.A.N.S. Method 767.
- b) The profile produced by blast cleaning shall be angular and shall have an average peak to valley height of 50 to 100 micrometers (or as recommended by the approved supplier), when tested in accordance with either S.A.N.S. 5772 or Testex Replica Tape.

Hackles shall be removed with coarse abrasive paper.

- c) Residual dust and debris shall not exceed 0,2% when tested in accordance with S.A.N.S. 5769.
- d) Water soluble salts shall not exceed 100mg/m² at any point when tested with the Weber-Reilly Reagent.
- e) Any laminations revealed by blast cleaning shall be ground out and reblast cleaned to meet the requirements given in (a) to (d) above. If grinding penetrates the steel to a depth greater than 8% of the nominal wall thickness, the pipe shall be rejected.

iii) Handling of Cleaned Pipe

After cleaning, the pipe surface shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces in contact with the pipe surface shall be clean and free from oil, grease, grit, dirt and other contamination.

iv) Cut Back of Lining

The blast cleaned surface shall be stopped off or cut back by suitable masking which shall not contaminate the cleaned surface, to 50mm from both ends of the pipe.

v) Protection of Uncoated Pipe Ends

All pipe surfaces left unlined due to cut back of the solvent free liquid epoxy lining shall be painted with an approved weldable vinyl butyral etch primer to a dry film thickness of 15 to 25 micrometers. This coating shall overlap the lining by 20mm.

PLS1.4 Application of Lining

i) Method of Application

The two components shall be thoroughly and completely mixed in the proportions specified by the manufacturer. Application shall be by dual feed hot airless equipment or by single component airless equipment, as appropriate and as recommended by the

material manufacturer. The lining shall be applied in a uniform manner and, when cured, shall comply with all the appropriate requirements of the specifications.

The specified thickness shall be achieved in one application for solvent free epoxies. In the event of the thickness being less than the minimum specified the lining shall be removed and the pipe length shall be reblasted and relined to comply with the specification.

The specified thickness may be achieved in multicoat applications for solvent borne epoxies. When more than one coat is applied, the time interval between coats shall be not less than the minimum, nor greater than the maximum specified by the manufacturer and appropriate to the pipe surface temperature.

Applicators are recommended to measure wet film thickness at the time of application to avoid rejection or recoating when the dry film thickness is outside the specified limits of the specification.

ii) Thickness of Lining

The pipes shall be lined to a dry film of a minimum of 300 and a maximum of 500 micrometers with a solvent free liquid epoxy as specified.

iii) Cut Back of Lining

The lining shall be cut back as specified in clause PLS1.3(iv).

iv) Repairs

Repairs of electrical insulation defects may be carried out provided that the number of repairs necessary does not exceed 20 per 12 metre length of pipe.

A cluster of pinholes within a radius of 25mm shall be regarded as one defect.

Any pipe needing repairs in excess of the number given above or where the lining shows any sign of flaking or loss of adhesion shall not be repaired. The lining shall be removed and the pipe length shall be reblasted, cleaned and recoated to comply with the requirements of the specification.

v) Method of Repair

When repairs are permissible, the following method shall be used.

a) Abrade an area at least 25mm diameter around and beyond the defective area.

The abrasive paper shall not be coarser than 220 mesh but preferably 400 mesh. It shall preferably be used wet to avoid excessive removal of coating.

The repair area shall be smoothly feathered into the surrounding sound area. The repair area shall be abraded to a matt finish, free from deep scratches and excessive removal of coating.

After abrasion, the area shall be wiped clean with M.E.K. or other suitable clean solvent and allowed to dry.

- b) Repair material shall be solvent free epoxy repair material sourced from the supplier of the lining being repaired and approved by the eThekweni Water and Sanitation. The colour shall differ from the colour of the epoxy lining. It shall be thoroughly mixed in the correct proportions as recommended by the supplier. The materials shall be sufficiently thixotropic that 500 micrometres dry film thickness can be achieved in one application without sagging. If this requirement is not achieved, the material shall be rejected.
- c) Repair material shall be mixed in the proportions supplied by the manufacturer. No splitting of packs shall be permitted unless the material is supplied in self metering packs.

The mixed repair material shall be applied to the clean, dry, abraded repair area so as to cover the defect and extend to within 1 or 2mm of the edge of the abraded area. A "halo" of abraded area shall be visible around the repair material.

- d) After curing, the repair and at least 250mm surrounding area shall be tested for electrical insulation defects as specified in the contract. There shall be no electrical insulation defects.

PLS1.5 Performance Criteria

The applied solvent free lining shall comply with all the requirements given in TABLE PLS1.1.

PLS1.6 Frequency of Testing

Tests 1 to 3 of TABLE PLS1.1 shall be applied to each and every pipe.

Tests 4, 5(a) and 6 shall be applied to at least one pipe selected at random from the first day's production or from each batch of liquid epoxy, whichever is more frequent.

Tests 5(b) shall be applied to at least one pipe or sample panel from each lining application run. A lining application run is defined as the continuous operation of the twin feed airless spray equipment from start-up to shut-down.

TABLE PLS1.1: REQUIREMENTS OF CURED SOLVENT FREE EPOXY LINING

PROPERTY	REQUIREMENT	TEST METHOD
1. Visual	Smooth glossy or semi glossy finish, free from excessive runs, sags, orange peel, occlusions or other visible defects	Use an experienced observer. Runs may not exceed 600 micron in thickness.
2. Coating Thickness	Min. 300 Max 500 microns Thickness readings outside this range will be assessed in terms of S.A.N.S. 1217 Clause 5.1.2. using a $\pm 20\%$ criteria	S.A.N.S. Method 141. Take a minimum of 2 readings per m ² of surface up to 300mm nominal dia., or 1 reading per m ² over 300mm.
3. Electrical Insulation Defects	Lining: Nil defects at 90 Volts, 2 MegaOhm	S.A.N.S. 1217 Section 8.12.1
4. Impact Resistance	No defect at 1 Joule	S.A.N.S. 1217 Section 8.7 but modified as given in Note 1 below
5. Degree of Cure: (a) Static Test (b) Dynamic Test	No softening or discolouration when fully cured No softening or discolouration when fully cured	S.A.N.S. 1217 Section 8.9. Cure time shall be in accordance with the manufacturer's data 50 double rubs with cotton wool swab soaked in MEK. Cure time shall be in accordance with the manufacturer's data See Note 2 below.
6. Adhesion (Hot water soak)	Disbonded length not to exceed 15mm from point of V	Immerse in water at 75° C for 48 hr. Remove and make V-cut at 30 degree angle. Test adhesion when cooled to 25 ° C See Note 3 below.

NOTE 1:

Impact resistance shall be carried out on a sample of production pipe firmly clamped and chocked (to be rebound free) to a rigid base. No electrical insulation defects shall be detected at the point of impact when tested at 1 Joule.

NOTE 2:

The Degree of Cure - Dynamic Test is required to confirm that the lining applied to the pipe has the correct ratio of base to curing agent as determined by the settings on the twin feed airless spraying equipment. An >off-ratio mix produces a defective lining. To enable this test to be carried out timeously, sample panels (See Note 3 below) with a maximum coating thickness of 250 micron may be force cured at 60°C for 4 hours, allowed to cool to ambient temperature, and then tested.

NOTE 3:

Tests to be carried out on a coupon cut from the pipe or a certified test panel coated during the same lining application run as the pipe. Additional tests may be required at the discretion of eThekweni Water and Sanitation.

PLS 2: Cement Mortar Lining System

PLS2.1 Cement-Mortar Lining

Cement shall comply with S.A.N.S. 471 while the aggregate shall comply with S.A.N.S. 1083 in respect of organic impurities and dust content.

PLS2.2 Thickness of Lining

- | | | |
|----|---|--------|
| a) | Pipes up to and including 150mm nominal diameter: | 6mm |
| b) | Pipes greater than 150mm nominal diameter up to and including 300mm nominal diameter: | 10mm |
| c) | Pipes greater than 300mm nominal diameter up to and including 600mm nominal diameter: | 12,5mm |
| d) | Pipes greater than 600mm nominal diameter up to and including 1 200mm nominal diameter: | 19mm |
| e) | Pipes greater than 1 200mm nominal diameter: | 25mm |

PLS2.3 Cut Back of Lining

For diameters up to and including 250mm the lining shall run the total length of the pipe and shall finish square with the end of the pipe.

For diameters from 300mm up to and including 600mm (i.e. belled end pipe), the lining shall be stopped-off flush with the plain end and at the start of the bell section as indicated in Fig. 1. attached hereto.

For diameters of 700mm and larger the lining shall be stopped-off or cut back 50mm from the ends of the pipe.

PLS2.4 Protection of Uncoated Pipe Ends

All pipe surfaces left unlined due to cut back of the cement-mortar lining shall be painted with an approved weldable vinyl butyral etch primer to a dry film thickness of 25 micrometres.

PLS2.5 Cleaning of Pipe

All surfaces to be cement mortar lined shall be cleaned as follows:

- a) Weld spatter shall be removed by chipping or minimal grinding or both.
- b) Gross deposits of grease and oil shall be removed by scraping and wiping with cloths soaked in white spirit or a similar solvent.
- c) The pipe shall be degreased internally by the use of a water rinsable solvent degreaser such as that complying with S.A.N.S. 1244 or, for use in enclosed systems, with S.A.N.S.

1365. After complete removal of oil or grease contamination, the pipe shall be thoroughly washed with clean potable water to remove all residues. The surface shall be water break free.

PLS2.6 Mixing of Cement-Mortar

The ratio of cement to aggregate shall be 1:2 by mass or richer. The water cement ratio shall be approximately 45:100. Only clean fresh water shall be used, and the cement-mortar shall be free from all foreign matter. Only freshly mixed concrete shall be used. The maximum size of aggregate shall not exceed one third the thickness of the lining. The mortar shall be mixed in batches and shall be placed within 1 hour from the time of discharge from the mixer. Re-tempering by the addition of water or other material will not be permitted.

From each batch of cement-mortar, three 150mm test cubes shall be prepared, the cubes being thoroughly vibrated, in accordance with S.A.N.S. Method 863.

When tested after 28 days curing, the compressive strength shall not be less than 30 MPa.

PLS2.7 Lining of Pipe

The cleaned pipe shall be lined by either drag trowel or spinning methods. The resultant lining shall be smooth and of uniform thickness not less than that specified in clause A.5.3.1.

The Contractor shall take whatever measures are necessary to compensate for any bow along the pipe which will give rise to variation of lining thickness greater than the permissible tolerance (see Clause A.5.3.8)

PLS2.8 Curing of Cement-Mortar

After lining, the pipes shall be closed with approved waterproof end caps or similar means and the pipe shall be left undisturbed for 48 hours for the cement mortar to set.

After 48 hours the lining shall be sprayed with water, and shall be kept moist for 7 days. Pipes shall not be dispatched within 7 days of the date of applying the lining.

During the application and the curing of the cement-mortar lining, the pipes shall be kept covered or protected from direct sunlight to avoid "baking" of the mortar lining and the formation of excessive shrinkage cracks and disbondment.

PLS2.9 Appearance and Quality

Cement-mortar linings shall be smooth and even. The thickness tolerance shall be within ± 3 mm for pipe 100mm up to and including 250mm diameter and ± 4 mm for pipe larger than 250mm nominal diameter.

All defects such as substandard surface finish, thin spots, cracking as a result of impacts and spalling shall be cut out and replaced to the full required thickness of the lining.

Temperature and shrinkage cracks in the mortar lining less than 1,5mm in width need not be repaired. Cracks wider than 1,5mm shall be chipped back and the lining replaced to the full required thickness.

PLS2.10 Reinforcing

No reinforcing mesh will be required for the cement-mortar lining of pipes up to and including 1 000mm diameter unless specifically called for in the Special Conditions of Contract.

Cement-mortar lining to pipes of diameter greater than 1 000mm shall be reinforced by means of a welded or woven steel wire mesh.

The wire shall be 3mm in diameter and spaced at 100mm centres both ways.

The reinforcing shall be secured by adequate tack welding to the pipe to ensure that it is not displaced during the lining procedure.

APPENDIX C:**APPROVED EXTERNAL COATING SYSTEMS**

Specification Number	Coating Type	Page No
PCS 1	Fusion bonded epoxy powder	22
PCS 2	Fusion bonded medium density polyethylene powder	29
PCS 3	Bitumen/polyolefin sleeve duplex coating	36
PCS 4	3 Layer polyethylene pipe coating system	39
PCS 5	Rigid polyurethane coating	46
PCS 6	Polyamide 11 (Nylon 11) thermoplastic lining and coating for 100 to 300 mm piping	50
PCS 7	Two layer Polyethylene / Visco-elastic Polyisobutene Coating system (2LPE)	54
PCS 8	Two layer Glass-fibre Reinforced Epoxy / Visco-elastic Polyisobutene Coating system (2LGRE)	60

APPENDIX D: SPECIFICATION DETAILS FOR EXTERNAL COATING SYSTEMS

PCS 1: Fusion Bonded Epoxy Powder

PCS1.1 Approval of Supplier

The epoxy coating shall be a fusion bonded epoxy powder coating, Interpon PCL 331, Vedoc VPC 2001, BASF Basepox PE50-1080 or a similar approved fusion bonded epoxy powder.

The brand type or grade, and the supplier of the powder to be used shall be approved in writing by eThekwini Water and Sanitation. To obtain approval, the supplier shall provide independent test results in writing that demonstrate that the powder is capable of meeting the requirements 1 to 20 specified in Table PCS1.1. Following initial approval, eThekwini Water and Sanitation reserves the right to have any or all of the tests repeated on an annual basis in order to confirm that formulation changes have not been made.

PCS1.2 Approval of Batches

Each batch of powder supplied to the applicator shall be approved by eThekwini Water and Sanitation. No change in formulation of powder is permitted without prior approval of eThekwini Water and Sanitation. Such approval shall not exonerate the Contractor from the due performance of the coating system in terms of this specification.

The manufacturer shall supply Batch Conformance Certificates for each batch, which shall include results of tests 1, 2, 3, 4, 7, 8, 9, 10, 11, and 12 of Table PCS1.2. The number of batches shall be kept to a minimum so as to avoid excessive costs being incurred with the Quality Control testing required prior to application of the product.

Pipes coated with powder that has not been approved by eThekwini Water and Sanitation may be rejected.

PCS1.3 Preparation and Cleaning of Pipe

i) Degreasing

Pipes shall be degreased externally (and internally) by the use of a water rinsable solvent degreaser or by passing the pipes over gas burners to carbonise contaminants.

The pipes shall then be abrasive blast cleaned.

Abrasive used for blast cleaning shall be free from oil or grease, as shall be the compressed air used in air blast cleaning.

ii) Blast Cleaning

The exterior surface of the pipe shall be blast cleaned by centrifugal or air blast cleaning methods, then vacuum cleaned or blown off to achieve the following standards:

- a) Cleanliness shall be equal to Sa3 of ISO 8501-1 when tested in accordance with S.A.N.S. 5767. Cleanliness equal to Sa2½ will be allowed when recommended by the approved powder manufacturer and quoted in his Product Data Sheet.
- b) The profile produced by blast cleaning shall be angular and shall have an average peak to valley height of 40 to 90 microns (or as recommended by the approved supplier), when tested in accordance with S.A.N.S. 5772.
Hackles shall be removed with coarse abrasive paper.
- c) Residual dust and debris shall not exceed 0,2% when tested in accordance with S.A.N.S. 5769.
- d) Water soluble salts shall not exceed 100mg/m² at any point when tested with the Weber-Reilly Reagent.
- e) Any laminations revealed by blast cleaning shall be ground out and reblast cleaned to meet the requirements given in (a) to (d) above. If grinding penetrates the steel to a depth greater than 8% of the nominal wall thickness, the pipe shall be rejected.

iii) Handling of Cleaned Pipe

After cleaning, the pipe surface shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces in contact with the pipe surface shall be clean and free from oil, grease, grit, dirt and other contamination.

iv) Cut Back of Coating

The blast cleaned surface shall be stopped off or cut back by suitable masking which shall not contaminate the cleaned surface as follows:

- a) All pipes up to and including 250mm nominal diameter - 100mm from both ends of the pipe.
- b) All pipes from 300mm nominal diameter up to and including 600mm nominal diameter - 50mm from the belled end of the pipe and 100mm from the plain end of the pipe. (See Fig. 1).
- c) All pipes larger than 600mm nominal diameter - 100mm from both ends of the pipe.

v) Protection of Uncoated Pipe Ends

All pipe surfaces left uncoated due to cut back of the fusion bonded epoxy powder coating shall be painted with an approved weldable vinyl butyral etch primer to a dry film thickness of 25 microns. This coating shall overlap the fusion bonded epoxy powder coating by 20mm.

vi) Chemical Treatment

Chemical pre-treatment of the blast cleaned pipe surface may be applied provided that:

- a) The process to be used is approved by eThekweni Water and Sanitation in writing.
- b) The process is applied in a manner and in such quantity as is specified by the manufacturer of the powder.

vii) Heating of the Pipe

Heating of the pipe shall be affected by heat soak in an oven or by the use of electric induction coils provided that:

- a) The pipe surface is not contaminated by fumes, soot deposition, acid deposits or other harmful contamination
- b) The pipe surface is not discoloured by excessive heat
- c) The surface temperature of the pipe is uniform and does not vary by more than $\pm 5^{\circ}$ C from optimum coating temperature when measured immediately prior to coating. Pipe temperature shall not exceed 275° C at any point.
- d) Infra red pyrometers shall be calibrated by measurement of pipe temperature by thermocouple, heat sensitive crayon or other approved method.

PCS1.4 Application of Coating

i) Method of Application

Powder shall be applied by electronic spray guns whilst the pipe is rotated and moved forward on a suitable conveyor. The number and grouping of the guns, distance from the pipe surface, angle of projection, air pressure, conveyor speed and other variables shall be determined by the Contractor to obtain a uniform application on each pipe such that the coating complies with the requirements of the specification.

Powder shall pass through a magnetic separator (which shall be regularly cleaned) in order to remove any iron or steel particles.

Powder reclaimed from the spray booth shall not be mixed with virgin powder. The normal in-process system for powder reclaiming is permitted to a maximum of 20% of virgin powder. Powder recovery during any cleaning process may not be introduced into the system.

The specified thickness shall be achieved in one application. In the event of the thickness being less than the minimum specified, the coating shall be removed and the pipe length shall be reblasted and recoated to comply with the specification.

ii) Thickness of Coating

The pipes shall be coated to a dry film of a minimum of 300 microns and a maximum of 600 microns with a fusion bonded epoxy powder.

iii) Cut back of Coating

The coating shall be cut back as specified in clause PCS1.3(iv)

iv) Handling of Coated Pipe

Coated pipe shall not touch the conveyor rollers until the coating has cured to a sufficient degree that contact with the rollers does not mark or damage the coating.

v) Quenching of the Coated Pipe

Quenching of the pipe with clean water is permitted provided that the coating is fully cured and complies in all respects with the requirements of the specification.

vi) Repairs

Repairs of electrical insulation defects may be carried out provided that the number of repairs necessary does not exceed 20 per 12 m pipe length.

A cluster of pinholes within a radius of 25mm shall be regarded as one defect.

Any pipe needing repairs in excess of the number given above or where the coating shows any sign of flaking or loss of adhesion shall not be repaired. The coating shall be removed and the pipe length shall be reblast, cleaned and recoated to comply with the requirements of the specification.

vii) Method of repair

When repairs are permissible, the following method shall be used.

a) Abrade an area at least 25mm diameter around and beyond the defective area.

The abrasive paper shall not be coarser than 220 mesh but preferably 400 mesh. It shall preferably be used wet to avoid excessive removal of coating.

The repair area shall be smoothly feathered into the surrounding sound area. The repair area shall be abraded to a matt finish, free from deep scratches and excessive removal of coating.

After abrasion, the area shall be wiped clean with M.E.K. or other suitable clean solvent and allowed to dry.

- b) Repair material shall be solvent free epoxy or polyurethane repair material approved by the eThekweni Water and Sanitation. The colour shall differ from the colour of the epoxy coating. It shall be thoroughly mixed in the correct proportions as recommended by the supplier.
- c) Repair material shall be mixed in the proportions supplied by the manufacturer. No splitting of packs shall be permitted unless the material is supplied in self metering packs.

The mixed repair material shall be applied to the clean, dry, abraded repair area so as to cover the defect and extend to within 1 or 2mm of the edge of the abraded area. A "halo" of abraded area shall be visible around the repair material.

- d) Pipes shall not be moved until the repair material is cured and sufficiently hard to withstand the pressure of the pipes on the ramps. Cure may be accelerated by heating with infra red lamps provided that the heat applied is insufficient to cause any damage to the surrounding coating.
- e) After curing, the repair and at least 250mm surrounding area shall be tested for electrical insulation defects as specified in the contract. There shall be no electrical insulation defects.

PCS1.5 Performance Criteria

The applied coating shall comply with all the requirements given in TABLE PCS1.2

PCS1.6 Frequency of Testing

Tests 1 to 3 of TABLE PCS1.2 shall be applied to each and every pipe.

Tests 4, 5, 6, and 7 shall be applied to at least one pipe selected at random from each powder application production run.

A production run is defined as the continuous operation of the FBE application plant from start-up to shut-down.

Additional tests may be required at the discretion of eThekweni Water and Sanitation.

TABLE PCS1.1: QUALIFICATION REQUIREMENTS FOR EPOXY POWDER

PROPERTY	REQUIREMENT	TEST METHOD
1. I.R. Spectrogram	For reference against contract supplies	Potassium Bromide disc
2. Thermal Characteristics	$\Delta T_g \pm 5^\circ\text{C}$	Differential Scanning Calorimetry 20° C/min scan rate
3. Gel Time at 180°C	26 to 32 seconds.	Hot plate
4. Particle Size Distribution	< 1% above 250 µm < 5% above 150 µm < 8% below 10 µm	Lazer Diffraction Analyser
5. Dielectric Strength	Not less than 30 V/µm	S.A.N.S. 1217 Section 8.10
6. Accelerated Cathodic Disbonding (48 hr)	Total disbonded area (including holiday) ≤ 10mm dia	GBE/CW6 Part 1 Appendix F, or CAN/CZA-Z245.20-M92: 12.8 Impressed current, - 3,5V potential at 65° C for 48 hr, 3mm dia. holiday
7. Hot Water Soak Adhesion Test	Disbonded length not to exceed 5mm from point of V	Immerse in water at 75 ° C for 48 hr. Remove and make V-cut at 30 degree angle. Test adhesion when cooled to 25° C
8. Flexibility Test	No electrical insulation defects after bending over mandrels: 300 mm @ 5°C 200 mm @ 20°C	GBE/CW6 Part 1 Appendix B
9. Impact Resistance	No electrical insulation defects after impact of 6 joules	ASTM G14 direct and reverse impact on 0,8 mm sheet.
10. Density	1,45 ±0,07 gm/cm ³	Mass divided by volume (g per ml) Volume determined by volumetric displacement using of a suitable solvent (white spirit) and a pycnometer.
11. Moisture Content	< 5% by weight	Mass loss of sample after 3 hours at 110°C.
12. Appearance	Free from pin-holes, blistering and cissing.	350 - 500 µm coating applied at to a pre-heated mild steel panel and visually assessed.
13. Sagging	No sagging.	350 - 500 µm coating applied at to a pre-heated vertical mild steel panel and visually assessed.
14. Hardness	F to mar.	Pencil Hardness.
15. Porosity of Coating	Rating 4	CAN/CZA-Z245.20-M92: 12.10 Figure 12.6
16. Tensile Strength and Elongation	50 MPa	ASTM D2370-82 Head speed 75mm/min
17. Water absorption (detached film)	< 3%	Water absorbed as weight gain after 3 months immersion at 20°C.
18. Strain Polarisation Cracking Test	No electrical insulation defects or disbonding	GBE/CW6 Part 1 Appendix G Bend at 20°C. Polarised @ -1,5 V for 28 days.
19. Salt Spray Resistance	No under film creep or blistering.	BS3900 F4, 1000 hrs
20. Artificial Weathering Test.	No deterioration, only superficial chalking	BS3900 F3, 1000 hrs

TABLE PCS1.2: REQUIREMENTS OF CURED FUSION BONDED EPOXY POWDER COATING

PROPERTY	REQUIREMENT	TEST METHOD
1. Visual	Smooth glossy or semi glossy finish, free from excessive runs, sags, orange peel, occlusions, lumps or other visible defects.	Use an experienced observer
2. Coating Thickness	Min. 300 Max 500 microns	S.A.N.S. Method 141. Take a minimum of 2 readings per m ² of surface up to 300mm nominal dia., or 1 reading per m ² over 300mm.
3. Electrical Insulation Defects	Nil defects at 3500 Volts. 20 repairs allowed per 12 m pipe length.	S.A.N.S. 1217 Section 8.12.2
4. Impact Resistance	No defect at 2 Joule	S.A.N.S. 1217 Section 8.7 but modified as given in Note 1 below
5. Degree of Cure: Thermal Characteristics	$\Delta T_g \pm 5^\circ\text{C}$	Differential Scanning Calorimetry 201C/min scan rate
6. Hot Water Soak Adhesion Test	Disbonded length not to exceed 5mm from point of V	Immerse in water at 75°C for 48 hr. Remove and make V-cut at 30° angle. Test adhesion when cooled to 25°C
7. Accelerated Cathodic Disbonding (24 hr)	Total disbonded area (including holiday) $\pm 10\text{mm}$ dia	GBE/CW6 Part 1 Appendix F, or CAN/CZA-Z245.20-M92: 12.8.3.5(c) Impressed current, - 3.5V potential at 65° C for 24 hr, 3mm dia. holiday

NOTE 1:

Impact resistance shall be carried out on a sample of production pipe. The inside of the pipe shall be supported by a wooden block fitted vertically across the internal pipe diameter and chocked so as to fit tightly and immediately beneath the point of impact. Damage to the coating shall be assessed by measuring electrical insulation defects at the point of impact. No defect is permitted after impact at 2 Joules. Alternatively, the test may be carried out on a sample cut from the pipe and rigidly supported beneath the point of impact.

PCS 2: Fusion Bonded Medium Density Polyethylene Powder

PCS2.1 Compliance

The medium density polyethylene powder shall comply with clause 4 -MATERIALS of A.S. 4321. A certificate of compliance with Clauses 4.2 and 4.3 shall be provided by the polyethylene compound manufacturer.

PCS2.2 Application

Fusion Bonded Medium Density Polyethylene powder shall be applied generally in accordance with this specification and the Australian Standard AS 4321 (1995). Where a discrepancy in requirements arises the eThekwin Water and Sanitation Specification shall take precedence.

PCS2.3 Preparation And Cleaning Of Pipe

i) Degreasing

Pipes shall be degreased as specified.

ii) Blast Cleaning

Pipes shall be blast cleaned to grade SA2½ .

iii) Handling of Cleaned Pipe

After cleaning, the pipe surface shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces in contact with the pipe surface shall be clean and free from oil, grease, grit, dirt and other contamination.

iv) Cut Back of Coating

The blast cleaned surface shall be stopped off or cut back by suitable masking which shall not contaminate the cleaned surface as follows:

- a) All pipes up to and including 250mm nominal diameter - 100mm from both ends of the pipe.
- b) All pipes from 300mm nominal diameter up to and including 600mm nominal diameter - 50mm from the belled end of the pipe and 100mm from the plain end of the pipe. (See Fig. 1).
- c) All pipes larger than 600mm nominal diameter - 100mm from both ends of the pipe

v) Protection of Uncoated Pipe Ends

All pipe surfaces left uncoated due to cut back of the coating shall be painted with an approved weldable vinyl butyral etch primer to a dry film thickness of 25 microns. This

coating shall overlap the fusion bonded epoxy powder coating by 20mm.

PCS2.4 Application of Coating

i) Method of Application

The coating shall be applied in accordance with clause 5 'COATING AND LINING APPLICATION' of AS 4321.

ii) Thickness of Coating

The pipes shall be coated to a minimum film thickness as follows:

Nominal pipe diameter (mm)	Coating thickness (mm)
$> 100 \leq 250$	1,6
$\geq 250 < 500$	1,8
$\geq 500 < 750$	2,0
≥ 750	2,3

iii) Cut Back of Coating

The coating shall be cut back in accordance with clause PCS2.3(iv).

iv) Repairs

Repairs of electrical insulation defects may be carried out provided that the number of repairs necessary does not exceed 3 per 9m pipe length (or equivalent pro rata number per pipe length). The area of any single repair shall not exceed 0,01m²

Where a pinhole is located it shall be repaired to produce a continuous coating. Damaged areas that pass the continuity test need not be repaired provided the coating thickness remains greater than or equal to 1,0 mm.

v) Method of Repair

When repairs are permissible, they shall be carried using one of the following methods:

- (a) Fusion bonded repairs.
- (b) Heat shrink sleeve repairs.
- (c) Hot gas welding repairs.
- (d) Repairs using pipeline wrapping system.

Methods (a), (b) and (c) shall be carried out in accordance with Clause 8 of AS 4321.

Method (d) shall be carried out as follows:

vi) Repairs Using Pipeline Wrapping System

a) Description

The Repair System comprises:

a polymer bitumen primer:

Denso Primer D or equivalent approved an inner seal of modified rubber bitumen sealing tape:

Denso Mastic Sealing Tape or equivalent approved an outer protective layer of acrylic coated/modified bitumen adhesive pipeline tape:

Denso Acrylic Pipeline Tape or equivalent approved

b) Cleaning Of Area To Be Repaired - Pinholes And Large Areas.

Grease and oil shall be removed with a suitable cleaning solvent.

At each repair section, the surrounding area shall be abraded to a minimum area of 175 mm x 175 mm in the case of pinholes or small defect areas.

The area is demarcated by using a suitable template 175 mm x 175 mm and tracing the perimeter with a marking pen. The marked area shall be abraded with emery paper 80 to 100 mesh, so as to provide a suitably rough surface profile without causing the removal of excessive amounts of coating material.

All debris, dust, grease and oil shall be removed with a suitable cleaning solvent by means of a clean rag or brush.

Immediately the solvent has flashed off, apply the polymer bitumen primer at a nominal coverage rate of 8m²/l by brush to the prepared surface in a uniformly thin film free of runs and sags, and allow to flash off for a minimum period of 15 minutes depending on ambient temperatures.

c) Tape Application - Pinholes

Once the polymer bitumen primer has dried, the prepared surface is then covered with a patch of modified rubber bitumen sealing tape 100 mm x 100 mm, followed by an outer patch of acrylic coated/modified bitumen adhesive pipeline tape 150 mm x 150 mm.

To ensure a bond free of voids and air bubbles, the tape is applied by firstly bonding the leading edge of the square and then smoothing out by thumbs or hand pressure in an outward direction. To ensure a perfect bond of the tape, roll out the entire area using an aluminium fluted roller.

d) Tape Application - Larger damaged areas

When repairing larger areas, the edges of the damaged coating must first be chamfered with a sharp Stanley knife or blade to remove potential void areas.

Pre-cut the correct sizes of modified rubber bitumen sealing tape and apply to the reclined and primed areas in weatherboard fashion with a 55% overlap to provide a double thickness of material, working up towards the crown of the pipe to ensure that overlaps are facing downwards.

Overwork by hand or finger pressure to ensure full bond is achieved and no air is entrapped.

Finally, apply pre-cut strips of acrylic coated/modified bitumen adhesive pipeline tape with a 25 mm overlap, ensuring that it is 50 mm wider on all sides of the inner repair tape.

Notes:

Where the pipe has been severely damaged in numerous areas, a full spiral circumferential wrap is recommended.

Maximum width of the inner modified rubber bitumen sealing tape and outer acrylic coated/modified bitumen adhesive pipeline tape should not exceed 150 mm.

Apply the tapes with sufficient tension to ensure full conformance to the shop coating, and stagger the spiral overlaps which should be no less than 50 mm.

Commence and end the wrapping/repair system by a minimum of 100 mm each side of the damaged sections.

PCS2.5 Performance Criteria

The coating material shall comply with all the requirements given in TABLE PCS2.1. The applied coating shall comply with all the requirements given in TABLE PCS2.2

PSC2.6 Frequency of Testing

Tests 1 to 7 and 9 to 11 of TABLE PCS2.1 shall be carried out on the first contract using this material and thereafter at intervals of no greater than five years and at any change in formulation or source of polyurethane compounds and at any change in the application process.

Test 8 of TABLE PCS2.1 shall be carried out on the first contract using this material and thereafter at intervals of no greater than one year and at any change in formulation or source of polyurethane compounds and at any change in the application process.

Tests 1 to 3 of TABLE PCS2.2 shall be carried out on every pipe.

Test 4 of TABLE PCS2.2 shall be carried out at a frequency of two per shift.

Test 5 of TABLE PCS2.2 shall be carried out on at least two pipes selected at random from each item.

Additional tests may be required at the discretion of eThekweni Water and Sanitation.

**TABLE PCS2.1: QUALIFICATION REQUIREMENTS FOR FUSION BONDED MEDIUM DENSITY
POLYETHYLENE POWDER COATING**

PROPERTY	REQUIREMENT	TEST METHOD
POLYETHYLENE COATING COMPOUND		
1. Thermal Stability	Melt flow index must not change by more than 35% after exposure to air at 100°C for 100 days	AS 4321, Appendix B
2. Water Absorption	≤0,1% when immersed in water at 23°C for 100days	AS 4321, Appendix C
3. Penetration Resistance	Compressive stress of 10 MPa: ≤0,15 mm penetration at 23°C ≤0,25 mm penetration at 70°C	AS 4321, Appendix D
4. Tensile Stress at Yield	≥ 15,0 MPa	AS 4321, Appendix E
5. Environmental Stress Cracking Resistance	F ₅₀ ≥ 100h	AS 4321, Appendix F
6. Density	≥ 920 kg/m ³ at 23°C	AS 4321, Clause 6.1.2.7
7. Impact Resistance	≥ 18,0 J	AS 4321, Appendix H (See Note 1)
8. Cathodic disbondment	Disbondment length ≤ 15 mm after 28 days	AS 4321, Appendix N
POLYETHYLENE REINSTATEMENT COMPOUND		
9. Water Absorption	≤0,2% when immersed in water at 23°C for 100days	AS 4321, Appendix C
10. Adhesion to Steel	Bond strength to steel ≥ 3,0 N/mm width of strip	AS 4321, Appendix I
11. Adhesion to polyethylene coating compound	Bond strength to polyurethane ≥ 3,0 N/mm width of strip	AS 4321, Appendix J

NOTE 1:

Impact resistance shall be carried out on a sample of production pipe. The inside of the pipe shall be supported by a wooden block fitted vertically across the internal pipe diameter and chocked so as to fit tightly and immediately beneath the point of impact. Damage to the coating shall be assessed by measuring electrical insulation defects at the point of impact. No defect is permitted after impact at 10 Joules. Alternatively, the test may be carried out on a sample cut from the pipe and rigidly supported beneath the point of impact.

**TABLE PCS2.2: REQUIREMENTS OF CURED FUSION BONDED MEDIUM DENSITY
POLYETHYLENE POWDER COATING**

PROPERTY	REQUIREMENT	TEST METHOD
1. Visual	Smooth finish, free from visible defect	Use an experienced observer
2. Coating Thickness	> 100 # 250mm dia. - 1,6mm > 250 < 500mm dia. - 1,8mm ≥ 500 < 750mm dia. - 2,0mm ≥ 750mm dia. - 2,3mm	ISO 2820 Method 5. Take a minimum of 2 readings per m ² of surface up to 300mm nominal dia., or 1 reading per m ² over 300mm. Thickness tolerance as per AS 4321, Clause 6.3.2
3. Continuity Test (Electrical Insulation Defects)	Nil defects at 12 kV For conditions of repair see clause A.5.5.2.(vii)	S.A.N.S. 1217 Section 8.12.2 Note: DC instrument to be used
4. Bond Strength	Bond strength to steel ≥ 3,0 N/mm width of strip.	AS 4321, Appendix M
5. Cathodic disbondment	Disbondment length ≤ 15 mm after 28 days	AS 4321, Appendix N

PCS 3: Bitumen/Polyolefin Sleeve Duplex Coating

PCS3.1 Approval of Supplier

The coating shall be a bitumen/polyolefin sleeve duplex coating, TOSAWRAP, or similar approved.

PCS3.2 Approval of Batches

All raw materials as compounded in the manufacturer's Quality Assurance Manual. A compliance certificate must be provided by each raw material supplier.

PCS3.3 Preparation And Cleaning Of Pipe

i) Degreasing

Pipes shall be degreased by passing a gas flame over the surface to carbonise any contaminants.

ii) Pipe Cleaning

Pipes shall be mechanically wire brushed to Grade St 2 of ISO 8501-1 and all rust and foreign matter removed by means of blowing with compressed air, or solvent wiping.

PCS3.4 Application of Coating

i) Inner Layer

The molten compound shall be hot poured onto the pipe surface and smoothed to the required thickness before it cools.

ii) Outer Layer

Once the sleeve is positioned over the full length of the pipe, the heat shrinking of the sleeve is commenced one end to eliminate the risk of air entrapment. The sleeve edge is trimmed from each side of the pipe before it is transferred to the pipe inspection table.

iii) Thickness of Coating

The pipe shall be coated to a minimum thickness as follows;

Inner layer	1,0mm
Outer layer	1,0mm
Overall thickness	2,0mm

iv) Method of Repairs

The area of a single repair shall not exceed 10mm². The repair shall be carried out using a compatible melt stick. The number of repairs shall not exceed 3 per 6 metre length of pipe.

v) Cut Back of Coating

The coating shall be cut back for a distance of 100mm to facilitate site welding.

PCS3.5 Performance Criteria

The coating material shall comply with all the requirements given in TABLE PCS3.1. The applied coating shall comply with all the requirements given in TABLE PCS3.2.

PCS3.6 Frequency of Testing

Tests 2 and 6 of TABLE PCS3.1 shall be carried out on the first contract using this material and thereafter at intervals of no greater than one year and at any change in formulation or source of sleeve and primer compounds and at any change in the application process.

Tests 1, 3, 4, 5 and 7 of TABLE PCS3.2 shall be carried out on the first contract using this material and thereafter at intervals of no greater than five years and at any change in formulation or source of sleeve compounds and at any change in the application process.

Tests 1 to 3 of TABLE PCS3.2 shall be carried out on every pipe.

Test 4 of TABLE PCS3.2 shall be carried out on every 100th pipe.

Additional tests may be required at the discretion of eThekweni Water and Sanitation.

**TABLE PCS3.1: QUALIFICATION REQUIREMENTS FOR BITUMEN/POLYOLEFIN SLEEVE
DUPLEX COATING MATERIALS**

PROPERTY	REQUIREMENT	TEST METHOD	FREQUENCY
1. Water absorption of sleeve	≤ 0,1% when immersed in water at 23°C for 100 days	S.A.N.S 1117	5 years
2. Cathodic disbondment of duplex system	Disbondment length ≤ 15 mm after 28 days	S.A.N.S 1117	Annually
3. Tensile strength of sleeve at yield	≥ 10 MPa	ASTM D 882	5 years
4. Tensile strength of sleeve at break	≥ 15 MPa	ASTM D 882	5 years
5. Elongation of sleeve at break	≥ 500%	ASTM D 882	5 years
6. Adhesion to steel of duplex system	Adhesion to steel > 2 N/mm	S.A.N.S. 1117	Annually
7. Density of sleeve	≥ 915 kg /m2	ASTM D1505	5 years

**TABLE PCS3.2: REQUIREMENTS OF APPLIED BITUMEN/POLYOLEFIN SLEEVE DUPLEX
COATING**

PROPERTY	REQUIREMENT	TEST METHOD	FREQUENCY
1. Visual	Free from visible defect	Observation	100%
2. Coating thickness	2,0 mm	Take a minimum of three readings per 6 mm pipe.	100%
3. Holiday test	Nil defects at 15 KV	S.A.N.S 10129	100%
4. Bond strength	$\geq 1,5$ N/mm width of strip (not temperature dependant)	In house	1 in 100

PCS 4: 3 Layer Polyethylene Pipe Coating System

PCS4.1 Approval of Supplier

The 3-layer polyethylene coating system consists of a powdered epoxy primer, a polymeric adhesive and a polyethylene outer sheath classified as System B1 in terms of the Canadian Standards Association specification Z245.21-02. The respective layers of the 3-layer system shall comprise of the following materials:

Fusion Bonded Epoxy primer:

Akzo Nobel	Akzo Nobel PCL 331 (or similar approved)
Jotun	Jotun CORRO-COAT EP-F 1003 HW (or similar approved)

Adhesive:

Borealis	Borcoat ME0420 (or similar approved)
Industrie Polieco M.P.B. SRL	Industrie Polieco Cohesive L8.92.8 (or similar approved)

High Density Polyethylene Outer Sheath:

Borealis	Borcoat HE3450 (or similar approved)
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NOTE:

Pipe is not laid (i.e. buried) immediately upon delivery but is generally stockpiled in exposed pipe yards for “free issue” at a later date or kept as stock for emergency use. As a result of this extended exposure of the polyethylene coating to effect of UV it will be a requirement that the supplier of the coating provide written proof to the City Council that the polyethylene product to be used in the High Density Polyethylene Outer Sheath contains a **minimum of 2% finely dispersed carbon black.**

PCS4.2 Approval of Batches

Each batch of materials supplied to the applicator shall be approved by eThekwini Water and Sanitation. No change in formulation of the materials is permitted without prior approval of eThekwini Water and Sanitation. Such approval shall not exonerate the Contractor from the due performance of the coating system in terms of this specification.

The manufacturers shall supply Batch Conformance Certificates for each batch, which shall include results of all tests listed in Table PCS4.1.

Pipes coated with powder that has not been approved by eThekwini Water and Sanitation may be rejected.

PCS4.3 3 Layer Polyethylene Pipe Coating System

The 3 Layer Polyethylene Pipe Coating System shall be applied generally in accordance with this specification and the Canadian Standards Association specification Z245.21-02.

PCS4.3.1 Preparation And Cleaning Of Pipe

i) Degreasing

Pipes shall be degreased as specified.

ii) Blast Cleaning

Pipes shall be blast cleaned to Grade Sa3.

iii) Handling of Cleaned Pipe

After cleaning, the pipe surface shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces in contact with the pipe surface shall be clean and free from oil, grease, grit, dirt and other contamination.

iv) Cut Back of Coating

The blast cleaned surface shall be stopped off or cut back by suitable masking which shall not contaminate the cleaned surface as follows:

- a) All pipes up to and including 250mm nominal diameter - 100mm from both ends of the pipe.
- b) All pipes from 300mm nominal diameter up to and including 600mm nominal diameter - 50mm from the belled end of the pipe and 100mm from the plain end of the pipe. (See Fig. 1).
- c) All pipes larger than 600mm nominal diameter - 100mm from both ends of the pipe

v) Protection of Uncoated Pipe Ends

All pipe surfaces left uncoated due to cut back of the coating shall be painted with an approved weldable vinyl butyral etch primer to a dry film thickness of 25 microns. This coating shall overlap the fusion bonded epoxy powder coating by 20mm.

PCS4.4 Application of System

i) Application of Primer

The epoxy powder primer shall be applied in accordance with the powder manufacturer's recommendations. The thickness of the primer shall be between 150 and 200 μm .

ii) Application of Adhesive

The adhesive shall be applied in accordance with the powder manufacturer's recommendations. The thickness of the adhesive shall be between 150 and 250 μm .

iii) Application of Polyethylene

The polyethylene shall be applied immediately following the application of the adhesive to the pipe. The thickness of the polyethylene shall be a minimum of 1 mm.

The coating application shall be a continuous process in order to provide an outer sheath of uniform thickness, free from pin-holes, cracks and visible defects.

PCS4.5 Repairs

Any damage to the coating system occurring during manufacturing, storage or transportation of the coated pipes shall be repaired in accordance with the relevant repair procedure as follows;

- i) For Damage Not Greater Than 25mm In Diameter And Where The Steel Surface Is Not Exposed.

- a) Remove damaged coating with a razor knife; sand grinder, power wire brush or equivalent.
 - b) Care should be taken not to expose the steel surface during the repair procedure.
 - c) Eliminate all sharp edges.
 - d) Clean the damaged area and adjacent pipe coating with a dry clean cloth to remove the presence of dust, dirt and any foreign material.
 - e) Abrade (using sandpaper) adjacent HDPE coating extending 100mm beyond the damage.
 - f) Clean damaged area again
 - g) A melt stick (such as those obtained from CANUSA or RAYCHEM) can be used to fill the damaged area.
 - h) Use a low intensity yellow flame for preheating the coating and applying the repair product.
 - i) With quick back and forth strokes, pre-heat the repair zone sufficiently to remove moisture and assist in adhesion.
 - j) Heat the melt stick with the torch until it becomes fluid.
 - k) Heat the melt stick and repair zone simultaneously with the torch and spread the melt stick over the damaged area.
 - l) Keep the flame moving to prevent damage to the coating.
 - m) Some ignition of the melt stick is acceptable.
 - n) Continue spreading the melt stick over the repair zone until the entire area is covered.
 - o) After sufficient melt stick material is on the surface, apply additional heat in quick back-and-forth strokes to create a smooth surface.
 - p) Ensure that the melt stick material completely covers the repair zone.
 - q) The melt stick material should be spread liberally so that the material is raised above the coating surface.
 - r) Holiday detection shall be performed on each repair using a maximum voltage of 15kV.
- ii) For Damaged Areas Greater Than 25mm In Diameter, And Where The Steel Surface Is Not Exposed.
- a) Use an appropriate heat-shrinkable sleeve, if the damage has a diameter greater than 150mm x 150mm.
 - b) Mastic Filler (MF) is used to fill larger voids and deep crevices in damaged coatings prior to the application of repair patches. Melt sticks may also be used as a filler material below Coating Repair Patches.
 - c) Follow steps i) a) to i) f) above.
 - d) Unroll the filler material and cut off the required amount, leaving the release paper in place.
 - e) Use a low intensity yellow flame for pre-heating the coating and applying the repair products.
 - f) With quick back and forth strokes, pre-heat the repair zone sufficiently to remove moisture and assist in adhesion.
 - g) Place the filler material onto the damaged area with the release paper facing up.

- h) Firmly press the material into the damaged area by hand and remove the release paper.
 - i) After filling the damaged area, remove the excess filler to create a smooth surface.
 - j) As an option, use a low intensity yellow flame to warm the filler material and assist in smoothing it out.
 - k) Patch Preparation:
 - Cut a patch of CRP large enough to extend a minimum of 50mm beyond the edge of the repair zone.
 - Trim each corner of the patch about 10-25mm at a 45° angle.
 - l) Warm the damaged area (repair zone + 50mm overlap) to remove moisture and assist in adhesion.
 - m) Take the cut repair patch and remove the release liner.
 - n) Place the patch with the adhesive side up on a heat resistant-gloved hand or on top of the pipe, and heat gently.
 - o) Heat until the adhesive softens and the surface becomes glossy. Also, reheat the damaged area to keep it warm.
 - p) Apply the softened adhesive side of the patch to the damaged area and press down firmly.
 - q) Heat the patch with a low intensity flame, and using a roller or a gloved hand, pat down and remove any air or wrinkles. Roll to ensure a good bond.
 - r) Allow the patch to cool down to ambient temperatures prior to further handling.
 - s) The heat shrink sleeve shall then be applied over the repair patch as per the manufacturer's recommendations.
 - t) Holiday detection shall be performed on each repair using a maximum voltage of 15kV.
- iii) For All Damaged Areas Where The Steel Surface Has Been Exposed.
- a) The repair system shall consist of two layers: a 2 part 100% solid epoxy primer and a cross-linked polyethylene, in the form of a self adhesive shrink sleeve.
 - b) Clean the damaged area to a "white metal finish" (Sa 2½), using sandpaper or blasting equipment.
 - c) Slightly abrade the line coating that shall be covered to a distance 50mm beyond the sleeve width.
 - d) Using a clean cloth, remove all dust and particles that may be present.
 - e) Follow the Preparation, Mixing and Application instructions provided with the supplied Epoxy Pack.
 - f) Apply mixed epoxy to a minimum uniform thickness of 150 microns on both the bare metal and the abraded portion of the mill coating, with a cloth, brush or applicator pad.
 - g) Preheat the area with a low to moderate intensity flame to substantially cure the epoxy and warm the surface. Drying time is dependent on preheating, weathering conditions and ambient temperature.
 - h) Follow steps ii) k) to ii) s) above.
 - i) Prior to sleeve application, check that the entire steel surface is fully covered with the epoxy. Holiday detection is suggested.
 - j) Using the propane torch, reheat the area to be covered with the heat shrink sleeve to the manufacturer's recommended temperature.

- k) Wrap the sleeve around the heated epoxy ensuring proper overlap onto the mill applied coating.
- l) Holiday detection shall be performed on each repair using a maximum voltage of 15kV.

PCS4.6 Performance Criteria

The coating material shall comply with all the requirements given in TABLES PCS4.1 and PCS4.2. The applied coating shall comply with all the requirements given in TABLE PCS4.3.

PCS4.7 Frequency of Testing

The tests of TABLE PCS4.1 shall be carried out on each batch of supplied materials.

The tests of Table PCS4.2 shall be carried out for each pipe diameter for each contract.

Tests 1 to 3 of TABLE PCS4.3 shall be carried out on every pipe.

Tests 4 and 5 of TABLE PCS4.3 shall be carried out at a frequency of one per shift.

Tests 6 and 7 of TABLE PCS4.3 shall be carried out once per week.

Additional tests may be required at the discretion of eThekweni Water and Sanitation.

**TABLE PCS4.1: MATERIAL BATCH TEST REQUIREMENTS FOR POWDER PRIMER, ADHESIVE
AND OUTER SHEATH OF 3 LAYER POLYETHYLENE COATING**

PROPERTY	REQUIREMENT	TEST METHOD
POWDER PRIMER		
1. Gel time (s)	Within 20% of manufacturer's specified nominal	CSA Z245.20, Clause 12.2
ADHESIVE		
1. Flow rate (g/10 min)	Within 20% of manufacturer's specified nominal	ASTM D 1238 190°C/2.16 kg
POLYETHYLENE OUTER SHEATH		
1. Density (g/cm ³)	>0,940	ASTM D 792 or ASTM D 1505
2. Elongation at break (%)	600 minimum	ASTM D 638 Type IV sample: crosshead speed 50 mm/min
3. Flow rate (g/10 min)	0,15 – 0,80	ASTM D 1238 190°C/2.16 kg
4. Hardness (Shore D)	60 minimum	ASTM D 2240
5. Heat aging (MPa, %)	At least 65% of original tensile stress at yield; minimum elongation of 150%	CSA Z245.21, Clause 12.6
6. Tensile stress at yield (MPa)	18,5 minimum	ASTM D 638 Type IV sample: crosshead speed 50 mm/min
7. Oxidative-induction time in oxygen at 220°C, aluminium pan, no screen (minute)	10 minimum	ASTM D 3895
8. Brittleness temperature (°C)	-70 or lower (for F ₂₀)	ASTM D 746
9. Environmental stress-cracking resistance condition (h)	300 minimum (for F ₅₀). Condition "B"	ASTM D 1693 100% Igepal
10. Vicat softening point (°C)	120 minimum	ASTM D 1525

TABLE PCS4.2: QUALIFICATION REQUIREMENTS FOR 3 LAYER POLYETHYLENE COATING

PROPERTY	REQUIREMENT	TEST METHOD
1. 28 d cathodic disbonding at 20°C.	12 mm maximum radius	CSA Z245.21, Clause 12.3 *
2. Impact resistance	A minimum of 3.0 J/mm of actual total coating thickness	CSA Z245.20, Clause 12.12, except that for each μm of thickness, the voltage setting for the dc holiday detector (see Clause 12.12.3.3) shall be 10 V per μm thickness up to a maximum of 15 000 V.
3. Flexibility	No cracking of polyethylene	CSA Z245.20, Clause 12.11; bend of 2,5°
4. Peel adhesion	150.0 N minimum	CSA Z245.21, Clause 12.14 or 12.15
5. Polyethylene tensile stress at yield	17.0 MPa minimum	ASTM D 638 Type IV sample: crosshead speed 50 mm/min
6. Polyethylene elongation at break	300% minimum	ASTM D 638 Type IV sample: crosshead speed 50 mm/min

* In clause 12.3.3.6 the radial cuts may be replaced by circumferential chiseling to remove the test area circle.

TABLE PCS4.3: REQUIREMENTS OF APPLIED 3 LAYER POLYETHYLENE COATING

PROPERTY	REQUIREMENT	TEST METHOD	FREQUENCY
1. Visual	Smooth finish, free from visible defects	Visual	Every pipe
2. Coating Thickness	Minimum of 1,3 mm	ISO 2808	Every pipe
3. Holiday test	Nil defects at 15 kV	CSA Z245.21, Clause 7.4.2. 10 V per μm thickness up to a maximum of 15 000 V.	Every pipe
4. Peel adhesion	150.0 N minimum	CSA Z245.21, Clause 12.14 or 12.15	1 test per shift
5. 24 h cathodic disbondment at 65°C.	7 mm maximum radius	CSA Z245.21, Clause 12.3 *	1 test per shift
6. Tensile stress at yield	17,0 MPa minimum	ASTM D 638 Type IV sample: crosshead speed 50 mm/min	1 test per week
7. Elongation at break	300% minimum	ASTM D 638 Type IV sample: crosshead speed 50 mm/min	1 test per week

* In clause 12.3.3.6 the radial cuts may be replaced by circumferential chiseling to remove the test area circle.

PCS 5: Rigid Polyurethane Coating

PCS5.1 Approval of Supplier

The rigid polyurethane coating system proposed by the contractor shall be prequalified in accordance with tests 1 to 7 listed in Table 11 and shall be identified in the bid by coating manufacturer name and product number. These prequalification test results shall be submitted at the time of tender. All coatings proposed shall have established case histories of use on the external surfaces of buried pipelines with complementary cathodic protection systems.

PCS5.2 Approval of Batches

Each batch of materials supplied to the applicator shall be approved by eThekweni Water and Sanitation. No change in formulation of the materials is permitted without prior approval of eThekweni Water and Sanitation. Such approval shall not exonerate the Contractor from the due performance of the coating system in terms of this specification.

The manufacturers shall supply Batch Conformance Certificates for each batch together with the FTIR Fingerprint that will be compared with the qualification fingerprint from Table PCS5.1.

Pipes coated with rigid polyurethane materials that have not been approved by eThekweni Water and Sanitation may be rejected.

PCS5.3 Rigid Polyurethane Coating

The required coating shall be a two component liquid applied rigid polyurethane, the mixing ratio being 1:1. The two coating components shall have different colours allowing the verification of the correct mixing and checking of the uniformity of the colour of the mixed product. The coating is considered cured when it has attained the hardness recommended by the product manufacturer. The coating materials shall be handled, stored, applied, and cured in accordance with the recommendation of the material manufacturers.

PCS5.4 Preparation and Cleaning Of Pipe

i) Degreasing

Prior to blast cleaning, all surfaces shall be inspected and any oil or grease shall be removed by means of solvent cleaning in accordance with the manufacturer's recommendations using water dispersible cleaners. The solvent shall leave no residue.

ii) Blast Cleaning

The exterior surface of the pipe shall be blast cleaned by centrifugal or air blast cleaning methods, then vacuum cleaned or blown off to achieve the following standards:

- a) Cleanliness shall be equal to Sa3 of ISO 8501-1 when tested in accordance with S.A.N.S. 5767.
- b) The profile produced by blast cleaning shall be angular and shall have an average peak to valley height as recommended by the approved supplier, when tested in accordance with S.A.N.S. 5772. When recycling abrasives, daily additions of new grit are required to retain the angularity of the profile.

Hackles shall be removed with coarse abrasive paper.

- c) Residual dust and debris shall not exceed 0,2% when tested in accordance with S.A.N.S. 5769.
- d) Water soluble salts shall not exceed 100mg/m² at any point when tested with the Weber-Reilly Reagent.
- e) Any laminations revealed by blast cleaning shall be ground out and reblast cleaned to meet the requirements given in (a) to (d) above. If grinding penetrates the steel to a depth greater than 8% of the nominal wall thickness, the pipe shall be rejected.

iii) Handling of Cleaned Pipe

After cleaning, the pipe surface shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces in contact with the pipe surface shall be clean and free from oil, grease, grit, dirt and other contamination.

iv) Cut Back of Coating

The blast cleaned surface shall be stopped off or cut back by suitable masking which shall not contaminate the cleaned surface as follows:

- a) All pipes up to and including 250 mm nominal diameter – 100 mm from both ends of the pipe.
- b) All pipes from 300 mm nominal diameter up to and including 600 mm nominal diameter - 50mm from the belled end of the pipe and 100mm from the plain end of the pipe. (See Fig. 1).
- c) All pipes larger than 600 mm nominal diameter - 100 mm from both ends of the pipe.

v) Protection of Uncoated Pipe Ends

All pipe surfaces left uncoated due to cut back of the fusion bonded epoxy powder coating shall be painted with an approved weldable vinyl butyral etch primer to a dry film thickness of 25 microns. This coating shall overlap the rigid polyurethane coating by 20mm.

PCS5.5 Application of Coating

i) Heating

The surface shall be heated using an induction heating coil, radiant heaters or hot air to a temperature as recommended by the coating material manufacturer and in accordance with this specification.

The use of propane torches or gas burners for pre-heating and post-heating is expressly prohibited. Infrared heaters may be used for post-heating.

The temperature of the bare steel shall be monitored using temperature-indicating crayons. The amount of crayon used shall be the minimum amount required for accurate measurement. Crayon markings shall be removed with a wire brush.

Care shall be taken to ensure a uniform heating pattern.

ii) Method of Application

The liquid coating shall be applied to the blast cleaned surfaces using the method and equipment recommended by the coating manufacturer.

If a second layer is required to reach the prescribed thickness, this shall be applied in accordance with the over-coating time prescribed by the coating manufacturer.

Particular care should be taken in the handling of the coated pipes before the coating has reached the minimum value of hardness recommended by the manufacturer.

iii) Thickness of Coating

The applied coating thickness shall be between 1,2 and 1,8 mm.

iv) Cut Back of Coating

The coating shall be cut back in accordance with clause A.5.1.5.

v) Repairs

Repairs shall be carried out with repair grade materials of the same grade as the spray-applied, and tested in accordance with the approved procedures.

PCS5.6 Performance Criteria

The coating material shall comply with all the requirements given in TABLE PCS5.1. The applied coating shall comply with all the requirements given in TABLE PCS5.2.

PCS5.7 Frequency of Testing

Tests 1 to 4 of TABLE PCS5.2 shall be carried out on every pipe. Test 5 shall be carried out once per day (or shift). Test 6 shall be carried out at the start of each new contract. Test 7 shall be carried out on each new batch of coating material, and compared with the qualification results.

TABLE PCS5.1: QUALIFICATION REQUIREMENTS FOR RIGID POLYURETHANE COATING

PROPERTY	REQUIREMENT	TEST METHOD
1. Composition	FTIR Fingerprint	
2. Hardness Shore “D”	≥75	ASTM D2240
3. Adhesion, pull-off at 23°C	>15 MPa at 1000 micron DFT	ASTM D 4541/ISO4624
4. Cathodic disbondment, 23 °C, 28 days, 1.5V	<18mm	ASTM G8, Method B only, ECD Group A compliant
5. Cathodic disbondment, 66 ± 3°C, 24 hrs, 3.5V	<6mm	NACE RP 0394
6. Adhesion to steel after hot water soak, 70 ±3°C, 30 days and 60 days	≥7MPa	ISO 4624
7. Impact resistance	3J/mm	ASTM G14, 23°C

TABLE PCS5.2: REQUIREMENTS FOR APPLIED RIGID POLYURETHANE COATING

PROPERTY	REQUIREMENT	TEST METHOD	FREQUENCY
1. Visual	Smooth finish, free from visible defects	Visual	Every pipe
2. Coating Thickness	1,2 to 1,8 mm	ISO 2820	Every pipe
3. Holiday test	Nil defects (test voltage as per manufacturer’s specification)	ASTM D 5162-01	Every pipe
4. Hardness Shore “D”	≥75	ASTM D2240	1 test per day’s production
5. Adhesion, pull-off at 23°C	>7 MPa at 1000 micron DFT	ASTM D 4541 /ISO4624	1 test per day’s production
6. Cathodic disbondment, 23 °C, 28 days, 1.5V	<18mm	ASTM G8	1 test per contract
7. Composition	FTIR Fingerprint	Check against manufacturer’s qualification scan	1 test per material batch

PCS 6: Polyamide 11 (Nylon 11) Thermoplastic Lining and Coating for 100 to 300mm Piping

PCS6.1 Approval of Supplier

The polyamide 11 (Nylon 11) thermoplastic coating and lining shall be Rilsan or similar approved. The approved supplier shall be ISO 9001 certificated.

The brand type or grade, and the supplier of thermoplastic coating to be used shall be approved in writing by eThekwini Water and Sanitation. To obtain approval, the supplier shall provide independent test results in writing that demonstrate that the proposed material is capable of meeting the requirements specified in Table PCS6.1.

To maintain their approved status, suppliers will carry out the above tests on an annual basis and submit their results to eThekwini Water and Sanitation for approval.

PCS6.2 Approval of Batches

Each batch of thermoplastic coating to be used by the applicator shall be approved by eThekwini Water and Sanitation before use. No change in formulation of the coating is permitted without prior approval of eThekwini Water and Sanitation. Such approval shall not exonerate the Contractor from the due performance of the coating systems in terms of this specification.

The manufacturer shall supply Quality Control Certificates for each batch of material supplied. The Quality Control Certificates shall include results of tests carried out in accordance with the manufacturer's approved procedures.

Pipes lined or coated with thermoplastic powder products that have not been approved by eThekwini Water and Sanitation may be rejected.

PCS6.3 Polyamide 11 (Nylon 11) Thermoplastic Lining and Coating

The polyamide 11 (Nylon 11) thermoplastic coating and lining shall be Rilsan or similar approved.

PCS6.4 Preparation And Cleaning Of Pipe

i) Degreasing

Prior to blast cleaning, all surfaces shall be inspected and any oil or grease shall be removed by means of solvent cleaning in accordance with the manufacturer's recommendations using water dispersible cleaners. The solvent shall leave no residue.

ii) Blast Cleaning

The surface of the pipe shall be blast cleaned by centrifugal or air blast cleaning methods, then vacuum cleaned or blown off to achieve the following standards:

- a) Cleanliness shall be equal to Sa3 of ISO 8501-1 when tested in accordance with S.A.N.S. 5767.

- b) The profile produced by blast cleaning shall be angular and shall have an average peak to valley height of 40 to 90 micron or as recommended by the approved supplier, when tested in accordance with S.A.N.S. 5772. When recycling abrasives, daily additions of new grit are required to retain the angularity of the profile.

Hackles shall be removed with coarse abrasive paper.

- c) Residual dust and debris shall not exceed 0,2% when tested in accordance with S.A.N.S. 5769.
- d) Water soluble salts shall not exceed 100mg/m² at any point when tested with the Weber-Reilly Reagent.
- e) Any laminations revealed by blast cleaning shall be ground out and reblast cleaned to meet the requirements given in (a) to (d) above. If grinding penetrates the steel to a depth greater than 8% of the nominal wall thickness, the pipe shall be rejected.

iii) Handling of Cleaned Pipe

After cleaning, the pipe surface shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces in contact with the pipe surface shall be clean and free from oil, grease, grit, dirt and other contamination.

iv) Cut Back of Coating

The blast cleaned surface shall be stopped off or cut back by suitable masking which shall not contaminate the cleaned surface as follows:

- a) All pipes up to and including 250 mm nominal diameter – 100 mm from both ends of the pipe.
- b) All pipes from 300 mm nominal diameter up to and including 600 mm nominal diameter - 50mm from the belled end of the pipe and 100mm from the plain end of the pipe. (See Fig. 1).

v) Protection of Uncoated Pipe Ends

All pipe surfaces left uncoated due to cut back of the thermoplastic powder coating shall be painted with an approved weldable vinyl butyral etch primer to a dry film thickness of 25 microns. This coating shall overlap the rigid polyurethane coating by 20 mm.

PCS6.5 Application of Coating

i) Primer Application

The cleaned pipe shall be primed with the approved primer to a nominal thickness of 8 to 12 micron.

ii) Heating

Within 8 hours of priming the pipe shall be pre-heated to the temperature recommended by the coating material manufacturer for the pipe wall thickness being coated. This temperature is typically some 350 °C.

The temperature of the bare steel shall be monitored using temperature-indicating crayons. The amount of crayon used shall be the minimum amount required for accurate measurement. Crayon markings shall be removed with a wire brush.

Care shall be taken to ensure a uniform heating pattern.

iii) Method of Application

Following preheating the thermoplastic powder coating shall be applied by the fluidized bed process as recommended by the coating manufacturer and application equipment supplier.

iv) Thickness of Coating

The optimal applied coating thickness is 350 micron. The minimum acceptable thickness is 250 micron.

v) Cut Back of Coating

The coating shall be cut back in accordance with clause A.5.6.1.(iv).

vi) Repairs

Repairs shall be carried out with either an approved two pack solvent free epoxy or an approved hot melt compound and tested in accordance with the specified procedures.

PCS6.6 Performance Criteria

The coating material shall comply with all the requirements given in TABLE PCS6.1. The applied coating shall comply with all the requirements given in TABLE PCS6.2.

PSC6.7 Frequency of Testing

Tests 1 to 4 of TABLE PCS6.2 shall be carried out on every pipe. Test 5 shall be carried out once per day (or shift). Test 6 shall be carried out at the start of each new contract.

**TABLE PCS6.1: QUALIFICATION REQUIREMENTS FOR POLYAMIDE 11 (NYLON 11)
THERMOPLASTIC LINING AND COATING**

PROPERTY	REQUIREMENT	TEST METHOD
1. Hardness Shore "D"	75 - 85	ASTM D2240
2. 28 d cathodic disbonding at 20°C.	12 mm maximum radius	CSA Z245.21, Clause 12.3
3. Impact resistance	> 2J/mm	ASTM G14, 23°C

TABLE PCS6.2: REQUIREMENTS FOR APPLIED POLYAMIDE 11 (NYLON 11)
THERMOPLASTIC LINING AND COATING

PROPERTY	REQUIREMENT	TEST METHOD	FREQUENCY
1. Visual (Lining and coating)	Smooth finish, free from visible defects	Visual	Every pipe
2. Coating Thickness (Lining and coating)	250 micron minimum	ISO 2820	Every pipe
3. Electrical Insulation Defects (Lining and coating)	Nil defects at 90 Volts, 2 Mega Ohm	S.A.N.S. 1217 Section 8.12.1	Every pipe
4. Hardness Shore "D" (Lining and coating)	75 - 85	ASTM D2240	Every pipe
5. Adhesion, pull-off at 23°C (on test panel coated with a pipe)	>7 MPa at 1000 micron DFT	ASTM D 4541 /ISO4624	1 test per day's production
6. 28 d cathodic disbonding at 20°C. (on test panel coated with a pipe)	12 mm maximum radius	CSA Z245.21, Clause 12.3	1 test per contract

PCS 7: Two Layer Polyethylene / Visco-elastic Polyisobutene Pipe Coating System (2LPE)

A factory applied double sided non crystalline, prefab monolithic viscous polymer wrap coating with cold flow, self-healing, visco-elastic properties for corrosion prevention.

PCS7.1 Approval of Supplier

The 2-layer polyethylene pipe coating system comprises of a visco-elastic polyisobutene based coating and a polyethylene outer sheath classified as System B1 in terms of the Canadian Standards Association Specification Z245.21-02. The respective layers of the 2-layer system shall comprise of the following materials:

Visco-elastic Polyisobutene Corrosion Protection Layer:

Stopaq Stopaq Basecoat DS (or similar approved)

High Density Polyethylene Outer Sheath:

Application Method 1:

Stopaq Stopaq HSS Heat Shrinkable material (or similar approved)

Application Methods 2 & 3:

Borealis Borcoat HE3450 – Extrusion material (or similar approved)

PCS7.2 Approval of Batches

Each batch of materials supplied to the applicator shall be approved by eThekwini Water and Sanitation before use. No change in product type of the material is permitted without prior approval from eThekwini Water and Sanitation. Such approval shall not exonerate the Contractor from the due performance of the coating system in terms of this specification.

The manufacturers shall supply Batch Conformance Certificates for each batch, which shall include results of all tests listed in Table 7.1.

Pipes coated with material that has not been approved by eThekwini Water and Sanitation will be rejected.

PSC7.3 Two Layer Polyethylene Pipe Coating System

The 2-layer polyethylene pipe coating system shall be applied generally in accordance with the Canadian Standards Association Specification Z245.21-02.

PCS7.4.1 Preparation and Cleaning of Pipe

i) Degreasing

Pipes shall be degreased externally by the use of an approved water rinsable solvent degreaser to remove all oils and lubricants present on the surface prior to blasting.

ii) Blast Cleaning

Pipes shall be blast cleaned to a clean finish removing all mill scale.
No surface profile is required.
No salt test is required.

iii) Handling of Cleaned Pipe

After cleaning, the pipe surface shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces in contact with the pipe surface shall be kept clean and

free from oil, grease, grit, dirt and other contamination.

iv) Cut Back of Coating

The coating shall be cut back by 100mm from the pipe ends.

v) Protection of Uncoated Pipe Ends

Uncoated pipe ends shall be wrapped with a protective PVC tape and have a protective end cap placed at each pipe end.

PCS7.4.2 Application Methods

PCS7.4.2.1. Application method 1

PCS7.4.2.1. (a) Application of the Visco Elastic (Stopaq) Basecoat corrosion preventative layer:

- i) The abraded line pipe will be protected by a visco-elastic basecoat material holding an overlap of 10mm on each round.
- ii) The width of the Basecoat Material shall be as follows:

Pipe OD (mm)	Basecoat Material Width (mm)
< 200	100
200 to 1100	200
>1100	300

PCS7.4.2.1. (b) Application Mechanical Protection PE layer to the Visco-elastic Basecoat:

- i) A polyethylene shrink material is applied on top of the visco-elastic basecoat coated pipe to act as the mechanical protective layer. After the application of the polyethylene shrink materials this material shall be heated to allow shrinking and adherence to the visco-elastic material.
- ii) The thickness of the Mechanical Protection PE layer shall be a minimum of 1,5mm and a maximum of 2mm on the pipe with a minimum of 2mm on the weld seam.

PCS7.4.2.2 Application method 2

PCS7.4.2.2 (a) Application of the Visco-elastic (Stopaq) Basecoat corrosion preventative layer:

- i) The abraded line pipe will be protected by a visco-elastic basecoat material with an overlap of 10mm on each round.
- ii) The width of the Basecoat Material shall be as specified in Clause PSC7.4.2.1. (a) ii) above

PCS7.4.2.2 (b) Application Mechanical Protection PE layer to the Visco-elastic (Stopaq) Basecoat:

- i) The Visco-elastic Basecoat coated pipe will pass by a side or overhead polyethylene extruder. The process delivering sufficient HDPE material to the surface of the rotating line pipe and forming a uniform mechanical

protective layer, as per thickness required by the consulting engineer, a minimum of 2mm on the weld seam.

- ii) The polyethylene shall be applied immediately following the application of the visco-elastic material to the pipe. The coating application shall be a continuous process in order to provide an outer sheath of uniform thickness, free from pinholes, cracks and visible defects.

No adhesives are required between the layers; visco-elastic material is applied cold.

PCS7.4.2.3. Application method 3

PCS7.4.2.3 (a) Application of the Visco-elastic (Stopaq) Basecoat corrosion prevention layer

- i) The abraded line pipe will be protected by a visco-elastic basecoat material holding an overlap of 10mm on each round.
- ii) The width of the Basecoat Material shall be as specified in Clause PSC7.4.2.1. (a) ii) above

PCS7.4.2.3. (b) Application Mechanical Protection PE layer to the Stopaq Basecoat

- i) The Visco-elastic Basecoat coated pipe will pass through a crosshead polyethylene extruder. The process delivering sufficient polyethylene material to the surface of the line pipe and forming a uniform mechanical protective layer at a minimum thickness of 1,5mm and a maximum of 2mm on the pipe with a minimum of 2mm on the weld seam.
- ii) The polyethylene shall be applied immediately following the application of the visco-elastic material to the pipe. The coating application shall be a continuous process in order to provide an outer sheath of uniform thickness, free from pinholes, cracks and visible defects.

No adhesives are required between the layers. Visco-elastic material is applied cold.

PCS7.5 Repairs

Any damage to the coating system occurring during manufacturing, storage or transportation of the coated pipes shall be repaired in accordance with the relevant repair procedure as follows utilizing the following materials:

Corrosion Protection Layer :	Stopaq CZH Paste and CZH Wrapping band (or similar approved)
Mechanical Protection Layer – Option 1:	Stopaq Outerwrap PVC (or similar approved)
Mechanical Protection Layer – Option 2:	Stopaq Outerwrap PE (or similar approved)
Mechanical Protection Layer – Option 3:	Stopaq PE Patch Repair Material (or similar approved)

Repair Procedure:

- a) Remove damaged coating with a razor knife; sand grinder, power wire brush or equivalent.

- b) Care should be taken not to expose the steel surface during the repair procedure.
- c) Eliminate all sharp edges.
- d) Clean the damaged area and adjacent pipe coating with a dry clean cloth to remove the presence of dust, dirt and any foreign material.
- e) Abrade (using sandpaper) the adjacent polyethylene coating extending 100mm beyond the damage.
- f) Clean damage area again.
- g) Fill voids and crevices in damaged coatings with Visco-elastic paste material prior to the application of repair patches.
- h) Unroll the filler material and cut off the required amount, leaving the release paper in place.
- i) Firmly press the material into the damaged area by hand and remove the release paper.
- j) After filling the damaged area, remove the excess filler to create a smooth surface.
- k) Patch Preparation:
 - Cut a patch of visco-elastic material large enough to extend a minimum of 50mm beyond the edge of the repair zone
 - Trim each corner of the patch about 10-25mm at a 45° angle.
- l) Assist adhesion by removal of moisture with the use of a dry rag.
- m) Remove oil with the use of isopropanol.
- n) Remove the release liner from the cut repair patch.
- o) Place the repair patch on the damage point and smooth down by hand.
- p) Holiday detection shall be performed on each repair using a maximum voltage of 15kV.
- q) Cover the coating with the relevant mechanical protection layer which has been specified on the project.

PCS7.6 Performance Criteria

The coating material shall comply with all the requirements given in TABLES 7.1 and 7.2. The applied coating shall comply with all the requirements given in TABLE 7.3.

PCS7.7 Frequency of Testing

The tests of TABLE 7.1 shall be carried out on each batch of supplied materials.

The tests of TABLE 7.2 shall be carried out for each pipe diameter for each contract.

Tests 1 to 3 of TABLE 7.3 shall be carried out on every pipe.

Tests 4 and 5 of TABLE 7.3 shall be carried out at a frequency of one per shift.

Tests 6 and 7 of TABLE 7.3 shall be carried out once per week.

Additional tests may be required at the discretion of Engineer.

**TABLE 7.1: MATERIAL BATCH TEST REQUIREMENTS FOR OUTER SHEATH OF 2 LAYER
POLYETHYLENE COATING**

PROPERTY	REQUIREMENT	TEST METHOD
POLYETHYLENE OUTER SHEATH		
1. Density (g/cm ³)	>0,940	ASTM D 792 or ASTM D 1505
2. Elongation at break (%)	600 minimum	ASTM D 638 Type IV sample: crosshead speed 50mm/min
3. Flow rate (g/10min)	0,15 – 0,80	ASTM D 1238 190°C/2.16kg
4. Hardness (Shore D)	60 minimum	ASTM D 2240
5. Heat aging (MPa,%)	At least 65% of original tensile stress at yield; minimum elongation of 150%	CSA Z245.21, Clause 12.6
6. Tensile stress at yield	18,5 minimum	ASTM D 638 Type IV sample: crosshead speed 50mm/min
7. Oxidative-induction time in oxygen at 220°C, aluminum pan, no screen (minute)	10 minimum	ASTM D 3895
8. Brittleness temperature (°C)	-70 or lower (for F20)	ASTM D 746
9. Environmental stress cracking resistance condition (h)	300 minimum (for F50) Condition “B”	ASTM D 1693 100%Igepal
10. Vicat softening point (°C)	120 minimum	ASTM D 1525

TABLE 7.2: QUALIFICATION REQUIREMENTS FOR 2 LAYER POLYETHYLENE COATING

PROPERTY	REQUIREMENT	TEST METHOD
1) 28 d cathodic disbonding at 20°C	0 mm maximum radius	CSA Z245.21, Clause 12.3*
2) Impact resistance (J/mm)	3,0 minimum	ASTM G14, 23°C
3) Flexibility	No cracking of polyethylene	CSA Z245.20, Clause 12.11; bend of 2,5°
4) Peel adhesion	Cohesive fraction of the corrosion coating	CSA Z245.21, Clause 12.14 or 12.15
5) Polyethylene tensile stress at yield	17.0 MPa minimum	ASTM D 638 Type IV sample: crosshead speed 50mm/min
6) Polyethylene elongation at break	300% minimum	ASTM D 638 Type IV sample: crosshead speed 50mm/min

*In Clause 12.3.3.6 the radial cuts may be replaced by circumferential chiseling to remove the test area circle.

TABLE 7.3: REQUIREMENTS OF APPLIED 2 LAYER POLYETHYLENE COATING

PROPERTY	REQUIREMENT	TEST METHOD	FREQUENCY
1. Visual	Smooth finish, free from visible defects	Visual	Every pipe
2. Coating Thickness	Minimum of 2mm	ISO 2808	Every Pipe
3. Holiday test	Nil defects at 15kV	CSA Z245.21, Clause 7.4.2. 10 V per µm thickness up to a maximum of 15 000 V	Every pipe
4. Peel adhesion	Cohesive fracture	CSA Z245.21, Clause 12.14 or 12.15	1 test per shift
5. 24 h cathodic disbondment	0 mm maximum radius	CSA Z245.21, Clause 12.3*	1 test per shift
6. Tensile stress at yield	17,0 MPa minimum	ASTM D 638 Type IV sample: crosshead speed 50mm/min	1 test per week
7. Elongation at break	300% minimum	ASTM D 638 Type IV sample: crosshead speed 50mm/min	1 test per week

*In Clause 12.3.3.6 the radial cuts may be replaced by circumferential chiseling to remove the test area circle.

PCS 8: Two Layer Glass-fibre Reinforced Epoxy (GRE)/Visco-elastic Polyisobutene Coating System (2LGRE)

A factory applied double sided non crystalline, prefab monolithic viscous polymer wrap coating with cold flow, self-healing, visco-elastic properties for corrosion prevention covered by a glass-fibre reinforced epoxy mechanical protection layer.

PCS8.1 Approval of Supplier

The 2 layer GRE pipe coating system comprises of a visco-elastic polyisobutene based coating and a GRE epoxy resin. The respective layers of the 2-layer system shall comprise of the following materials:

Visco-elastic Polyisobutene Corrosion Protection Layer:

Stopaq Stopaq Fast Basecoat GRE (or similar approved)

Glass Reinforced Epoxy Resin Mechanical Protection Outer Layer:

Stopaq Stopaq Fast GRE (or similar approved)

PCS8.2 Approval of Batches

Each batch of materials supplied to the applicator shall be approved by eThekweni Water and Sanitation before use. No change in product type of the material is permitted without prior approval from eThekweni Water and Sanitation. Such approval shall not exonerate the Contractor from the due performance of the coating system in terms of this specification.

The manufacturers shall supply Batch Conformance Certificates for each batch, which shall include results of all tests listed in Table 8.1

Pipes coated with material that has not been approved by eThekweni Water and Sanitation will be rejected.

PCS8.3 Two Layer GRE Coating System

The 2 layer GRE pipe coating system shall be applied generally as follows:

- i) Load the Line pipe onto the rotation unit.
- ii) Apply (viscoelastic) coating wrapping to the surface of the pipe, overlapping at 10mm.
- iii) Wrap to each end leaving 100mm cut back on all pipe ends.
- iv) Holiday Test the corrosion coating as per PSC8.5.1.(a).(viii) below.
- v) Begin the mechanical protection - the second layer.
- vi) The saturated 600 Glass layer/resin and tissue is to be rotated onto the pipe at 50% overlap - cold application.
- vii) Complete the process to each end leaving 150mm cut back on all pipe ends.

PCS8.4 Preparation and Cleaning of Pipe

i) Degreasing

Pipes shall be degreased externally by the use of Isopropanol (or a similar approved water rinsable solvent degreaser) to remove all oils and lubricants present on the surface prior to blasting.

ii) Blast Cleaning

- a) Remove loose corrosion, loose mill scale, dust or other loosely adherent contaminants to cleanliness St-2 / St-3 (hand tool / machine tool cleaning) or by means of abrasive blasting to cleanliness Sa-1 ("brush-off" blasting) in accordance with ISO 8501-01.
- b) Mechanically remove all weld spatters, laminations, slivers, sharp edges, high points, and other visual roughness, which might penetrate into the corrosion protective coating layer.
- c) No specific surface profile is required.
- d) No salt test is required.
- e) Residual dust and debris shall not exceed 0,2% when tested in accordance with S.A.N.S. 5769

iii) Handling of Cleaned Pipe

After cleaning, the pipe surface shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces in contact with the pipe surface shall be kept clean and free from oil, grease, grit, dirt and other contamination.

iv) Cut Back of Coating

The coating shall be cut back by 100mm from the pipe ends.

v) Protection of Uncoated Pipe Ends

All pipe surfaces left uncoated due to cut back of the fusion bonded epoxy powder coating shall be painted with an approved weldable vinyl butyral etch primer to a dry film thickness of 25 microns. This coating shall overlap the Stopaq coating by 20mm.

PCS8.5 Application Method

PSC8.5.1. (a) Application of the Visco Elastic (Stopaq) Basecoat corrosion preventative layer:

- i) The width of the Basecoat Material shall be as follows:

Pipe OD (mm)	Basecoat Material Width (mm)
< 200	100
200 - 1100	200
>1100	300

- ii) Prior and during application, pipe surface shall be maintained at a temperature at least +3°C above the dew-point temperature and between -30°C and +70°C
- iii) Before and during application, wrapping band shall be maintained within the temperature range +5°C to +70°C
- iv) Wrapping Band shall be applied with the sticky side in contact to the substrate, wrapped without tension, avoiding air entrapment and without tape creases and wrinkling
- v) Wrapping Band overlaps shall be 10mm with itself and at least 50mm on adjacent existing epoxy coated piping. Overlaps between the end of a tape roll and the tape of a new roll shall be at least 100mm.

- vi) At terminations (start and end points) one, full straight wrapping shall be applied onto substrate, following with wraps from “straight to spiral”, and then continue with spiral wrapping, with 10mm minimum overlap. End with one straight, circumferential wrapping.
- vii) The nominal thickness of the Wrapping Band shall not be lower than 0.85mm
- viii) After wrapping and prior to application of the mechanical protective layer the Wrapping Band shall be subject to a high spark holiday test at 5 kV per mm coating thickness plus 5 kV. The Wrapping Band has a constant minimum thickness between 0.85mm and 1.2mm, therefore the testing voltage should be $(1 \times 5\text{kV}) + 5 \text{ kV} = 10 \text{ kV}$. A clean, copper-brush probe is recommended for the high spark testing. Where a ring-probe is used it is recommended that the test voltage be increased by 5 kV in order to compensate the less efficient ring probe.
- ix) All defects (holidays) shall be repaired with the addition of new materials and re-tested.

PCS8.5.1. (b) Application of GRE Mechanical Protection layer to the Visco-elastic Basecoat:

- i) No adhesive is required between the visco-elastic basecoat corrosion protection layer and the glass reinforced epoxy mechanical protection layer.
- ii) Saturate the 600 grams per m² glass fibre membrane with resin mix at 400 grams per m² and wind onto the surface of the pipe over the viscoelastic basecoat ensuring a 50% overlap of the cloth to itself.
- iii) Follow this with a 30 grams per m² layer of fibre tissue on the same application run ensuring a 50% overlap of the cloth to itself and beginning and ending with a straight wrap covering over the glass completely.

PCS8.6 Repairs

Any damage to the coating system occurring during manufacturing, storage or transportation of the coated pipes shall be repaired in accordance with the relevant repair procedure as specified by the product supplier as follows utilizing the following materials:

Corrosion Protection Layer: Stopaq CZH Paste and CZH Wrapping Band (or similar approved)

Mechanical Protection Layer: Stopaq Fast GRE (or similar approved)

Repair procedure:

- a) Small defects (< 20mm x 20mm) to bare steel:
 - i. Remove damaged coating
 - ii. Eliminate all sharp edges
 - iii. Clean the damaged area and adjacent pipe coating with a dry clean cloth to remove the presence of dust, dirt and any foreign material.
 - iv. Fill voids and crevices in damaged corrosion protection coating with Visco-elastic paste material
 - v. Fill remaining void in damaged mechanical protection layer with resin mix
 - vi. After filling the damaged area, remove the excess filler to create a smooth surface.
 - vii. Cut a patch of visco-elastic material large enough to extend a minimum of 50mm beyond the edge of the repair zone
 - viii. Trim each corner of the patch about 10-25mm at a 45° angle.

- ix. Place the repair patch on the damage point and smooth down by hand.
- x. Holiday detection shall be performed on each repair using a maximum voltage of 15kV.

b) Large defects (> 20mm x 20mm) to bare steel:

- i. Remove damaged coating
- ii. Eliminate all sharp edges
- iii. Clean the damaged area and adjacent pipe coating with a dry clean cloth to remove the presence of dust, dirt and any foreign material.
- iv. Cut and apply patch from Visco-elastic corrosion protection material
- v. Fill remaining void in damaged mechanical protection layer with glass fiber mesh and brush in resin mix
- vi. After filling the damaged area, remove the excess filler to create a smooth surface.
- vii. Cut a patch of visco-elastic material large enough to extend a minimum of 50mm beyond the edge of the repair zone
- viii. Trim each corner of the patch about 10-25mm at a 45° angle.
- ix. Place the repair patch on the damage point and smooth down by hand.
- x. Holiday detection shall be performed on each repair using a maximum voltage of 15kV.

PCS8.6 Performance Criteria

The coating materials shall comply with all the requirements given in TABLES 8.1 and 8.2.
The applied coating shall comply with all the requirements given in TABLE 8.3.

PCS8.7 Frequency of Testing

The tests of TABLE 8.1 shall be carried out on each batch of supplied materials.

The tests of TABLE 8.2 shall be carried out for each pipe diameter for each contract.

Tests 1 to 3 of TABLE 8.3 shall be carried out on every pipe.

Tests 4,5 and 6 of TABLE 8.3 shall be carried out at a frequency of one per shift.

Test 7 of TABLE 8.3 shall be carried out once per 100 pipes.

Additional tests may be required at the discretion of Engineer.

TABLE 8.1: MATERIAL BATCH TEST REQUIREMENTS

PROPERTY	REQUIREMENT	TEST METHOD
CORROSION PROTECTION LAYER:		
1. Density (g/cm ³)	≥ 1.40	ISO 1183-1
2. Elongation at break (%)	> 100	ASTM D1000
3. Water absorption (%)	< 0.03	ASTM D570
4. Permeability (g/m ² /24 hrs)	< 0.20	ASTM E96
5. Glass transition temp. (°C)	≤ -65	ISO 21809-3:2008 Amendment1:2001
6. Drip resistance	No dripping of compound	Tested 72 hrs @ +130°C
MECHANICAL PROTECTION LAYER:		
7. Glass transition temp. (°C)	76	ISO 21809-3:2008 Amendment1:2001
8. Elongation at break (%)	8.2	
9. Hardness (Shore D)	≥ 70	ASTM D2240

TABLE 8.2: QUALIFICATION REQUIREMENTS FOR 2 LAYER GRE COATING

PROPERTY	REQUIREMENT	TEST METHOD
1. 24 hr cathodic disbonding at 23°C and 70°C	0 mm maximum radius	Artificial defect 6mm dia. self-healed after 24 hrs
2. Impact resistance (J/mm)	40 min	ISO 21809-3 Amendment 1(2011) Tested at 20°C
3. Compressive Strength (N/mm ²)	85 min	
4. Flexural strength (N/mm ²)	80 min	
5. Tensile strength (N/mm ²)	70 min	
6. Peel adhesion	Cohesive failure	CSA Z245.21, Clause 12.14 or 12.15
7. Hardness (Shore D)	≥ 70	ASTM D2240

TABLE 8.3: REQUIREMENTS OF APPLIED 2 LAYER GRE COATING

PROPERTY	REQUIREMENT	TEST METHOD	
1. Visual	Smooth finish, free from visible defects	Visual	Every pipe
2. Coating Thickness	2.5 to 3.0mm	ISO 2808	Every pipe
3. Holiday test	Nil defects	CSA Z245.21, Clause 7.4.2. (5 kV per mm thickness plus 5Kv)	Every pipe
4. Peel adhesion	Cohesive fracture	CSA Z245.21, Clause 12.14 or 12.15	1 test per shift
5. Impact resistance (J/mm)	40 min	ISO 21809-3 Amendment 1(2011) Tested at 20°C	1 test per shift
6. Hardness (Shore D)	≥ 70	ASTM D2240	1 test per shift
7. 24 h cathodic disbondment	0 mm maximum radius	CSA Z245.21, Clause 12.3*	1 test per 100 pipes

MSS: MECHANICAL STANDARD SPECIFICATION**MSS.1 PREAMBLE AND SCOPE**

This standard specification covers the general requirements for typical mechanical services which are to be provided within contracts relating to Water Infrastructure within eThekweni Municipality.

This specification must be read in conjunction with the project specification and drawings which provide specific detail related to the scope of work.

In the event of any discrepancy between a part or parts of the Standard Specifications and the Project Specification, the Project Specification shall take precedence. In the event of a discrepancy between the Specifications, (including the Project Specifications) and the drawings and / or the Bill of Quantities, the discrepancy shall be resolved by the Engineer before the execution of the work under the relevant item.

This Specification lays down the performance, quality and overall system requirements of the Works. Deviation from the Specification will only be considered if the Engineer considers such deviation an improvement.

MSS.2 SAFETY

Safety shall be an all-important and overriding consideration and proper attention shall be paid to this aspect at the design stage. Equipment which is potentially dangerous shall be designed in accordance with a relevant South African or international Standard.

Hazards must be avoided or guarded. Nip points shall be guarded; sharp corners shall be rounded off; operating handles, supports and protrusions shall be kept clear of access ways.

Moving parts shall be properly guarded to the satisfaction of the Engineer.

An emergency stop button shall be installed in a convenient position next to each machine. The installation shall be designed to provide immediate access without the danger of accidental operation. In addition, trip wires which will stop the driving motor when pulled shall be provided along the accessible side/s of moving conveyor belts, chains and the like irrespective of operating speed and irrespective of guards provided.

Where, in the opinion of the Engineer, an installation is not safe, the Contractor shall remedy such defect at his own cost to the satisfaction of the Engineer.

MSS.3 DESIGN FACTORS

A high-quality standard is demanded and reliability, long-life, trouble-free operation, efficiency, ease of maintenance and operation, and neatness are essential.

All plant and equipment shall be of robust construction and the design shall, as applicable, be based on:

- the full range of duties which can be reasonably anticipated
- the power and torque transmitted by the driver system under full load and stalled conditions
- the maximum pressure or vacuum which can be produced by pumps, blowers and compressors under all conditions including blocked or closed inlet and outlet circuits

- conservative service and safety factors based on approved standards or laid down in the printed specifications of reputable and approved manufacturers
- suitable safety margins where relevant and specified in the standard specifications, in addition to any service or safety factors the original equipment manufacturer (OEM) deems necessary
- twenty-four hour per day operation
- a minimum life of 100 000 hours before repair or major part replacement
- prevention of serious damage from normal operational problems such as blockages, blinding, jamming, seizure, malfunction and, as far as is practical, mal-operation, if these occurrences cannot be avoided by good design.
- Machines with non-overloading characteristics shall be selected wherever possible; e.g.: motors shall be sized so that they cannot be overloaded by the driven machine.

MSS.4 FAIL-SAFE OPERATION AND PROTECTIONS

Where damage can occur from normal operational or other foreseeable problems, Plant, equipment and systems must be designed to be fail safe; i.e. must have built-in redundant elements, or be fail-to-safe; i.e. must return to a safe condition where no further damage can be done in the event of a failure, malfunction, mal-operation, overload and, as far as practical, misuse. All reasonable and economically justifiable protections to prevent or limit damage to Plant and equipment, particularly in high risk situations, must be incorporated. Protections shall:

- be directed at the source of the problem, limit forces to safe levels and act quickly enough to prevent damage;
- stop or prevent from starting all equipment at risk;
- activate an alarm with a labelled indicator on the control panel whenever a protection operates;
- not permit unauthorised tampering;
- operate reliably after long inactive periods exposed to corrosive and dirty conditions.

MSS.5 MOVING PARTS

The following general requirements apply not only to machines but to all equipment with moving parts such as headstocks, extension spindles, swivelling davits, heavy duty hinges, pivots and the like:

- All rotating or swivelling shafts, pins and the like, shall be adequately supported, guided and restrained by lubricated or self-lubricating bearings, collars and/or bushes.
- Swivelling joints on linkages and the like shall be of the "universal" or fork and rod type with bearings or bushes fitted to the eyes or forks.
- On abrasive applications, abrasion resistant materials and slow speed operation shall be utilised.
- Susceptibility to fatigue failure shall be minimised by proper design and manufacturing procedures. In particular, changes in section shall be radiused and care must be taken to avoid the use of welded components in areas of fluctuating stress.
- The locking of nuts and pins in position shall be done to the approval of the Engineer.
- Wearing parts shall be designed for interchangeability and ease of removal and replacement.\

MSS.6 ARRANGEMENT AND MOUNTING

The arrangement and general design shall take the following requirements into consideration:

- Lifting eyes, lugs, hooks, etc., shall be provided on heavy or large items to facilitate handling.

- Castings or fabrications shall have machined pads for seating and be mounted on either soleplates or baseplates as appropriate.
- Where accurate alignment is required, positioning pins and/or jacking screws shall be provided.
- The needs of operation and maintenance including neatness, access, working space, safety, cleaning, adjustment, handling, assembly, alignment, disassembly, removal, etc.
- With Plant and equipment to be mounted on or against concrete or brick structures, provision shall be made for adjustment in the mechanical design. Any special accuracy requirements must be specified on the Contractor's Drawings.

MSS.7 LIFTING EQUIPMENT

All lifting equipment shall comply with the following requirements unless otherwise stated:

- All aspects of lifting equipment, including design, fabrication and installation work shall be full in accordance with the relevant aspects of the Occupational Health and Safety Act and Regulations.
- Lifting equipment shall be designed and constructed in accordance with a generally accepted technical standard.
- The safe working load (SWL) shall be marked clearly on all items.
- The complete installation shall be inspected and shall be tested over its complete lifting range using a load which is at least 125 % of the safe working load.
- High-tensile or alloy steel chains shall have a factor of safety of at least four.
- Chains shall have a factor of safety of at least five.
- Steel-wire ropes shall have a factor of safety of at least six.
- Man made fibre ropes or woven webbing shall have a factor of safety of at least six.
- Natural fibre ropes shall have a factor of safety of at least ten.

MSS.8 NAME PLATES

All machinery shall have a plate affixed showing the name and address of the manufacturer, rated loadings, speeds, etc. and any further information the manufacturer may feel necessary for the satisfactory operation of the plant.

Plates shall harmonise with the equipment on which they are fixed and shall be of non-corrosive material with non-corrosive fixings.

Pump plates shall indicate manufacturer, model, type and serial numbers, number of stages, total mass, rated speed, duty flow (m³/hr), duty head (m), rated power (k). Motor plates shall show manufacturer, model, type and serial numbers, country of manufacture, rated speed, frame size, enclosure, insulation class and total mass. Bearing lubrication details are also to be displayed.

MSS.9 MATERIALS OF CONSTRUCTION**MSS.9.1 General**

The Works shall comply with the following:

- When erected and installed, the Plant and equipment shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.
- The requirements of Sub-clause "Arrangement and Mounting" must be noted.

- The Contractor shall provide all foundation bolts, supports, hangers, brackets, etc. required for the support and fixing of equipment.
- The use of more than three shims in the alignment of equipment will not be permitted. Machined spacers shall be prepared where necessary. Shims and spacers shall be of a corrosion resistant material such as stainless steel.
- Corrosion protection requirements shall be carefully attended to and the relevant paragraphs of Sub-clause "Paint Application" (see Clause "Corrosion Protection : Paint Coatings) must be noted. All mating faces must be coated before and sealed after assembly.
- Fastener threads must be coated with a nickel-based, anti-seize compound before assembly.
- Crevices which are formed between two surfaces shall be filled, prior to final fastening, with a suitable formable packing. This applies particularly to stainless steel.

MSS.9.2 Alignment of shafts

Shafts for drives, such as motors, shall be aligned to the driven shaft as follows:

- Final alignment shall be done after installation and before commissioning, shall be checked in the presence of the Engineer and shall be to his approval. Alignment shall be sufficiently accurate to ensure that no initial pre-load is placed on the shaft coupling.
- Each motor shall be aligned to its pump using laser aligning equipment.
- The use of pourable epoxy resin chocks shall be acceptable. If pourable chocks are used, the baseplate feet do not have to be machined but each machine foot shall be provided with a screw for vertical alignment. The chock thickness shall not be less than 15 mm.

MSS.9.3 Materials**Materials – generally**

All materials used in the manufacture and construction of Plant and equipment shall be new, unused and shall be the best of their respective kinds. The Contractor shall ensure that the materials are selected in accordance with the best engineering practice to suit the working conditions and an extremely corrosive environment.

Steel

All structural steel shall comply with the requirements of SANS 1431 grade 300W and shall be legibly marked with the maker's name or trademark and identification marks.

Plastics

Thermoplastics and fibre reinforced polymers shall be UV resistant, have adequate tensile strength and high impact strength and generally suit the application. PVC is regarded as too brittle and shall not be used unless called for in this Specification or approved in writing by the Engineer before supply.

MSS.9.4 Castings

Castings shall comply with the relevant South African or British Standard for the material used, including the following:

- | | |
|------------------------------------|------------------------|
| • Grey Cast Iron Castings | - SANS 1034 BS.1452 |
| • S.G. Iron Castings | - SANS 936/7 BS.2789 |
| • Steel Castings (General Purpose) | - SANS 1465 BS.3100 |
| • Aluminium Castings | - SANS 989/992 BS.1490 |
| • Copper and Copper Alloy Castings | - SANS 200 BS 1400 |

Particular attention shall be paid to cleanliness, soundness and neat fettling and dressing of castings. Surfaces shall be smooth and irregularities caused by mould washaways, and the presence of porosity and sand and slag inclusions will not be tolerated. Areas under bolt heads, nuts and washers, shall be machined or spot faced to ensure a flat and smooth pressure bearing area, and sufficient space shall be provided for the use of ring or socket spanners.

All pressure retaining castings shall be hydrostatically tested to not less than 1,5 times the maximum working pressure after machining and shall be pressure tight.

No repairs shall be undertaken to castings without the written permission of the Engineer and welding will not be permitted on cast iron castings.

Castings shall be heat treated to provide optimum corrosion resistance and toughness combined with reasonable machinability. In particular stainless steel castings shall be heat treated so as to ensure that all carbides are in solution, to ensure optimum grain size and to provide maximum corrosion resistance.

The Contractor shall provide a test certificate for each casting or batch of castings, except for those made of grey cast iron, giving details of the material analysis, the heat treatment and any mechanical tests carried out.

MSS.9.5 Fabrication of carbon steels

Standards

Steelwork shall be constructed, fabricated and erected in accordance with SANS 1200H where applicable.

Finish

Weld spatter and other protrusions shall be removed. Sharp edges shall be rounded to a radius of at least 2 mm.

Requirements for corrosion protection

In addition to finishing requirements, the requirements of corrosion protection application shall be taken into consideration. All surfaces must be accessible for surface preparation and coating. Inaccessible pockets, open hollow sections or the like shall not be permitted except where hot-dip galvanizing (without painting) is called for. Surfaces which cannot be properly prepared after fabrication must be abrasive blasted and coated with a two-pack epoxy pre-weld primer before fabrication.

Inspections

The Contractor shall arrange for the Engineer to inspect fabrications, including fabricated pipework, in the

fabrication workshop and prior to corrosion protection.

MSS.9.6 Fabrication of stainless steels

The requirements regarding the fabrication of carbon steels apply to the fabrication of stainless steels as well. In addition, the following requirements apply to the fabrication of stainless steels:

- Surfaces which become contaminated with steel or otherwise stained or otherwise marked so as to be of uneven colour, shall be cleaned by pickling or electro-cleaning rather than by grinding.
- The Contractor shall arrange for the Engineer to inspect fabrications, including fabricated pipework, in the fabrication workshop.

MSS.9.7 Welding**General Welding Requirements**

Standards: Standards complying with good modern practice, and acceptable to the Engineer, shall be adopted. These include the following:

- BS 5135 - Arc welding carbon and carbon manganese steelwork
- BS 4677 - Arc welding austenitic stainless-steel pipework
- BS 2633 - Class 1 Arc welding of steel pipework
- BS 2971 - Class II Arc welding of steel pipework.
- BS 806 - Design and construction of ferrous piping in connection with land boilers (used for arc welding specification of all pipe flanges).
- Welders shall be experienced competent artisans approved in accordance with BS 4872.

Welding to be continuous: All welding shall be continuous on all sides of any joint unless otherwise approved in writing by the Engineer. No crevices will be permitted and where stitch welding has been approved by the Engineer, the crevices so left shall be sealed with an approved filling compound after priming but before further painting.

Weld appearance: Welding shall be free of blowholes and all welding flux shall be removed. All weld spatter and other sharp imperfections shall be removed prior to abrasive blasting. Prior to painting, weld beads with a surface irregularity exceeding 3 mm or with sharp crests having a radius under 2 mm shall be ground. Weld grinding must not be performed on 304L or 316L stainless steel, however, unless unavoidable.

Site welding: Site welding shall be kept to a minimum and shall only be undertaken with the approval of the Engineer.

Type of stainless steel: Austenitic stainless steels to be welded shall be of the low carbon grade (i.e.: 304L, 316L, etc.).

Welding rods: The welding rods used shall be the most suitable for the metal and purpose. Type 309 stainless steel welding rods shall be used for welding 3CR12 unless otherwise approved in writing.

General: All possible steps shall be taken to ensure maximum corrosion resistance, strength of the welds and welded material. Special care shall be taken to avoid prolonged heating. Welds shall be passivated. Discolouration and steel contamination must be removed by pickling or electro-cleaning as approved by the Engineer but should rather be avoided by taking the appropriate measures.

MSS.9.8 Guards

Guards shall comply in all respects with the Occupational Health and Safety Regulations and the following points shall also be noted:

- Guards are required to cover all moving or revolving components of machinery. Guards which do not adequately cover moving protrusions such as keys, lock-nuts, lockwashers, setscrews, etc., or irregularities such as keyways, will under no circumstances be accepted.
- Guards shall be neatly and rigidly constructed and fixed and shall not vibrate or cause noise during operation.
- Where expanded metal or similar mesh is used, the mesh opening shall not permit a circular object 10 mm or larger to penetrate.
- Mesh shall not be used for chain guards but on belt drives the side of the guard most conveniently sited for inspection shall be constructed of expanded metal or similar. Mesh should similarly be used in other situations where inspection or ventilation is required.
- Guards shall completely enclose drives and shall entirely prevent a person from touching any moving protrusion.
- Allowance must be made for adjustment on belt guards or where adjustment will be required.
- It shall be possible to remove the guard easily for maintenance purposes.
- Guards shall preferably be fabricated of 316 stainless steel (uncoated) but may also be hot-dip galvanized, zinc-sprayed or aluminium-sprayed carbon steel, coated to specification in all these cases. Fasteners shall be M10 or larger and shall be of 316 stainless steel.

MSS.9.9 Machine vibration levels

The mechanical vibration of machines measured at all important points such as bearings shall be lower than that specified as "good" for that class of machine in BS 7854 (ISO 10816).

MSS.9.10 Noise control**Noise levels**

The noise level of the complete installation shall not exceed the following:

- a maximum noise level at the Site boundaries not exceeding an equivalent continuous sound level of 55 dB(A) when all equipment installed is being operated;
- a maximum noise level at a distance of 1 m of each sound producing mechanical equipment of 80 dB(A).

Where the Contractor is unable to restrict the noise level of the machines to the maximum specified, by the appropriate selection of suitable equipment; e.g. by selecting slow speed or silent type machines, quiet type cooling fans, suitable silencers, etc. then an alternative solution, such as an acoustic hood or similar shall be offered.

MSS.9.11 Bearings

Bearing systems shall be designed to provide safe shut down without damage under normal stoppages as well as electrical supply failure.

MSS.9.12 Lubrication**Grease lubrication**

Grease lubrication is preferred, and all greasing points must be easily accessible.

Equipment with multiple greasing points shall be provided with grease lines which are piped, separately, to a single easily accessible position.

In cases in which motorised lubrication is provided to more than one destination; a distributor shall be provided. The distributor shall be a positive displacement device which ensures equal, successive lubrication to all destinations.

Pipework for grease distribution shall be of stainless steel or non-ferrous metal.

Oil lubrication

Oil level indicators shall be fitted for visual checking. Drain cocks, including 316 SS fittings where necessary to permit convenient draining, and plugged at the end, shall be provided for oil reservoirs exceeding 1.5 litre capacity. Drains shall be from the lowest point and syphon type drains are unacceptable.

Lubrication systems shall be designed to exclude dirt and moisture. Air vents on the oil reservoir shall contain an air filter.

MSS.10 CORROSION PROTECTION

Where corrosion of metal may be expected, the Contractor shall supply materials which are resistant to corrosion. Any material showing signs of corrosion, tuberculation or pitting before expiry of the Defects Liability Period must be replaced by the Contractor at no cost to the Employer. The Tenderer's prices will be held to include the cost of all painting or other surface treatment which is not separately specified or scheduled but which is nevertheless necessary for the protection of surfaces against corrosion.

MSS.10.1 Application and Control**MSS.10.1.1 Painting contractor**

Surface preparation and coating application shall be carried out by experienced industrial painting contractors who are fully equipped and staffed to do such work in their own covered premises strictly in accordance with the paint manufacturer's recommendations. Before proceeding with the corrosion protection coatings, the Contractor shall submit the name of the painting sub-contractor for approval by the Engineer.

MSS.10.1.2 Site work

Surface preparation and coating application shall not be done on Site except for minor repairs, for application of the final aesthetic coat, where specifically called for or where permitted by the Engineer in writing.

MSS.10.1.3 Systems to be used

Systems: The corrosion protection systems to be used on the Plant will usually be specified for the Plant, but if not, the Contractor shall recommend a suitable system for approval by the Engineer. If doubt exists as to the system or colour to be used, the Engineer's requirements must be ascertained.

Alternative systems: Alternative systems superior to those specified may be used if approved in writing by the Engineer.

All items to be painted: Except where otherwise specified, all metal surfaces shall be painted. This includes hot-dip galvanized items and metal-sprayed coatings. In the latter case the paint shall be in the form of a sealer. Details of approved painting systems to be used are given below.

Coating appearance: After installation on Site the finished paintwork must be neat, smooth, of uniform colour and to the approval of the Engineer.

316 Stainless steel: It is not usually necessary to paint 316 stainless steel. If corrosion of 316 stainless steel does occur and depending on the appearance or extent of the problem, the Engineer may call for pickling, electro-cleaning, painting or replacement of the item at no additional cost. Painting may however be required if contaminated or stained surfaces cannot be properly cleaned or where stitch welding has been approved.

MSS.10.1.4 Quality control of coating application

Inspection: The Contractor shall arrange for the coating application on fabricated steelwork to be inspected throughout by the Engineer. The Engineer may approve inspections by an independent competent person (hereinafter called the Inspector) appointed by and at the cost of the Contractor.

Inspection report: A written report of the inspections, prepared by the Inspector and signed by both the Inspector and the Contractor, shall be submitted for appraisal by the Engineer before delivery of the Plant to Site.

Inspector qualifications: Inspectors appointed by the Contractor shall hold an appropriate qualification from any of the CISA, the SAIW or the SAQCC.

Identification of items: Every item to be coated shall be identified by a welded or hard-stamped code. Records shall be maintained for each item.

MSS.10.2 Surface Preparation**MSS.10.2.1 Imperfections**

Welding shall be free of blowholes and all welding flux removed. All weld spatter, sharp edges and other imperfections shall be removed prior to abrasive blasting. Prior to painting, weld beads with a surface irregularity exceeding 3 mm or with sharp crests having a radius under 2 mm shall be ground. (Weld grinding must not, however, be performed on stainless steel). Areas to be painted shall be free of crevices. If the Engineer has permitted stitch welding, crevices shall be filled with a compatible sealing compound after the priming coat has been applied.

MSS.10.2.2 Abrasive blasting

Before coating, all surfaces shall be properly degreased and abrasive blast cleaned to an SA3 finish with a 40-65µm surface profile to Swedish Standard SIS 055900 of 1967. The abrasive shall comply with paragraph 4.3.3 of SANS 064 and shall be free from all traces of oil, grease, foreign matter and corrosive contaminants such as chlorides, etc. The prepared surface shall be given the first coat of the painting system within 4 hours after cleaning.

In instances where stainless steel and 3CR12 are to be painted, the surface shall be suitably abrasive blasted prior to primer application.

MSS.10.2.3 Between coats

Between coats or with previously painted surfaces in good condition, all traces of oils, greases, soluble salts and corrosive air borne contaminants shall be thoroughly washed from the surface to be painted using a detergent type cleaning agent, rinsed and dried. The previous coat shall then immediately be lightly sanded or otherwise prepared as recommended by the paint manufacturer, wiped clean, dried and painted. Solvents are not acceptable as a surface cleaning agent.

MSS.10.2.4 Hot-dip galvanized surfaces

Hot-dip galvanized surfaces to be painted shall be free from white rust and shall be cleaned with an approved water based galvanizing cleaner using non-metallic abrasive pads until a "water break free" surface is obtained. The surface shall then be thoroughly rinsed with clean potable water to remove all residues and dried immediately prior to painting. Where necessary to obtain adhesion a sweep blast of the surface shall be done after cleaning.

MSS.10.3 Metal Coatings**MSS.10.3.1 General**

Fabrication of items to be protected by metal coatings shall be in accordance with SANS ISO 14713.

MSS.10.3.2 Hot-dip galvanizing

Standard: Hot-dip galvanizing shall be done in accordance with SANS 121 (ISO 1461:1999) Hot-dip Galvanized Coatings on Fabricated Iron and Steel Articles.

Thickness: Coatings shall be to the thicknesses detailed in the Standard.

Passivation: Hot-dip galvanized material which is to remain unpainted shall be passivated as specified in SANS 121. Items to be painted after hot-dip galvanizing shall be air dried and not passivated.

White rust: Hot-dip galvanized material shall be substantially free from white rust when it is erected on site. Stacking and storing shall at all times be done in a manner to prevent white rust forming.

Repair: Damage to hot-dip galvanizing caused by welding, grinding, etc. is not acceptable. The repair to hot-dip galvanizing damaged by handling or transport shall be done by cleaning the area and applying 3

coats of a zinc rich primer giving a dry film thickness of at least 100 µm and containing at least 94 % zinc in the dried film. If the opinion of the Engineer is that damage is excessive, such items will be rejected by the Engineer and shall be replaced by the Contractor at his own expense.

Welding: Welding after hot-dip galvanizing is not acceptable.

Test certificate: The Contractor shall supply a galvanizer's guarantee or test certificate prior to installation.

MSS.10.3.3 Sprayed metal coatings

Standard: Sprayed metal coatings shall be done in accordance with SANS 1391: Standard Specification for Thermally Sprayed Metal Coatings as amended below. The statements below apply to Part 1 of SANS 1391.

Symbols: The type symbol described in Table 1 of the Standard shall be used to specify material and thickness requirements; i.e. AL for aluminium, Zn for zinc, followed by the minimum average thickness in microns.

Thickness: The minimum coating thickness for both Aluminium and Zinc shall be 150 µm.

Thickness testing procedure: The procedure laid down in Clauses 4.2.1.3 a(1) or b(1) of SANS 1391: Part 1 for the determination of the coating thickness shall not be regarded as sufficient. The thickness shall be checked on every surface plane at points not more than 300 mm apart for small articles and 500 mm for large articles, e.g. angles shall be checked along all 4 surfaces, channels along all 6 surfaces, pipes in 4 planes etc. The minus tolerance on thickness in isolated areas shall also not exceed -10% and such low areas shall not be larger than 50 mm in diameter.

Period between preparation and coating: For the purpose of Clause 3.3 of SANS 1391: Part 1, the time between preparation and coating shall be shortened from 4 hours to 2 hours at any application area closer than 10 km from the coast.

Sealing: Unless otherwise specified, all metal coatings shall be sealed immediately after metal-spraying using a suitable pre-treatment wash primer followed by coats of low viscosity sealant until absorption is complete. This shall be followed by a suitable top coat system to give a smooth final finish. The various coatings used shall be as specified or, if not specified, shall be selected by the Contractor to suit the duty and submitted to the Engineer for approval. The final coat shall normally be applied on site after installation. Colours shall be as specified or as agreed with the Engineer.

Depending on the particular application, the following systems are acceptable:

System 1

- Application of micaceous oxide pigmented polyamide cured epoxy to achieve a dry film thickness of 60-80 µm; (Sigmarite Sealer, or equivalent).
- One coat of solvent borne modified acrylic coating to achieve a dry film thickness of 70 µm; (Sigma Topacryl coating, or equivalent).
- One coat of solvent borne modified acrylic finish to a dry film thickness of 30-45 µm; (Sigma Topacryl finish, or equivalent).

System 2

- Application of one coat of two component epoxy primer to a dry film thickness of 40 µm; (Intergard 269, Chemrite Carboline Rustbond Penetrating Sealer, or equivalent).
- Application of one intermediate coat chemical resistant vinyl copolymer to a minimum dry film thickness of 70 µm.
- Application of one coat of vinyl copolymer chemical resistant enamel to a minimum dry film thickness of 40 µm.

System 3

- Application of one coat of two component epoxy primer to a dry film thickness of 40 µm; (Chemrite Carboline Rustbond Penetrating Sealer, Intergard 269, or equivalent).
- Application of two coats of polyurethane enamel (twin pack) to a minimum combined dry film thickness of 70 µm.

MSS.10.4 Paint Coatings**MSS.10.4.1 Paint selection**

Paint quality: Paint shall be of best quality, of approved manufacture and brand and comply with the requirements of the relevant SANS or BS specifications.

Compatibility: To avoid incompatibility between paint coats due to variations in formulation, the different coats in any one paint system shall be provided by the same manufacturer.

Confirmation of suitability: Contractors shall obtain confirmation from their paint suppliers that, when using their paints, the systems specified are technically correct and suitable for the application and the material being coated.

MSS.10.4.2 Paint application

Surface preparation: All surfaces shall be properly prepared as specified in Clause "Corrosion Protection: Surface Preparation".

Painting: Paints shall be applied strictly in accordance with the manufacturer's instructions by tradesmen skilled in this class of work. Thinning of paint shall only be allowed for spray application and the manufacturer's recommended thinners shall be used.

Coating of hidden areas: Areas which will be inaccessible after erection and surfaces resting on floors shall receive the full paint system prior to erection. Mating or contact surfaces shall be prepared and primed and be brought together while the paint is still wet.

Items encased in concrete: Metal to be encased in concrete shall be painted externally up to 30 mm inside the concrete section, leaving the remainder bare so as to facilitate bonding with the concrete.

Crevices: Crevices will not be permitted. Where unavoidable crevices are accepted by the Engineer, such crevices shall be filled with a compatible filler after application of the priming coat.

Protection of machined surfaces: Where painting of machined surfaces is not possible or advisable, these surfaces shall be coated with an approved proprietary anti-corrosion compound giving 12 months protection under operating conditions. Shaft ends and machined mating or mounting surfaces or pads shall be so coated and shall not be painted.

Coating thickness: The dry film thickness shall be measured using a non-destructive thickness gauge such as the "Mikrotest" or equivalent and shall comply with the Specification.

Repair: Painted areas damaged during transportation, erection or any means whatever shall be repaired as follows - Rusted spots shall be removed and cleaned by means of a wire brush or emery paper to a bright metal finish and the surrounding paint which is still intact shall be feathered for a distance of 50 mm beyond the damaged area. Spot priming and repair shall consist of all the coats previously applied and shall overlap the undamaged area.

Protection on site: Proper and adequate use of cover sheets and other means shall be made to protect the existing paintwork from damage and from metal dust and sparks when welding, grinding, and wire brushing on site. Similarly effective steps shall be taken to prevent spillage or splashing or other damage to floors, walls and Plant when painting on site and any damage or mess caused shall be corrected at the Contractor's cost.

Final coat: The final external coat/s shall always be applied on site after installation except for System A/1, where all coats shall be applied by a specialist applicator at his premises. A professional, smooth finish with a uniform colour is required.

MSS.11 SPARES, TOOLS AND LUBRICANTS

Tenderers must submit in the appropriate Schedule a priced list of spare parts which it is recommended should be kept by the Employer for maintenance of the plant. All spares must be packed separately and the cases appropriately marked. All spares must be new and unused.

Tenderers must submit a price for any special spanners, keys and tools required for the operation, adjustment and overhaul of the plant supplied, together with a metal cabinet for same for mounting in a convenient position in a nearby building. All spanners, keys and tools shall be new and unused.

In addition to the lubricating oil to be provided for commissioning the plant (where applicable) an additional quantity of oil adequate for at least two complete refills of such plant must also be provided.

A grease gun suitable for use in conjunction with all the grease nipples on the plant must be provided together with at least 5 kg of the appropriate grease to be used. If more than one type of grease is required, a separate grease gun for each type of grease and 5 kg of each type of grease must be provided.

The spare parts to be offered shall not be limited to but shall include the following:

Centrifugal Pumps:

- Impeller Shaft sleeves
- Spacers Keys
- Bearings Seals

- Races Glands
- Wearing rings Shaft
- Two complete sets of gland packing and sufficient other parts for the complete replacement of all moving and wearing parts of one pump.

Electrical:

- One set of bearings for each size of motor.
- Two sets of fixed and moving main contacts for each type of contactor.
- One set of fixed and moving auxiliary contacts for each type of contactor.
- One operating coil for each type of contactor.
- One set of fixed and moving contacts for each type of relay.
- Two sets of HRC fuses for each size of fuse.

All spares that are ordered shall be supplied and handed over to the Employer. Each part shall be hermetically sealed and labelled by means of a corrosion proof label firmly affixed to it by wire. On each label shall be stated:

- The Manufacturer's name and address.
- The Manufacturer's catalogue or part number.
- A description of the spare part.
- A description of the particular plant for which the spare is supplied and the Contract Bills of Quantities item number under which the particular Plant was supplied originally.
- The date of supply of the spare part.

MSS.12 ELECTRIC MOTORS

The detailed specifications for the electric motors are included in the electrical technical project specifications that form part of this document. Electric motors are to be designed with an adequate safety margin as set out in the table below:

Maximum Power Absorbed by the Driven Machine Under All Operating Conditions	Percentage to be Added to the Absorbed Power Under the Operating Condition of Maximum Power Absorbed
Up to 4 kW	50%
> 4 kW & up to 30 kW	25%
> 30 & up to 100 kW	15%
> 100 kW	10%

MSS.13 PUMPS

The pumps offered shall be pumps of proven performance and preferably of standard design, except that the pumps must be located to suit the layout shown on the relevant drawing, if applicable, issued with the Tender Documents.

All parts are to be properly designed with ample margin of safety and are to be suitable for their pumping duties.

The speeds should preferably be as stated in the relevant clauses (preferably be less than 1500 rpm but

must not exceed 3000 rpm) and should be such as to permit direct drive by a squirrel cage induction motor except in those cases where the drive is to be adapted to suit future changes in duty or where stated otherwise.

Belt-driven pumps chosen for the sole purpose of manipulating the speed of driven machinery shall not be acceptable. Belt-drive shall be motivated on a case-by-case basis and presented for acceptance to the Engineer.

Pumps shall be of maker's standard and approved design, capable of doing the duty required and shall be so balanced that there will be no end thrust when the pump is new or after wear has taken place, or alternatively, suitable heavy duty thrust bearings must be provided. Pump casings are to be of high-grade close-grained cast iron or cast steel of grade suitable to withstand the field or factor test pressure specified elsewhere, rigidly secured to a neat, properly designed bedplate or base. Impellers and guides shall be of stainless steel or phosphor bronze (for potable water pumps) and the shaft of high tensile steel with protecting sleeves of bronze or other suitable metal, the diameter being sufficient to withstand and transmit without whip and with ample margin of safety all torsional and bending stresses to which it may be subjected. The pump manufacturer shall utilise suitable materials for impellers, guides, shafts and protecting sleeves and other parts in contact with the fluid to be pumped so as to enable them to resist all corrosions and erosion damage. Bearings are to be of ample bearing area, dustproof with suitable provision for continuous lubrication.

MSS.13.1 Centrifugal Type

All centrifugal pumpsets shall be designed and supplied in accordance with ISO 9908 – Technical specification for centrifugal pumps - Class III. The Manufacturer / Supplier shall review the rated (guarantee) duties and offer his best technical and financial solution at the highest operational efficiency for each station, based on the type (i.e. end-suction, multistage or horizontal split casing), size and arrangement of pumpsets proposed.

The pumps offered are preferably to be of the self-regulating type with a "stable" characteristic i.e. for any selected manometric head each pump shall be capable of pumping at only one rate. Performance particulars and characteristic curves for each type of pump shall be submitted at the time of tendering. Efficiencies should be as high as possible in the normal indicated operating range. These will be taken into account in the adjudication of tenders. Pumps offered should operate within 10% on the Best Efficiency Point flow-rate.

Wherever possible axial thrusts should be counteracted by hydraulic balancing rather than by thrust bearings. The pumps shall be statically and dynamically balanced.

Components of the pumps should be so fitted and fixed that neither normal nor contra rotation can give rise to torques which will set them free to move out of their proper position.

The arrangements for bearing lubrication, water seals, air bleeding and priming of all pumps and pipework shall be such as to permit unattended stopping, starting and operation of the pumping plant by means of automatic remote control for the longest possible period under the control and operating conditions specified and in accordance with the general duty requirements.

The parts of each pump from suction inlet flange to delivery outlet flange shall be capable of withstanding

the internal hydraulic pressures or at least four times higher than those applicable under normal working conditions on the site, whichever is the higher.

Submersible (borehole) pumps shall utilise high grade stainless steel (304) for the outer case, impellers and diffusers, as a minimum. It shall have a Teflon floating wear ring, ceramic coated bearing journal and Nitrile rubber bearing bushes and O-ring. There must be a built-in non-return valve to protect against water hammer (although there must be another wafer-type non-return valve installed in the pump delivery piping above the surface of the reservoir). The submersible motors must cater for over-temperature protection.

MSS.13.2 Factory Testing of the Pumps

A hydrostatic test shall be performed for pressure-containing parts of a pump at a test pressure of at least 1.5 times the basic design pressure. This pressure shall be maintained for a period of at least 10 minutes. The Employer or his agent shall be entitled to witness the pressure tests (as required and indicated on the data sheets provided with this tender) and at least two (2) weeks' notice shall be provided before such testing takes place. A test certificate shall be issued after the successful completion of such tests, in an approved format.

Each pump shall be subject to a hydraulic performance and NPSH test in accordance with ISO 9906, Class I or II, at an approved test facility. The Employer or his agent shall reserve the right to witness all tests (as required and indicated on the data sheets provided with this tender) and shall be granted full and complete access to all test data taken during the course of the test. They shall furthermore, be provided with copies of all test sheets, calibration certificates etc. upon completion of the tests. At least two (2) weeks' notice shall be provided before such tests are undertaken.

Where pumps are supplied as complete pumpsets, these shall preferably be tested as such and shall be complete with own job motors.

It should be particularly noted that all test data and performance curves produced shall be presented in the units as described in the variation above.

In addition to the test point required to establish the guaranteed performance, a sufficient number of test points shall be measured so as to establish the shape of the full performance curve as presented in the Tender.

During the execution of the performance test, the mechanical operation of the pump shall be monitored with particular reference to abnormal temperature, noise, vibration and leaks.

Failure to achieve the rated (guarantee) point may render the equipment liable for rejection. Should this occur the manufacturer/supplier shall then be responsible to rectify the equipment to achieve such guarantees at own expense.

Items have been included in the Bills of Quantities to enable Tenderers to submit separate prices for factory hydraulic testing and factory performance testing of the three pumps.

MSS.14 BASEPLATES, COUPLINGS AND GUARDS

MSS.14.1 Common Baseplates

Both direct coupled and belt driven machines shall be mounted with their drivers on common cast iron or fabricated steel baseplates of rigid construction.

MSS.14.2 Corrosion Protection

Steel baseplates shall be hot dip galvanized unless specified otherwise in the Project Specification.

MSS.14.3 Machined Mounting Pads

The baseplate shall incorporate machined mounting pads at the support and fixing positions of each item of Plant to be mounted on the baseplate. On fabricated baseplates this machining shall be done after fabrication, stress relieving (if applicable) and hot dip galvanizing are complete. The thickness of the solid pads shall be not less than 1,25 times the diameter of the holding down bolts. The pads shall not be provided with threaded holes for machine screws but shall be drilled for inserting through bolts and adequate provision shall be made for reaching the nut with a suitable spanner. In the period between machining and installation of the Plant, the machined surface shall be protected against corrosion by a removable coating. After installation, a non-hardening compound, Tectyl or equivalent, shall be applied to exposed machined surfaces and to the crevice formed at the foot of the Plant.

The above design may be suitably modified if the Contractor uses a pourable resin based chocking system. Such chocks shall be at least 15 mm thick.

MSS.14.4 Fasteners

Anchor fasteners shall be of grade 316 stainless steel with threads coated with a nickel based, anti-seize compound before assembly.

MSS.14.5 Alignment

Preliminary alignment shall be done at the factory to ensure that the baseplate has been correctly manufactured, but final alignment shall always be done on site after installation and grouting has been completed. Alignment shall be accurate and to the approval of the Engineer and a final alignment check witnessed by the Engineer must be carried out by the Contractor prior to start up.

MSS.14.6 Shimming

Not more than three shims may be used at any point, and these must be made of a corrosion resistant material.

MSS.14.7 Jacking Screws

At least two diagonally opposed jacking screws shall be provided for belt tensioning in the case of belt driven units. Direct coupled motors above 10 kW shall be provided with jacking screws for horizontal alignment and direct coupled motors above 150 kW shall be provided with jacking screws for vertical alignment as well. Jacking screws shall be of grade 316 stainless steel.

MSS.14.8 Grouting

Baseplates shall be so designed and grouted as to eliminate collection points for water or dirt. Except where otherwise approved in writing by the Engineer, all baseplates on concrete plinths shall be fully grouted in. Grouting holes must be provided on baseplates having a continuous top plate. Tapped holes and fixing setscrew protrusions shall be suitably protected.

The material used for grouting shall be a non-shrink, cementitious grout (ABE Duragrout 1000, or equivalent). ABE Epidermix 324, or equivalent, is acceptable if the Contractor's design requires an epoxy grout to be used.

The initial grouting shall be overseen by the supplier's technical representative.

MSS.14.9 Soleplates

In applications where baseplates are not practical, machined soleplates, suitably fixed and grouted to the concrete plinths, shall be provided. No machine may be mounted directly onto a concrete base without the use of either a baseplate or soleplate.

MSS.14.10 Couplings

Except in cases where special drives are required for future duty changes, in which cases the drive shall be arranged by the Contractor to suit his plant, each pump shall be direct coupled to its corresponding motor by means of pin and bush type, shrouded, flexible couplings of robust design constructed to restrict end-float of the motor shaft as required to prevent damage to motor bearings. Coupling halves shall be precisely machined and securely fitted so that the rims and faces of the two halves of any coupling may be used for checking alignment errors of parallelism and angularity of motor and pump shafts to accuracies of $\pm 0,025$ mm and $\pm 0,025$ mm on 100 mm, respectively

The coupling shall be of the so-called "tyre" type ("Fennaflex" or similar approved) which can tolerate slight mis-alignments. The coupling selection shall incorporate a minimum service factor of 1.5 of the rated power of the motor.

Clearance between the two halves of the flexible couplings shall be adequate to avoid interference between the metal halves. Sufficient clearance is to be provided between the halves of the coupling to allow unhampered end-wise movement of the shaft of the motor to the limit of its bearing clearance. The running position of the motor-half of the coupling is to be checked by the Contractor by running the motor alone and the couplings halves set on the shafts accordingly.

The importance of ensuring that the suction and/or delivery pipework does not impose any forces onto the pump casing(s) is recognised. The Engineer will therefore require the Contractor to complete carry out the following after completion of the installation of the pump sets and pipework but before hydraulic testing:

- Remove all the bolts and nuts in the pump suction/suction pipework connecting flange.
- Remove all the bolts and nuts in the pump delivery/delivery pipework connecting flange.

There shall be no apparent movement of either the pump flanges or the pipe flanges and each bolt shall not require excessive force to insert it back into its hole in the abutting flanges. In the event of it not being possible to easily (without force) insert every bolt, the Contractor shall rectify the matter.

Thereafter the hydraulic pressure test shall be carried out.

MSS.14.11 PAYMENT AND MEASUREMENT

The provision of all general mechanical design, construction and material requirements as specified within this standard specification shall be included for in the overall price of equipment offered and measured and paid on a re-measurement basis or as otherwise indicated in the Project Specification.

EWS STANDARD SPECIFICATIONS

GS.1 STANDARD SPECIFICATION FOR DB's AND MOTOR CONTROL CENTRES

(FOR HEAVY INDUSTRIAL AND COMMERCIAL USE)

All major motor control centres and equipment shall be designed in accordance with SANS 1473/60439. The equipment shall conform to SANS 60947 Parts 1-7, unless otherwise stated and shall be suitable for operation on supply voltages of 230/400 Volts and 500/550 Volts, 50Hz, AC. Reference must be made to the detailed technical specification, the relevant line diagram if provided, as well as the following specific requirements.

In addition the design must conform to the following standards:

- Act No. 85 of 1993 Occupational Health and Safety Act.
- SANS 10142 Code of Practice for the Wiring of Premises
- Relevant SANS specifications and Codes of Practice
- Relevant BSI Specifications and Codes of Practice in the absence of published SANS documents.
- Relevant IEC Specifications and Codes of Practice in the absence of published SANS and BSI documents.

GS.1.1 CONSTRUCTION OF MOTOR CONTROL CENTRE ASSEMBLIES

All motor control centres shall generally be of the free standing, floor mounted, individual starter with local isolator for each motor type, with front and back access, suitable for bottom cable entries from cable trenches below the assembly. The schematic drawings or project specification show the specific requirements applicable to each assembly.

The assembly will be constructed of powder coated 3CR-12 having a minimum thickness of 2mm except for gland plates which shall be a minimum of 3mm. If thinner material is offered, offered, the construction technique must be approved by the Employer's representative prior to fabrication.

Where specified the assembly enclosure may be required to be manufactured from stainless steel.

The degree of protection shall not be less than IP 43, in accordance with SANS 1222 and capable of withstanding the temperature, humidity and conditions normally associated with heavy industrial applications. The assembly shall be fully vermin proofed.

A hot dipped galvanized steel base frame shall be provided and removable lifting eyes with blanking off plugs shall be provided for heavy assemblies. All panels shall be suitably braced to ensure rigidity.

The MCC's are to be fully assembled in the manufacturer's factory for final acceptance tests. Where broken down for transportation to site, the MCC's will be provided with all items required for re-assembly. Provision must be made for future extension at either side of the MCC. All holes provided for such extension to be suitably plugged or covered.

The overall outside dimensions of the assembly shall be suitable for easy handling of the switchgear. The height of the assembly shall generally not exceed 2100mm above floor level.

All doors shall be fitted with stainless steel or heavy duty rustproof hinges of Barker & Nelson or Zeus manufacture and shall be secured in the closed position by means of locking devices of approved quality. Doors in excess of 450mm height shall be secured at both the top and bottom. Lockable catches are required on all doors. All doors are to be fitted with earth straps.

Covers, other than the hinges type, shall be provided with chromium plated handles to facilitate removal. Removable covers shall be secured in position by means of patent screw locking devices approved by the Employer's Representative. All the equipment shall be mounted behind the doors and neat machine punched openings shall be provided for the purpose of operating handles etc. Employer's Representative's drawings or specifications will detail the instruments required which will be flush mounted. The positions of instruments shall be such that the glass cannot be broken by other equipment when the doors are in the fully open position.

Cut outs which are provided for future equipment and instruments shall be neatly blanked off by means of removable dummy frames. Back plates shall be provided in all spare cubicles for the specified future starters.

The manufacturer's detailed working drawings of the assembly must be approved by the Employer's Representative before any fabrication commences. Any other construction or type of assembly proposed as an alternative to that specified, must have the approval of the Employer's Representative in writing. The drawings will detail all dimensions of busbars, connections, electrical components, make, type and rating. Position and layout of busbars, earth bars and gland plates must be shown in front and side elevation drawings.

GS.1.2

PAINT SPECIFICATION

In general, the following standard colours shall be used, but the final colours are to be confirmed with the Employee's Representative.

Non-essential section	Electric orange (Colour B26 – SANS 1091)
Essential sections	Signal red (Colour A11 – SANS 1091)
Uninterrupted power (UPS)	Electric orange (Colour B26 – SANS 1091)
Instrumentation and control	Electric orange (Colour B26 – SANS 1091)

GS.1.3

BUSBARS

All busbars shall be manufactured from solid high conductivity copper and shall comply with the requirements laid down in SANS 1195. The completed busbar system shall be a standard modular system and shall have been tested to SANS approval and a certificate shall be made available confirming the full busbar technical description, current rating and fault rating together with full details of the test results.

The busbar assembly shall be rated in accordance with the specified ultimate projected faulted level, which will be not less than the short-circuit stresses limited by the protective device(s) on the supply side of the busbars, as well as the specified continuous full load current, with a current density not exceeding 1.60 Amps per mm².

The busbars shall be continuously rated for the specified current with a maximum temperature of 40°C relative to a peak ambient temperature of 40°C giving a maximum peak busbar temperature of 80°C.

Busbars shall be mounted in the top section of the assembly and shall be rigidly supported by means of approved insulated busbar clamps to prevent damage resulting from the specified short circuit conditions.

The busbars shall run along the entire length of the assembly up to 76mm from either end. The phase busbars shall be identified in the phase colours red, white and blue.

The busbars shall be arranged horizontally with the longer side of the cross-section in the vertical plane and one behind the other in the horizontal plane. The minimum clearance between live conductors and live conductors and earth shall be 40mm.

GS.1.4

BUSBAR DROPPERS

All busbar droppers must be suitably supported and braced to suit the specified and/or project short circuit conditions. They should be fully insulated and screened against accidental contact.

The droppers to the supply side of a single functional unit, as well as the components included in this unit, may be rated on the basis of the reduced short-circuit stresses occurring on the load side of the short-circuit protective device in this unit provided that these conductors are arranged such that under normal operating conditions an internal short-circuit between phases and/or between phases and earth is only a remote possibility, for example by being provided with adequate insulation or shrouding.

Particular attention shall be paid to the provision of adequate facilities for making off the main power supply cables. Attention must be paid to the vermin proofing of single core cabling.

Bunched cable connections will not be accepted between busbars and outgoing power circuit breakers, fuses or isolators.

GS.1.5

EARTH BUSBAR

A solid copper earth bar shall be provided inside each assembly at the back and along the entire length, at a height of approximately 500mm above floor level, or 200mm above the gland plates. A bar is to be provided at the top of the assembly where top entries exist and this shall be solidly connected to the bottom earth bar.

The earth bar will be supported on robust spacers and will have a minimum clearance of 40mm to the sheet steel panel.

The earth bar shall have a cross-section of not less than 40mm x 6mm and shall be drilled with the requisite number of holes for the individual connection of all cable ECC and other earth conductors.

High tensile phosphor bronze or cadmium plated nuts, bolts and lock washers shall be provided through the earth bar at each earth position and at least 5 additional holes will be provided for future connections, each being fitted with nuts and bolts as above.

The earthing positions shall be evenly spaced along the length of the earth bar and the bar must be clearly identified as the earth.

GS.1.6

BUSBAR CONNECTIONS

All connections and extensions to busbars shall be effected by means of high tensile phosphor bronze nuts, bolts and washers or cadmium plated, high tensile steel bolts and nuts which shall also be provided for future extensions. The minimum diameter of any holes will be 10mm.

In exceptional cases a relaxation of SANS 1973 may be permitted to allow the drilling of holes, in which case the cross-sectional area as measured is to be reduced by the area of the holes.

GS.1.7

EQUIPMENT

Unless otherwise stated on the drawings or as specified, the latest version of the following minimum specifications shall be assumed for equipment to be installed in the switchboards.

Busbars	SANS 1195
Circuit breakers	SANS 60947 Part 2 and SANS 156
Switches, disconnectors and fuse Combination units	SANS 60947 Part 3
Contactors and motor starters	SANS 60947 Part 4
Control circuit devices and switching Elements	SANS 60947 Part 5
Multi-function switching devices	SANS 60947 Part 6
Ancillary Equipment	SANS 60947 Part 7
HRC fuses and fuse switches	SANS 60269

SANS 60947 relates specifically to equipment for use at voltages up to 500 Volts

Where a voltage in excess of 500 Volts is specified, the manufacturer must confirm that the equipment is suitable and has been tested to that higher voltage.

The equipment to be mounted in the panels will be detailed in the drawings or as specified and schedules provided.

All contactors and/or starters shall be protected with suitable back-up HRC fuses or current limiting circuit breakers to protect the equipment against abnormally high currents or short circuits developing in the system.

The manufacturer will be required to ensure the correct co-ordination between fuses, contactors and overload relays to comply fully with SANS 60947 Part 4 in order to achieve "Type 2" co-ordination. Current limiting circuit breakers will only be permitted if the manufacturer submits full details of tests results confirming to Type 2 co-ordination.

Unless otherwise stated, contactors and/or starters shall be rated for 10 million operations for making and breaking no-load current to category AC3 as laid down in SANS 60947. Note that SANS 60947 requires equipment and wiring to be suitable for $7.2 \times \text{FLC}$ for DOL starters.

Access to the various starters shall be possible without isolation of the entire MCC, but the doors corresponding to each compartment shall be inter-locked with a local isolator in order that any compartment must be isolated before access to the equipment can be obtained. A mechanical device shall be incorporated in each isolation in the off position to provide a locking out facility during maintenance periods.

Timers and relays controlling a starter shall be mounted in the compartment with the starter. All timers and relays must be clearly labelled with the identity given on the schematic diagrams.

GS.1.8

DERATING OF EQUIPMENT

Full cognizance must be taken of manufacturers derating tables of equipment located in enclosures and the rating of that equipment must be increased accordingly. In all such cases labels must be provided on the front of the associated cubicle stating the maximum permitted circuit loading.

Where high ambient temperature and/or continual high loadings are anticipated, the assembly must incorporate adequate ventilation systems to eliminate the possible build-up of excessive temperatures or humidity. Where specified, renewable filter elements must be incorporated.

GS.1.9

CABLE TERMINATIONS

Due to the continuing miniaturization of equipment, difficulties can be experienced in terminating power cables onto equipment terminals, particularly where more than one cable has to be terminated. The manufacturer shall ensure that suitably designed and rigidly braced copper stubs are extended from such terminals to facilitate the termination of all cables.

GS.1.10

INSTRUMENTATION

All instruments shall be of a matching flush pattern, preferably with a 96mm x 96mm square dial.

All main incoming panels shall be provided with three combined maximum demand/instantaneous ammeters, a voltmeter and selector switch as well as any additional instrumentation detailed on the single line diagrams or as specified.

GS.1.11

AMMETERS

Combined maximum demand type instruments will comprise a moving iron ammeter showing the instantaneous current value, combined with an ambient corrected, manually reset, thermal maximum indicating ammeter which will indicate the mean current reached during any 15 minute period.

The starter cubicles for all motors rated at 11kW and above and all motor driven pumps irrespective of size shall be provided with an ammeter, which shall incorporate an adjustable red pointer and an extended starting characteristic. Allowance must be made for the full load current of all motors to be checked and for all red pointers to be set accordingly.

GS.1.12 CURRENT TRANSFORMERS

Where applicable, the current transformers shall generally be of the ring type complying with the requirements of SANS 60044-1, as amended. The current transformers shall have a Class 3 or 5 accuracy.

GS.1.13 VOLTMETER

Voltmeters shall be of the moving iron, suppressed zero type, having a full scale deflection of not less than 480 Volts, unless otherwise specified.

GS.1.14 VOLTMETER SELECTOR SWITCH

All voltmeter selector switches shall be wired to connect the voltmeter between all phases and each phase and neutral and shall disconnect it in the OFF position. The switch shall have a position located switching mechanism.

GS.1.15 INSTRUMENTATION FUSES

All instrument fuses shall be mounted in the panel onto or next to the busbars. 6mm² wiring shall be used between the busbars and the fuses and shall be kept as short as possible.

HRC cartridge fuse links to SANS 60269 shall be used and shall incorporate visual indication devices to facilitate the location of blown fuses on visual inspection. They shall be designed to clip into the fuse carrier contacts without the use of fixing screws.

Wiring from fuses bases to instruments may be bunched but must be suitably supported in Bowthorpe Hellerman trunking or lacing.

GS.1.16 PROTECTIVE DEVICES AND PROTECTION SETTING

The switchgear shall be provided with the specified protection and auxiliary relays, which must be of a modular pattern, readily accessible, replaceable and extensible.

The thermal overload releases and instantaneous magnetic short circuit trips are to be adjustable over the trip ranges as specified by the Employer's Representative.

The contractor must allow to grade, set and test the protection devices for the main switch, bus section switches and each motor circuit.

GS.1.17 PUSH BUTTONS AND INDICATING LIGHTS

Unless otherwise indicated, the following is the minimum requirement for illuminated push button and indicating lights:

START and STOP push buttons

RUN, STOP, THERMISTORS and HEATER lights

Indicator lamps may only be of the neon or LED types. Where LED's are used as indicators on main supply voltages, a suitable current limiting capacitor and reverse voltage protection diode must be used. For low AC or DC voltage ($\pm 24V$) a current limiting resistor will suffice.

CONTROL VOLTAGE SUPPLY /BACK UP SUPPLY

The control voltage shall be provided by a single phase, double wound transformer supplied from the Red and White phases of the main busbars, with the secondary voltage as specified on the schematic diagrams or as specified.

The primary and secondary connections are to be provided by suitably rated and labelled HRC fuses.

Unless otherwise specified, the transformer shall be rated at $0.8 \times$ (total hold-on VA of all contractors plus VA of all lights and relays plus pull-in VA of largest device) with a further additional allowance of 50% for future extensions.

Should the main busbar system incorporate a bus-coupler, 2 control transformers shall be provided. Supplies to the 2 transformers shall be controlled by contactors interlocked to ensure that only one transformer supplies the control circuit at any one time.

Where suitable, a control voltage busbar shall be provided along the length of the MCC. A power supply unit with backup up battery for the PLC is to be installed and wired in a separate cubicle. The 12V DC circuit must be supplied by a 25W DC/DC converter for equipment using 12 Volts (eg. room security sensors). Two (2) backup batteries are to be low maintenance sealed lead acid type of 12 V DC 70AH.

CABLING, WIRING AND TERMINALS**STARTER WIRING**

Particular attention shall be paid to be the method of wiring from busbars to the individual compartments, in order to avoid any cable crossing through a compartment with which it is unrelated.

The wiring between all starter components, isolators, fuses, contactors, overload relays and terminals is to be rated to suit the maximum capacity of the starter and is to be not less than 6mm^2 .

Three phase panels shall be wired in red, yellow and blue PVC insulated conductors for the phases, black for neutral and green earthed circuits.

Single phase panels shall be wired in red and black PVC insulated conductors, for phase and neutral respectively and green for earthed circuits.

Neutral connections shall be black and this colour must not be used for any other wiring.

Multi-stranded or laminated conductors shall be used between all items of equipment in preference to solid conductors. The insulation of these conductors shall not be stripped beyond the leading edge of the terminal in which it has to be accommodated.

Stripping shall be carried out without damage to the conductors, preferably by means of a cable stripper.

Approved crimping lugs and ferrules or approved clamps shall be used for connection into equipment not provided with compression type terminals.

All panel wiring shall be completed and installed at the MCC manufacturing works. The wiring shall be loomed or encased in PVC cable trunking of Hellerman manufacture or equal approved and shall be carried out neatly along vertical and horizontal lines.

CONTROL AND INSTRUMENTATION

Suitably protected control supervisory and auxiliary circuits must be wired with 1 mm^2 conductors. The wire colour codes must be according to SANS 10142-1:2012. Edition 1.8

220 Vac	-Red
Neutral	-Black
+24 Vdc	-Grey (Marked +24Vdc)
-24 Vdc	-Blue
12 Vdc	-Yellow (Marked +12Vdc)
-12 Vdc	-Blue
Telemetry	-Purple

Each end of the conductor shall be terminated in a pre-insulated, spade or pin type lug, applied by means of the recommended colour coded crimping tool. All control wiring shall be clearly marked by interlocking plastic ferrules, the numbers corresponding to wire numbers on the schematic diagrams.

If control and/or supervisory wiring is required for equipment which is installed on the doors of the panel the wiring shall be bunched together and suitably strapped with spiral binding in the form of a vertical "U" loop between the door and the panel, to ensure that there is no tension on the wiring when the door is rotated along its vertical axis. Approved wiring supports shall be fixed onto the hinged panels, to relieve the weight of the cables off the equipment terminals. Each door shall be suitably earthed.

GS.1.19.3

POWER CABLE TERMINATIONS

Sufficient space must be allowed for the connection of all known and future incoming and outgoing cables.

Outgoing cables shall be glanded off on galvanized gland plates at the bottom or top of the vertical cables ways. Where top access is required, it will be specified in the tender document.

Approved shrouded and shielded terminals shall be provided for the outgoing connections to each motor for conductors up to and including 35mm², rated at least 50% in excess of the conductor rating. The terminals shall be fixed in the vertical cables way of the assembly and shall have ample space for making off the outgoing cable terminations.

Conductors of 50mm² and above shall be terminated directly onto the starter equipment, but the cables must be adequately supported to ensure that no strain is imposed on the equipment.

GS.1.20

GLAND PLATES

A strong and robust 3mm hot dipped galvanized cable gland shall be provided along the entire length of the assembly at a minimum height of 300mm above floor level. The gland plate shall be constructed in sections and bolted in position to take the load of the cables being glanded to it.

When cables enter/exit from the top of the board, the top cover plate will act as the cable gland plate and shall also be 3mm thick. It shall be bolted to the frame so that it can be removed if necessary. The terminals associated with these cables will be mounted not less than 200mm below the top cover plate.

All gland plates shall be machine punched in the factory to suit each and every cable gland required. Under no circumstances will any drilling or filing be allowed on site.

GS.1.21

OUTGOING POWER CIRCUITS

All cables shall be terminated with approved glands to suit the application. Particular attention shall be paid to the termination of ECC cabling to ensure the continuity of all earth conductors.

Every termination of a power cable shall be provided with an approved numbered Bowthorpe Hellerman tag identifying its size and destination, fixed below the cable gland plate in a position which is easily observed from the front to the boards. This procedure must also be incorporated at the motor termination box.

MARSHALLING COMPARTMENTS

When specified, marshalling compartments shall be provided for control circuit wiring.

The marshalling compartment shall be adequately sized to accommodate all the required terminals PLUS provision for a further 50% spare terminals.

Where a motor control centre is to be broken down for transportation to site, each section shall be provided with a marshalling compartment to the above requirement so that the associated wiring is not disturbed.

Where such control circuits are unavoidable and control wiring has to cross a break, it shall be suitably identified and disconnected at one end during transportation.

Terminals for each starter should be grouped together and clearly identified by a permanently affixed label. Terminals shall be mounted on rails and space shall be provided for spare terminals after each group of terminals.

A suitable gland shall be provided for terminating the control cables and adequately sized cable way shall be provided for running the cable ends to the terminals in the marshalling compartment.

A 220 Volt switched socket outlet shall be provided in each marshalling cubicle. Where specified, a switched light shall also be provided.

SURGE DIVERTERS AND 4-20 MA LOOPS

Where specified the MCC is to be equipped with surge diverters of approved manufacture and bearing the SANS mark.

The arrestors or diverters shall be mounted inside the panel on the incoming unit. The supply side connections shall be made in the factory to the three phase busbars, whilst the earth side connections shall be made to the earth bar of the board.

All 4-20 mA loops are to be electrically isolated from the PLC analogue input by means of an isolator unit or splitter unit.

All loops entering the panel from the field must be protected by means of surge protection units. With circuit breaker protection, equal or approved. All surge protection units are to be bonded to earth by means of 4mm² multi strand earth cable.

SPARE FUSE CARTRIDGES

Where HRC or other cartridge types fuses are specified or used to protect instruments or circuits, the MCC shall be suitably equipped with a compartment for housing one third of all fuse cartridges specified, having a minimum of 1 set (i.e. 3 phase) of fuses of each size specified and all such spare fuses shall be provided inside this compartment on handing over. The compartment shall be clearly labelled: "Spare fuse cartridge": replace used-up fuses.

LABELS

The requirements of SANS 10142-1 must be complied with.

All boards or panels shall be fully labelled using sandwich type labels, fixed to the board or panel by means of either screws or rivets, or by gluing into metal label holders which are bolted to the board.

Labels should be black lettering on a white background, not less than 6mm in height and mounted centrally below each respective starter unit, in an approved position. A centrally mounted label shall be provided to indicate the manufacturer's details, the design busbar rating and asymmetrical fault level.

A label indicating where the board is "Fed From" shall also be fixed to each MCC.

All relays and wiring terminal blocks inside the MCC shall be labelled to clearly identify the control gear and wiring to equipment.

The cable markings shall indicate the number of cores – core cross sectional area – original of the cable – cable number, of the cable. E.g.

4-35-M-01

2-2.5-M-02

Pump 1 cables

3-10-P1-01

7-1-P1-02

Pump 2 cables

3-10-P2-01

7-1-P2-02

Pump 3 cables

3-10-P3-01

7-1-P3-02

GS.1.26

WORK TESTS

The MCC shall be fully assembled and wired before being dispatched from the works. The Contractor and the switchboard manufacturer will carry out a full functional test to prove the correct operation of the entire MCC, including interlocking, remote control and the simulation of all protection devices. All other circuits external to the switchboard will be simulated and will be tested accordingly.

All MCC's with a fault level of 10kA or more shall be type tested by an accredited person and a signed certificate issued with the MCC, The costs of all these tests shall be borne by the contractor, The tests shall be witnessed by the Employer's Representative.

Unless otherwise specified, the correct function of the PLC hardware will not be the responsibility of the MCC manufacturer, but the contractor will be expected to have an artisan standing by during tests in order to observe the MCC operations and carry out any remedial work required.

The tests shall be witnessed by the Employer's Representative and shall be recorded in triplicate on approved test forms.

GS 1.27

SOFT STARTER

Conformity of standards

EC

The soft starter shall be constructed and tested in accordance with the international IEC standards EN 60947-1 and EN 60947-4-2 and respect the following EC directives:

- "Low voltage Equipment" No. 2006/95/EC
- "Electromagnetic compatibility Directive" (EMC) No.2004/108/EC

UL

The soft starter shall be constructed and tested in accordance with UL 508.

Product features

The soft starter shall comply with the following technical requirements:

General specification

- Three phase control with operation voltage: 208 - 600VAC or 208 - 690VAC, 50/60 Hz
- Wide rated control supply voltage: 100 - 250VAC 50/60 Hz
- Built-in bypass to reduce energy consumption at full speed and increase the life time of soft starter.
- Possibility for both in-line and inside-delta connection of the motor
- The soft starter shall have built-in Modbus RTU for communication. Support for other protocols shall be an option.
- The soft starter shall be equipped with one analog output
- The soft starter shall have a minimum of 3 signal Relays Output for Run, Bypass (Top of Ramp) and Event signal.

User interface

- The soft starter shall support multiple languages in both the manual and HMI, including: English, Swedish, German, French, Italian, Spanish, Portuguese, Dutch, Polish, Russian, Finnish, Turkish, Czech, Chinese and Arabic.
- The soft starter shall have a detachable keypad with graphical LCD display. The keypad shall have start and stop buttons, information button for access to a built-in manual and an USB-port for connection to a PC.

Environmental conditions

- The soft starter shall have coated PCBAs to withstand harsh environments
- The soft starter shall support operational temperature of -25 to +60°C with de-rating of maximum 0.8% per °C above 40°C
- The soft starter shall be able to operate on up to 4000 meters above sea level with de-rating of maximum 0.67% per meter above 1000 meters

Motor starting, stopping and operation

- The soft starter shall have pre-start functions:
 - Stand still brake, to keep the load still before start
 - Motor heating, to keep the motor well-tempered before start
- The soft starter shall have the following start ramps available:
 - Voltage start ramp
 - Torque start ramp
 - Full voltage start
- The soft starter shall have possibility for slow speed forward and backward operation for positioning of a motor load.
- The soft starter shall have Torque Control and pump cleaning feature, to eliminate water hammering and prolong lifetime of the pump system.
- The soft starter shall include a kick start feature to be able to start heavy loads.
- The soft starter shall have the following three types of current Limit:
 - Current Limit
 - Dual Current Limit
 - Current Ramp
- The soft starter shall have a limp mode feature to allow the soft starter to operate even with shorted thyristors in one phase.
- The soft starter shall have possibility for sequence start of up to 3 different motors.

Built-in motor protections

The soft starter shall integrate motor and load protections, which shall under no circumstances be disabled when the integrated bypass is used. The soft starter shall also be able to present a warning before tripping for each protection.

The soft starter shall have the following motor protections available

- Electronic Overload Protection, class 10A, 10, 20, 30
- Locked Rotor Protection
- Motor Underload Protection
- Current Imbalance Protection
- Voltage Imbalance Protection
- Overvoltage and Under Voltage Protection
- Phase Reversal Protection
- Earth-fault Protection

It shall also have input for PTC and PT100.

Built-in diagnostics

The soft starter shall have the following diagnostics features:

- THD(U)-Total Harmonic Distortion
- Counted number of start sequences
- Motor runtime measurement
- Thyristor runtime measurement
- Auto phase sequence detection
- Electricity metering
- Voltage sags detection
- Time to trip estimation
- Time to cool estimation

Fault detection

The soft starter shall provide following fault detection, to protect both the starting equipment, the load and the soft starter itself

- Phase loss
- High current
- Low control supply voltage
- Fault connection
- Bad network quality
- Thyristor overload

GS1.28

VARIABLE SPEED DRIVES

1. General

This part of the specification describes the general requirements for the Variable Speed Drives, the VSDs. The nominal values, the standard documents and the drive's minimum performance are defined in this part. The VSD does not include motor in this specification. The specification uses the term Motor unit which means a combination of the VSD and the motor.

If the project-specific part of the specification (Appendix A) is in contradiction with the other parts of the document, the project-specific document shall apply.

2. Requirements for the Manufacturer

2.1 Certifications

The Frequency Converter Manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system.

The Manufacturer shall have the Environment Certification ISO 14001.

2.2 Experience

The Manufacturer shall have adequate experience in frequency converter manufacturing and have adequate business volume in order to provide credibility in his commitments and a capability of long term support. The Manufacturer shall prove his experience by quoting references of units in the specified power and voltage range.

2.3 Local support

The Supplier shall have a permanent representative office with a trained and skilled support staff, in the country where the goods are delivered, in order to prove his commitment for local support and to provide a channel for communication. The local representatives shall be easily accessible and shall be able to arrive at the site within 24 to 48 hours' notice.

The engineers employed by the Supplier's regional office shall be certified by the Manufacturer and provide start-up service including physical inspection of the drive, connected wiring and final adjustments, to ensure that the VSD meets the required performance.

The Supplier shall be able to give basic drives training to the Customer's engineers, preferably on the site but anyway, in the country where the customer's site is. The training shall, as a minimum, include system concepts and basic troubleshooting. The Supplier shall also be capable of solving most VSD problems quickly. He shall also have a 24-hour support from the Drives Factory, to avoid any delays during service or repair work on the site.

The Manufacturer shall be able to offer commissioning of the drive to be done by the local office.

The most common spare parts like fuses, IGBTs as well as main control- and IO-boards shall be available in 48 hours from the notification through a regional service center of the Supplier. The more rarely used spare parts should be available in maximum 5 days on site!

3. Basic requirements for the VSDs

3.1 General requirements

The VSD shall be of the most modern design, yet user friendly and be simple to install, commission and maintain. The VSD shall be able to start and control the speed of a standard squirrel cage induction AC motor. The VSDs shall be CE marked. The VSDs have to be built to comply with the IEC standards. In the Australian market the VSDs shall have a C-tick.

The materials used in the VSD shall be recyclable, non-toxic and flame retardant.

The VSD shall be a digitally controlled drive, using, at least, the Pulse Width Modulation (PWM) with flux vector control, a Direct Torque Control (DTC), or equivalent. It shall have IGBT's in the inverter section of the throughout the power range, and it shall have the following minimum specifications.

Operating conditions:

Rated Input Voltage	:	380V - 415V, three-phase, $\pm 10\%$ or 380V – 500V, three-phase, $\pm 10\%$ or 525V – 690V, three-phase, - 10%, + 5%
Rated Input Frequency	:	48 - 63Hz
Fundamental Power Factor	:	0.97 or better at nominal load
Efficiency	:	$\geq 98\%$ at nominal load
Output Voltage	:	0 - U_N , three-phase
Output Frequency Range	:	0 to 300 Hz, adjustable
Output Frequency Resolution	:	0.01 Hz
Accel/Decel Time	:	0 – 1800 s, adjustable
Overloadability (by load type)	:	
Constant Torque	:	150% of nominal current for 1min in every 5 mins.
Variable Torque (pump & fan)	:	No overloadability required
Ambient Temperature	:	40 °C, for higher temperatures see below
Installation Altitude	:	1000 m, for higher altitudes see below
Max. Relative Humidity	:	95 %, non-condensing. In presence of corrosive gases, the max. relative humidity is 60 %
Max. Corrosion Level of the Cooling Air	:	
Chemical Gases	:	IEC 721-3-3, class 3C2
Solid Particles	:	IEC 721-3-3, class 3S2
Max. Vibration Level (IEC 68-2-6):	:	
2 to 9 Hz	:	0.3 mm
9 to 200 Hz	:	1 m/s ²
Main Protections	:	Overcurrent, short circuit, input/output phase loss, motor overload and underload, over/under- voltage, overspeed, overtemperature, motor stall, other internal fault.

The VSD shall be able to give a 100 % output current continuously in the above specified conditions. In order to ensure that the drive can provide the required output current in the specified ambient conditions, the Manufacturer shall inform the required derating, if the ambient temperature given in the project-specific specification is higher than 40 °C or if the installation altitude is more than 1000 m above the sea level. The derating factor shall be specified so that neither the lifetime of the VSD nor the unit's performance, overloadability included, nor the reliability of the VSD shall suffer.

Storage conditions (in the protective package):

Ambient Temperature	:	- 40 to +70°C
Corrosion Level of the Cooling Air	:	
Chemical Gases	:	IEC 721-3-3, class 1C2
Solid Particles	:	IEC 721-3-3, class 1S3
Max. Vibration Level (IEC 68-2-6)	:	
2 to 9 Hz	:	1.5 mm
9 to 200 Hz	:	5 m/s ²
Shock (IEC 68-2-29)	:	max. 100 m/ s ² , 11 ms
Free fall	:	250 mm for weight under 100 kg 100 mm for weight over 100 kg

3.2 VSD Accuracy

The VSD shall have a minimum speed control accuracy of $\pm 10\%$ of the nominal slip of the motor, without a pulse encoder feedback. In practise, this means e.g. for a four-pole, 50 Hz motor with a 45 rpm slip speed, an accuracy of $\pm 0.3\%$ of the motor nominal speed. The VSD shall be capable of a dynamic accuracy of at least 0.4 %sec. without additional options. If this accuracy is not achieved without a speed feedback, the Manufacturer shall specify the accuracy that can be reached and if required, a pulse encoder with adequate control devices shall be included in the motor unit at the VSD Supplier's expense. The dynamic accuracy means the drive's capability to response fast in a dynamic situation, for example, if the load changes. It is measured by the change of speed and time, i.e. how long it takes to recover to the reference speed.

3.3 Starting torque and torque step rise time

Constant torque applications: The Starting Torque of the Motor unit without a pulse encoder feedback shall be at least 150 % of the rated Motor unit torque.

Variable torque applications: The Starting Torque of the Motor unit without a pulse encoder feedback shall be at least 100 % of the rated Motor unit torque

In case of need of fast torque rise time, the torque step rise time from 10 % to 90 % of the full nominal torque should be less than 5 ms, when the motor is fully magnetised. If the motor mechanical time constants are longer than that, the torque step rise time should be according to mechanical time constant.

3.4 Quality assurance and warranty

Every VSD has to be tested functionally. The inverter part of the VSD or each inverter module at least has to be tested by running it with a motor at full nominal load. A test report of the tests made has to be included with the VSD.

The warranty period of the VSD has to be a minimum of 24 months from the date of delivery or 12 months from the date of commissioning, whichever comes first.

4. Enclosure and mounting

The VSDs up to 75 kW in 400 V and 690 V or 90 kW in 500 V, can be installed separately in drive modules. There should be a possibility for flange mounting, to provide for cases, when the drive is installed in a cabinet and to enable installation of the heatsink outside the cabinet.

The VSD shall be equipped with fuses and a main circuit switch must be available either as standard or, at least, as an option. The switch shall be equipped with a door interlocked handle, padlockable in the open position. Input fuses shall be of semiconductor type, and their characteristics co-ordinated with the drive's electronic protection circuits so that they do not blow from normal output faults such as an overcurrent fault. The Control Panel of the VSD shall be accessible for programming and controls with the main door closed. The whole assembly shall be implemented with a strict consideration of the EMC Compatibility and Regulations as described further in this specification.

Panel Design Specs:

Standards	:	IEC 439-1, EN 60439 & VDE660 Part 500.
Protection Class	:	IP21 or better
Cabinet access	:	From front
Cable entry and exit	:	Bottom entry as standard. Both bottom and top entry have to be possible.

5. User interface

5.1 General

The user interface shall be similar throughout the power range to avoid confusion amongst the users and need for training in several different units.

5.2 Inputs and outputs

The following standard Inputs and Outputs at least shall be provided, to be used in interface with the control system:

Analog Inputs	:	1 x Programmable differential voltage input 0(2) - 10V
		2 x Programmable differential current input 0(4) - 20mA
Analog Outputs	:	2 x Programmable current outputs 0(4) - 20mA
Digital Inputs	:	6 x Programmable Digital Inputs, optoisolated, common or separate ground
Relay Outputs	:	3 x Programmable Digital outputs with a changeover dry contact

All the control terminals shall be clearly marked.

The following functions at least shall be available via the IOs:

Input	Output
Analog	Analog
Speed reference	Motor speed
Torque reference	Motor torque
PID-control feedback (actual value)	Motor current
Correction signal to reference	Output frequency
	Output voltage
	Output of the process PID controller
	Control deviation of the PID controller
	Actual value of the PID controller
	Process speed
Digital	Relay
Start	Fault
Stop	Running
Forward/reverse	Ready
Pre-programmed constant speeds	Rotation direction
Speed up / down (motor potentiometer)	Fault/warning
Start and stop from 2 nd source	Warning

Selection of acceleration / deceleration ramp
Selection of user macro
Run enable
Selection of control place
Fault reset

Stall fault or warning
VSD temperature fault or warning
Motor temperature fault or warning
Speed or torque limit reached
Motor magnetised
Controlled via serial communications

5.3 Serial communications

The VSD shall as standard have a provision for communication with PC software tools. In addition, the following serial communication protocols at least shall be available as option: Modbus, Modbus+, Interbus-S, Profibus DP, LONWORKS and DeviceNet. It shall be possible to add the serial communication later.

5.4 VSD keypad

The VSD shall have a detachable keypad with alphanumeric operating display for programming and controlling purposes. The displayed messages shall be in user friendly, descriptive text. Coded messages are not acceptable. Parameter setting shall be possible by using the keypad.

Parameter setting shall be easily accessible and user friendly with actual text messages. Password protection shall be provided to avoid unauthorised tampering with the set parameters. It shall be possible to read and write the set parameters with the help of the control pad, enabling thus copying of parameters between the VSDs of a similar application, to save time during the commissioning and to avoid mistakes. The VSD shall have a local lockout to prevent accidental transfer from remote to local.

Direct keypad entry shall be provided to observe the following actual parameters. Any three of the following parameters or actual values shall be selected to be always displayed.

- Input Voltage
- Input Frequency
- Output Voltage
- Output Frequency
- DC Bus Voltage
- Output Power
- Output Torque
- Output Current
- Motor Speed
- Process Speed

The following parameters shall always be displayed during normal operation.

- Speed Reference
- Run / Stop / Fault
- Remote / Local

The VSD shall have self-diagnostic properties to display faults and warnings as they occur and be able to store at least 15 previous faults into the fault memory. The fault memory shall be accessible by PC maintenance tools.

The following drive control functions at least shall be available from the keypad:

- Run
- Stop
- Local / Remote selection.
- Forward/Reverse (if function enabled)
- Accelerate (manual/mode)
- Decelerate (manual/mode)
- Parameter setting

5.5 Application programming

The VSD shall be designed for both simple and the most complicated applications, yet it shall be user friendly. The VSD shall have built-in application macros, to allow selection of the range of pre-programmed control configurations and further, the VSD shall enable storing of two customer modified macros at least, to suit the specific application. It shall be possible to reset the parameter settings back to the original macro settings through the keypad. The parameter readouts shall be in text format and not coded.

5.6 PC Tools

The VSD Supplier shall have a Windows based PC software available for monitoring and controlling the VSDs, and the software shall be offered as an option. The software shall be supplied with the necessary hardware and a provision for connecting a PC with the VSD. It shall be possible to set and modify parameters, control the drive, read actual values and make trend analysis using the software.

6. Software features

6.1 Power loss ride-through

The drive shall have a power loss ride-through capability. This means that the drive controls should stay alive during a power loss by means of the energy stored in the load. The ride through time shall be the longer the higher the kinetic energy of the load is. The motor shall be magnetised as long as there is kinetic energy in the system.

6.2 Flying start

The drive shall have a built-in Flying Start feature. This feature will allow a Motor unit which is still rotating, to be restarted without first stopping it. The VSD shall restart the motor from the rotating speed and then reaccelerate to the speed indicated by the speed reference signal. The Flying Start feature shall be available in both directions, to be able to start the drive in the required direction regardless of the rotation direction of the motor.

6.3 Flux optimisation

The VSD shall have a built-in automatic Flux Optimisation function. The Flux Optimisation function minimises the sum of the magnetising current and the load current so that the drive can still follow the given reference. This feature reduces energy consumption and motor noise when driving at less than the nominal load.

6.4 Flux braking

There shall be a possibility for Flux Braking, where VSD increases the motor magnetisation to dissipate the extra energy in case of need for small braking power. It shall be possible to use the braking to decelerate the motor from one speed to another – not only for stopping the motor.

6.5 Critical speed jump-over

The VSD shall have programmable skip speeds to jump over critical resonance speeds. If the speed reference is in the critical speed area, it is ignored and the latest speed reference is maintained. Three programmable critical speeds at least shall be available.

6.6 Current/speed limiting

In case the acceleration or deceleration ramps are too fast for the drive capacity, the drive shall be able to automatically reduce the ramp to prevent tripping. Also, in case of transient overloads the drive shall automatically reduce speed to prevent an overcurrent trip, if the drive capacity is not sufficient to handle the load.

6.7 PID-controller

The drive shall have a built-in PID-controller for control of the customer process.

6.8 Restart

In the event of a fault trip due to overvoltage, overcurrent or loss of analogue signal, the VSD shall be programmable to attempt an automatic restart. For safety reasons, the maximum number of attempts shall be five (selectable) within a short time. If the fault does not clear after the attempts, the drive shall lock out.

7. Environmental effects

7.1 Harmonic Distortion

The VSD shall have built-in AC or DC chokes to minimise the Total Harmonic Distortion (THD). The THD of the unit for current has to be less than 50% in a supply network with a short circuit ratio (Rsc) of 300 (i.e. the ratio of the supply network's short circuit current to the unit's nominal current). If the supply voltage is 440 V or higher, the THD value has to be less than 55%. However, the VSD Manufacturer shall submit to the contractor the VSD Harmonic spectrum for the project-specific supply network. The spectrum shall be used in the design of appropriate harmonic filters, if required by the Customer. The single harmonics shall be presented up to 25th harmonic and the THD has to be calculated taking into consideration harmonics up to 40th harmonic.

7.2 EMC Regulations and Compatibility / C-Tick

The supplied VSDs shall carry the CE mark (or C-Tick in Australia) indicating that they comply with the essential requirements of the relevant EU directives (or C-Tick requirements in Australia). The VSDs shall meet the requirements set in EN 61800-3 for Industrial Low-Voltage Networks. If the project-specific specification states that the requirements for Public Low-Voltage Networks stated in EN 61800-3 must be met, the Supplier shall be able to provide such units at least up to 75kW in earthed networks. If separate EMC filters are required, they shall be of built-in type.

A detailed description and other directions to maintain the EMC Compatibility during the installation of the VSD and associated field cables and connections, shall be given by the Supplier in conformance with the EMC Directives or C-Tick. The Contractor shall follow the directions during installation, in order to achieve attenuation of the RFI.

7.3 Audible Noise

The full load audible noise of the frequency converter shall not exceed 70 dB(A) in 200 kW applications and below. Above 200 kW, the full load audible noise shall not exceed 78 dB(A). If the frequency converter is installed in a cabinet and requires a separate cooling fan, these limits also include the noise of the additional cooling fan. This requirement is made to keep the electrical room quiet so that it is not necessary to use hearing protection. The audible noise of the motor should also be minimised. For that purpose the switching frequency of the frequency converter shall be at least 2 kHz throughout the power range.

7.4 Efficiency

The full load efficiency of the VSD shall be at least 98 % including all the additional equipment which is needed to meet this specification.

GS.1.29

SITE TESTS

After completion of erection, cabling and field wiring, the contractor shall set all overloads, protection devices etc. and shall again carry out a full functional test to prove the correct operation of the entire MCC, including the simulation of all remote devices. A signed compliance certificate by the Contractor's accredited person for the MCC and its installation shall be handed over to the Employer's Representative on Completion.

The tests shall be witnessed by the Employer's Representative and shall be recorded in triplicate on approved test forms.

GS.1.30

INSTALLATION OF MOTOR CONTROL CENTRES

The contractor shall make it his responsibility to furnish the switchboard manufacturer with all the relevant information in respect of the accommodation to be provided, including cable trenches and ducts etc.

Where possible, the largest number of cubicles or panels should be installed intact, to avoid assembly on site, provided space and handling facilities and conditions do not lead to damage of the unit.

The contractor will advise the manufacturer which of the cables enter or leave from the top or bottom of the MCC.

GS.1.31

DRAWINGS, EMPLOYER'S REPRESENTATIVE'S APPROVAL, GUARANTEES

CAD generated drawings of the equipment showing full details of layout and proposed wiring system and equipment offered shall be submitted for approval to the Employer or his Representative prior to manufacture. The drawing must include part numbers and manufacturers of all plant and equipment.

The Employer's Representative shall also be advised when the board are being manufactured and when they will be ready for inspection at the works, Equipment which is despatched to the site without the authorization of the Employer or his Representative may be rejected and all costs incurred in having it returned to the factory, where necessary, and any liability for delays, will be for the contractors account.

The contractor will issue to the Employer's Representative one set of sepias and 3 copies of drawings of the "As Built" equipment which has been installed and connected on site after the draft copy has been approved. Handbooks, spares lists and maintenance instructions etc. will be issued to the Employer's Representative in triplicate at the time of handing over the equipment before the guarantees period commences.

The manuals shall be comprehensive and to include all equipment supplied. A 12 month guarantee shall cover the sheet metal enclosures and all the equipment installed therein against fault workmanship and materials. The guarantee period shall begin from the date the MCC's are completely installed and accepted by the Employer's Representative. Fair wear and tear of equipment will be excluded from the guarantee.

GS.1.32

COMPLETION

Prior to the handing over of the boards or panels and the associated electrical installation, they shall be rendered completely free of all dust or rubbish that may have collected during installation and building operations, and finished surfaces shall be made good where necessary, using the identical paint finishes from the same batch, as at the time of manufacture.

The MCC's shall be vermin proofed. Similarly, all cable trenches will be thoroughly cleaned out and all covers fitted before the work will be considered as complete. All labels will be correctly engraved and fixed to panels and cables as specified before the work can be considered complete.

All cable sleeve or other openings shall be closed or patched up and made good: Cable sleeves shall be sealed using an approved expanding foam sealer and neatly trimmed.

GS.1.33

SUGGESTED SUPPLIERS

Refer to Annexure A.

GS.1.34

MANUFACTURERS

Manufacturers may be considered by the Employer's Representative, but only if they have a proven track record of manufacture to SANS 1473/SANS 60439.

The tenderer shall ensure that copies of these Standard Specifications, Detailed Specifications, layout drawings and single line diagrams if available shall be provided to the manufacturers to ensure that they make full allowance for all requirements in their pricing.

ANNEXURE A**SCHEDULE OF RECOMENDED EQUIPMENT. THE TENDER MAY, HOWEVER, OFFER ALTERNATIVES**

Soft starters	ABB
Variable speed drives	ABB
Circuit Breakers	Merlin Gerin, ABB, CBI
Contactors, indication lamps	ABB, Telemecanique,
Relays, fuses, motor protection relay	Omron, ABB, Finder
Control switches, selector switches	Krause and Naimer, ABB, Telemecanique, Moeller
Electronic Motor Controller	ABB UMC22-FBP, Omron SEK
Ammeter, voltmeter, current transformer, operations counter, hour meter.	Hartmann and Braun
Cables, Wire	Aberdare
HRC fuses and holders	G.E.C.
DC Power Supplies	Meanwell Ad-155B
Electrically operated solenoids	Festo, Asco, Burkert
Level Control	Siemens Milltronics Multiranger MR200 DP 6R, Siemens stainless steel echo max transducer brackets FMS310.
Surge Arrestors	Dehnguard 275 and 1 No. DehnGap
Power supplies	Siemens / SITOP series
Relays	Omron, ABB
Terminal relays	Weidmuller, Klippon, Phoenix Contact
Electrical motors	WEG, ABB
Emergency stop stations	Cutler Hammer, ABB
Circuit breakers	ABB, Schneider, M&G
Fuse switches	ABB Stromberg
Terminals	Klippon, Phoenix Contact
Cable glands	Pratley Envirogland
Junction boxes	York enclosures
Power monitor	Schneider , ABB
Open channel measurement flow meter	Siemens Milltronics Multiranger MR-200 DP 6R
Radar level meter	Krohne, VEGA, Siemens
Magnetic flow meter	Safmag, Siemens, Krohne, Endress & Hauser
Other flow meters	Siemens, Fuji, Krohne, Endress & Hauser
Flow switches	EGE
Pressure transmitter	Wika, Siemens
Differential pressure transmitter	Wika, Siemens
Chlorine gas leak detectors	Siemens, Grundfos
Residual chlorine meter	Siemens, Grundfos

Dissolved oxygen meter	Hach LDO type
Turbidity meter	Hach, Endress & Hauser
Temperature measurement	Wika, Siemens
Pressure gauges	Wika ,Siemens
Air flow meters - Thermal resistance type	Endress & Hauser
Proximity switch	efector (Shorrock Automation)
Solenoid operated valves	Bürkert
Surge protection	Surgetek : BCT BE24 (signals) DEHNguard 275 (line) DEHNgap B (neutral) Phoenix Type TT-2-PE- 24VDC
	DehnVentil 255 - Mains
Loop splitters	Omniflex type LPI/LPS
UPS	APC
Industrial Ethernet network switch	Unmanaged - Hirschmann Managed - Hirschmann
Pneumatic actuators	Festo, Biman
Electrical Valve actuators	Aumanat
Pipework Coating	Plascoat PPA 571 Aqua
Non-Shrink Grout	Pro-Struct 531-MCI

ANNEXURE B

COMPULSORY DATA PACK FOR MCC

- 1) Drawings 3 sets
- 2) Drawings electronic format CD as built
- 3) Factory Routine Test Certificates (SANS 1473-1)
- 4) Site Test Certificates
- 5) Certificate of Compliance
- 6) Maintenance Manual
- 7) Technical Specifications
- 8) All Electronic and Electrical Manuals
- 9) Partial Type test certificates for MCC over 10Ka.
- 10) Paint Thickness certificate.
- 11) All programmable parameters of all electronic/instrumentation equipment, overload settings, soft starters, shall be supplied.
- 12) An electronic copy of the PLC program installed in the plant
- 13) A schematic of all cable routes and joints of all cables. This should show the position of all cable markers installed.
- 14) A life cycle letter from the manufactures of all electrical and electronic equipment. (Soft Starter/VSD).
Contact details of all agents/ sole suppliers of all electrical and electronic equipment for after sales service and back up.

ANNEXURE C

SPECIFICATION FOR THE INSTALLATION OF LIGHTING

This is the Standard Specification for the Installation of Lighting at the pump stations. All lighting installations shall comply with the Occupational Health and Safety Act (85 of 1993) and the SABS Wiring Codes of practice 01042. All lighting offered shall be of the latest energy efficient lighting and control. All lighting shall be of the Eskom approved energy saving LED type and shall match or exceed the existing lux levels.

The installation shall be done in the manner outlined below in the following areas.

PANEL ROOM, OUTSIDE, DRY AND WET WELL LIGHTS

Type of light Fixture

Five Foot (5ft) double dust and hose proof light fittings/250MV.

Method of Mounting

All light fittings shall be mounted with 8mm x 40mm stainless steel Double Wedged anchor Bolts.

Method of Termination:

Each light fitting shall have a 500mm, two core plus earth cable. Tail piece that is to be terminated in a four way round junction. Box (preferred CCG No1); having a rating of no less than IP65. The strip connectors shall be rated at 30amps for ease of connection and disconnection.

Electrical Circuit

The lighting circuit in each location shall have its own circuit breaker and must be labelled.

Light Switch

Each location shall have its own weather proof light switch in its own enclosure and be labelled. This should be mounted at the main door entrance of the panel room or as instructed by the Engineer.

Mounting Height

The light fittings shall be mounted at a height that is maintenance friendly. If a ladder is to be used it shall be of a maximum of a 5ft ladder. Lights in sumps must be mounted out of the flood zones.

General Installation of Conduits

The use of PVC conduit is only permitted if it is installed in such a manner that it is not exposed to direct sunlight. Hospital or spacer bar saddles shall be used to fix the conduit onto the wall. Bore pipe must be used for outside installations.

Outside Lighting

These lights shall be controlled via a timer.

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1. PROGRAMMABLE LOGIC CONTROLLERS (PLCS)

1.1 PLC HARDWARE & ENGINEERING

New Modicon M580 PLC's shall be supplied, installed, programmed, tested and commissioned for the complete control and operation of the respective existing and new plant installed. The PLC's and the required components shall be supplied as specified in the EWS standardised preferred equipment list.

The Contractor's engineering design shall include for all cubicles and hardware required for PLC control, and shall include comprehensive equipment lists, cubicle GA drawings and Control Centre drawings, I/O schedules and functional descriptions.

Provision shall be made for PLC control of all items require, plus allowance for expansion.

The Contractor shall furthermore ensure that the complete design, installation, commissioning shall include all necessary cabling, interfacing, connections, mountings etc. to ensure that the final product is complete, functional and to a good engineering standard.

The Contractor shall provide the following documentation to the integrator to enable the integrator to complete his scope. Documentation shall be at "For Construction" revision.

- Plant P&ID's
- IO Lists including:

- instrument ranges;
 - alarm setpoints;
 - IO allocations per PLC system/rack/card;
- Plant network layout
- SCADA Hardware specifications

On completion of electrical and control panel manufacture, the contractor shall complete a Factory Acceptance Test (FAT) of all panels at his premises before delivery to site. The contractor shall inform the engineer that panels are ready for FAT and a team including the employer, the engineer, and the integrator shall attend and witness the FAT.

Acceptance of the FAT shall require acceptance by the employer, the engineer and the integrator.

The integrator has then accepted the panels for site tests and commissioning.

1.2 SOFTWARE ENGINEERING:

1.2.1 PLC Software

Integrator Scope

The integrator shall utilise the latest revision Unity Pro Software Program for the programming of the PLCs. The integrator shall provide their own computer for the programming and software engineering and on completion of the project the engineered software shall be transferred to the Employer. The software shall remain the property of

the Employer with all copies kept by the Integrator during the course of the contract transferred to the Employer on completion of the Contract. No password protected codes will be accepted.

The integrator shall use information provided by the contractor and the EWS representative to develop the Function Design Specification (FDS) for approval by the EWS representative, prior to detailed software development.

Additional information shall be provided to the integrator in the form of the Process and Control Description which will assist with the FDS development.

The software engineering shall be developed in accordance with the final design P&ID and the FDS, which will include information from the Process and Control Description and sample FDS.

All control loops in the software engineering shall be based on an island control basis for the various process sections.

Software engineering shall be done using a structure format of function blocks to facilitate program simplicity and fault finding.

Certain standard programming function blocks might be provided by EWS to the successful tenderer to facilitate standardisation and shall be incorporated when programming the PLC and HMI for each section.

The integrator shall however be required to develop new function blocks in consultation with the Employer and the Engineer for approval prior to implementing the program.

The integrator shall allow for a minimum of three reiterations of the PLC program for changes as may be requested by the Employer and EWS representative without their pricing for this work.

2. I/O LIST:

The Process and Control Description is to be read in conjunction with the P&ID drawings and single line schematic diagrams.

The Contractor, on completion of design, shall submit to the EWS representative comprehensive I/O lists for the new PLC in the form of a I/O list. This list shall be the expansion of the instrumentation index supplied at tender stage and shall include information listed in section 1.2 above.

The resultant I/O's shall be forwarded to, and used by the integrator for configuration of the respective process PLC's and to provide the necessary input to the overall HMI system to be installed under this Contract.

3. HUMAN MACHINE INTERFACES (HMI'S)

3.1 HARDWARE

For the local interaction and control of the respective plant areas the contractor shall supply and install Schneider Magelis 15" Graphic Terminal (HMI) (model number) units.

Each MCC shall be fitted with an HMI.

3.2 SOFTWARE

Integrator Scope

The integrator shall use the latest revision Vijeo Designer Software Program for programming the HMIs. The integrator shall provide his own computer for the programming and on completion of the project transfer the software and licence to the Employer.

The software engineering shall be developed in accordance with the final design P&ID, the Process and Control Description and sample Process Control Philosophy. All control loops in the software engineering shall be based on an island control basis for the various process sections.

Software engineering shall be done using a structure format of function blocks to facilitate program simplicity and fault finding.

Certain standard programming function blocks and graphics might be provided by EWS to the successful tenderer to facilitate standardisation and shall be incorporated when programming the PLC and HMI for each section.

The integrator shall however be required to develop new function blocks in consultation with the Employer and the Engineer for approval prior to implementing the program. The new developed software shall however be required to follow the standard EWS display format.

The integrator shall allow for a minimum of three reiterations of the HMI program and display graphics and trending for changes as may be requested by the Employer and Engineer without their pricing for this work.

4. CONTROL NETWORK

The network design provides for a Modbus on Ethernet communication backbone which has been designed to support two systems namely:

- eThekweni Electrical MV Gear and Standby generator on site.
- eThekweni Water and Sanitation, PLC and SCADA data and control communications.

4.1 NETWORK HARDWARE

The Contractor shall supply and install ethernet switches, which shall be high quality industrial grade.

Network switches utilised in the design shall be the standard preferred model managed switches as specified in the Schedule of Quantities.

The switches shall have the option to accept both fibre and copper cable in order to reduce the number of media convertors required. Configurable ports are preferred for flexibility.

The manufacturing details in respect of the panels to house the network switches is covered under the Motor Control Centres.

4.2 NETWORK CONFIGURATION

Integrator Scope

The integrator shall configure each switch for maximum efficiency of the data transfer between his configured PLC's and SCADA systems.

4.2.1 Documentation

The integrator shall include design drawings & documentation to the SCADA system and allow for retrieval of documentation or drawings from the operator accessible system help screens.

Available documentation shall include:

- Process & Control Description
- Functional Design Specification

Available drawings shall include:

- Control Network Overview Layout
- Power Distribution Schematics & Drawings
- PLC Card Wiring Diagrams
- Loop Sheets
- MCC Schematics
- Instrument Data Sheets

ETHEKWINI MUNICIPALITY

WATER & SANITATION

SANITATION OPERATION

Control & Instrumentations Specification

Rev 4

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SECTION A

GPIS: GENERAL PROCESS INSTRUMENTATION SPECIFICATION

GPIS 1: DESIGN BASIS

GPIS 1.1 General

- 1.1.2 All panel mounted instrumentation and control equipment shall be capable of operating at the required capacity in ambient temperatures not exceeding 50°C and an average, over a period of 24 hours, not exceeding 40°C. The field mounted instruments and control equipment shall however, be suitable for operation under ambient temperatures not more than 55°C unless higher ambient temperatures are specifically stated in the Technical Specification.
- 1.1.3 All equipment and accessories shall be designed to withstand the environment and operational conditions within the plant.
- 1.1.4 Instrumentation sensing system shall be pneumatic or electronic. Electric signal transmission shall be of common standard and level or converted, where required to the common standard.
- 1.1.5 Special care shall be taken to make the equipment enclosures proof against entry of vermin and insects (IP rating).
- 1.1.6 The design shall include all reasonable precautions and provisions for the safety of operating and maintenance personnel as well as for their accessibility.

GPIS 1.2 Panel Instruments

- 1.2.1 It should be endeavoured not to have any panel instruments, but rather to make use of the PLC / SCADA. Where panel instruments are required for instance at a T/A set the following shall apply.
- 1.2.2 Standard size instruments shall be used on the control panels to indicate, record and control the major portion of the process variables.
- 1.2.3 Factory assembled panels or field assembled panels shall be furnished in accordance with Item 4.1 of this specification.

- 1.2.4 Process fluids shall not be piped directly to instruments in the control room.
- 1.2.5 Where separate electric power supplies are required for critical electronic instrumentation systems, it shall be taken off the UPS supplying that area Instrumentation.

GPIS 1.3 Field Instruments

- 1.3.1 All field mounted instruments shall be weather-proof and dust-tight, suitable for use under ambient conditions prevalent in a specific plant area with a minimum of IP rating of 65.
- 1.3.2 In plant areas giving rise to corrosive atmospheres, field mounted instruments such as transmitters, I/P converters, solenoid valves, pressure switches etc. shall be housed in steel boxes with IP65 rating. Piping and cable entries shall be made at the bottom of the box.
- 1.3.3 All field boxes will be fitted with canopies.
- 1.3.4 All valves and drives shall be correctly sized with a 50% turn down ratio.

GPIS 1.4 Control Performance

- 1.4.1 Automated production is performed by a distributed process control and information management system comprising supervisory computers and controllers linked to a distributed real-time network.
- 1.4.2 Automatic control systems shall, in general, be of feedback type, however, feed-forward control shall be used when process time-lag conditions that exist in a feed-back system are not tolerable. Modes of control shall, in general, be proportional (P), proportional plus automatic reset (I), or proportional plus reset plus rate (D).
- 1.4.3 All control loops shall be stable for all process conditions. Cyclic stability will not be accepted. Final value error shall be minimised whenever practical.

GPIS 1.5 Metering Base and PCS Units

Pressure above 1 bar - kPa

Pressure below 1 bar	- Pa
Draft	- mm H ₂ O
Vacuum	- kPa (abs)
Temperatures	- °C
Flow (all gases)	- m ³ /hr
Flow (steam and condensate)	- kg/hr tonne/hr
Flow (liquids)	- m ³ /h lt/sec
Flow base	- based at 760mm Hg and 0°C
Level	- % or m
Density	- kg/m ³

GPIS 1.6 Utilities

1.6.1 Electrical power, available from the plant system is 3 phase 400 V and 1 phase 240 V, 50Hz. If the equipment is required to operate at any other voltage level, the necessary transformer and/or conversion units shall be included in the scope of supply by the Contractor.

1.6.2 A power supply calculation shall be performed to determine the capacity of:

- UPS capacity including battery.

1.6.3 Standard voltage:

Main power supply	- 3 x 400/220 V 50 Hz
UPS Supply	- 1 x 220 V ± 5%, 50 Hz
Instrument Control Voltage	- 1 x 220 V ± 5%, 50 Hz
	- 24 V ±5%, DC
Digital Signals	- 24 V ±5%, DC
Analogue Signals	- 4 to 20 mA DC

1.6.4 Clean instrument compressed air will generally be available, however where specific instruments may require air quality above the normal quality of plant instrument air or at a lower pressure than the plant instrument air the contractor is to ensure that all necessary regulators, dryers, separators and lubricators are allowed for.

GPIS 2 PANEL INSTRUMENT DESIGN

GPIS 2.1 Recorders

Recorders are not preferred, SCADA trends, i.e. Real Time and History trends should be available for all measured variables.

GPIS 2.2 Controllers

2.2.1 Stand-Alone controllers, (panel mount controllers), are not preferred.

GPIS 2.3 Indicators

2.3.1 Stand-Alone indicators, (panel mount electronic indicators), are not preferred.

GPIS 2.4 Alarm Annunciator

2.4.1 Alarm display window shall be LED side lighted name plate type.

Each alarm system shall be equipped with flasher and horn and shall have provision for push-buttons to acknowledge, reset and test the system.

Visual alarms shall be located in the vicinity of monitored process conditions on graphics panels. Miscellaneous alarms shall be grouped into a common bank whenever practical.

Alarm initiating contacts shall be normally open, either fleeting or permanent type. For the case of power failure or wire break, closed safety circuit operation shall be applied wherever practical.

The response for alarm systems shall be less than 20 milliseconds.

Alarm annunciation systems shall be energised from a secure 24V DC or 220 V AC power supply source or UPS.

Client Preferences:

All alarm annunciation will take place on the PLC/SCADA, or HIM.

GPIS 3 FIELD INSTRUMENT DESIGN - TRANSMITTER DESIGN

GPIS 3.1 Magnetic Flow Meter

3.1.1 Transmitter shall be indicating, electronic type based on law of induction.

3.1.2 Transmitter shall meet the following minimum requirements:

Accuracy:	0,5% of span or better
Repeatability:	0,2% of span
Output:	Linear
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	
- Tube:	Stainless Steel
- Liner:	Teflon (depending on application)
- Electrode:	Hastalloy Tantalum

GPIS 3.2 Vortex Shedding Meter

3.2.1 Transmitter shall be indicating, electronic type based on the Vortex shedding measuring principle.

3.2.2 Transmitter shall meet the following minimum requirements:

Accuracy:	0,2% of span or better
Repeatability:	0,2% of span
Output:	Linear
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	
- Tube:	Stainless Steel
Vortex shedder:	Stainless Steel

GPIS 3.3 Pressure Transmitter

3.3.1 Transmitter shall be indicating, electronic type based on force balance principle.

3.3.2 Transmitter shall meet the following minimum requirements:

Accuracy:	0,2% of span or better
Repeatability:	0,1% of span
Dead band:	Not to exceed 0,1% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Proof Pressure:	200% of max. process static pressure.
Mounting:	Universal bracket type
Material:	Case, primary element and wetted parts shall be made of material that is

corrosion resistant to process fluid and ambient atmosphere.

Adjustment: Independent for span and zero. (Adjustment may be via bus or hand held calibrator)

GPIS 3.4 Temperature Transmitter

Transmitter shall be electronic type for thermocouple or RTD connection.

Transmitter shall meet the following minimum requirements:

Accuracy:	0, 5% of span or better
Repeatability:	0,1% of span
Dead band:	Not to exceed 0,1% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change
Proof Pressure:	200% of max. process static pressure
Mounting:	Head mounted unless specifically stated otherwise in instrument specification
Material:	Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere.
Adjustment: Independent for span and zero. (Adjustment may be via bus or hand held calibrator)	

GPIS 3.5 Capacitance Level Transmitter

Transmitter shall be indicating, two-wire electronic type for rod – or rope-probe connection.

Transmitter shall meet the following minimum requirements:

Accuracy:	1% of span or better
Repeatability:	0,2% of span
Dead band:	Not to exceed 0,2% of span

Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	Standard materials that are suitable for process and ambient conditions shall be used.
Probes:	Shall generally be stainless steel / Teflon coated.
Adjustment:	Independent for span and zero.

GPIS 3.6 Ultrasonic Level Transmitter

Ultrasonic level measuring device shall have facilities to compensate echo changes due to temperature changes and to ignore periodically recurring false echo due to agitators.

Evaluating device shall be indicating, two-wire electronic type.

Transmitter shall meet the following minimum requirements:

Accuracy:	1% of span or better
Repeatability:	0,2% of span
Dead band:	Not to exceed 0,2% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	Standard materials that are suitable for process and ambient conditions shall be used.
Adjustment:	Independent for span and zero. (Adjustment may be via bus or hand held calibrator)

GPIS 3.7 Radar Level

Microwave level measurement. Measures the transit time of a radar signal that is reflected from the surface of a liquid.

Transmitter shall meet the following minimum requirements:

Accuracy:	1% of span or better
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Repeatability:	0.2% of span
Temperature Drift:	<100ppm / °K
Material:	wetted parts stainless steel

Device shall be 2 wire, with a local indication.

GPIS 3.8 Guided Radar Level

Guided radar (TOR) level transmitter. Guided radar is based on time domain reflectometry principle. Low power microwaves are sent along conductors and at the point where the waves meet the product surface the waves are reflected.

Transmitter shall meet the following minimum requirements:

Accuracy:	1% of span or better
Repeatability:	0.2% of span
Temperature Drift:	<100ppm / °K
Material:	rod or cable – stainless steel

Device shall be 2 wire, with local indication.

GPIS 3.9 Weight Transmitter

Weight transmitters shall be selected in conjunction with load cells, shall have high immunity to plant vibration, allow long distances to load cells and shall be designed to compensate for temperature effects.

Transmitter shall meet the following minimum requirements:

Accuracy:	0,5% of span or better
Dead band:	Not to exceed 0,1% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere.
Adjustment: Independent for span and zero.	(Adjustment may be via bus or hand held calibrator)

GPIS 3.10 Open Channel Flow Transmitter

Open Channel Flow ultrasonic measuring device shall have facilities to compensate echo changes due to temperature changes and to ignore periodically recurring false echoes due to agitator.

Evaluating device shall be indicating, two-wire electronic type.

Transmitter shall meet the following minimum requirements:

Accuracy:	1% of span or better
Repeatability:	0,2% of span
Dead band:	Not to exceed 0,2% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Material:	Case, primary element and wetted parts shall be made of material that is corrosion resistant to process fluid and ambient atmosphere.
Adjustment: Independent for span and zero.	(Adjustment may be via bus or hand held calibrator)

GPIS 4 CONVERTER DESIGN

GPIS 4.1 Electric-Pneumatic Converter (I/P)

Electric to pneumatic converters are intended primarily for use in conjunction with controllers having electrical output or with electrical transmitter where the final control element is actuated from pneumatic actuator or controller.

Pneumatic-electric converter shall be of force balance type and shall convert the direct current input into a standard pneumatic output signal.

Converter shall be provided with a 1:1 relay wherever required in order to provide large volume of air required for rapid operation at long distance.

Transmitter shall meet the following minimum requirements:

Accuracy:	0,5% of span or better
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Linearity:	0,1% of span
Hysteresis:	0.2% of span
Ambient temperature effect:	Not to exceed 0,5% of maximum span per 10°C change.
Adjustment:	Independent for span and zero.
Mounting:	Universal bracket suitable for horizontal or vertical support
Case:	Dust-tight for general application

GPIS 5 PRIMARY ELEMENT DESIGN

GPIS 5.1 Orifice Plate Design

Orifice plates shall be made of suitable grade stainless steel, unless process conditions require some other material.

In general, orifice plates shall be designed for flange taps, however, Venacontracta taps may be substituted when designated by good engineering practice.

Concentric type orifices are preferential.

Eccentric or segmented types shall be used for measurement of dirty gases or fluids carrying suspended matter which might tend to cause build-up.

The orifice ratio (orifice inside diameter to process pipe line internal diameter) shall, in general, be between 0,3 and 0,7 for metering accuracy.

GPIS 5.2 Annubar Design

Annubar material shall be made of suitable grade stainless steel, unless process conditions require some other material.

In general, Annubars shall be designed for single support and on-line vertical, or horizontal taps.

Opposite side support are to be used only in extreme diameter and high flow cases.

On-line steam purge accessories are to be included for measurement of dirty gases or

fluids carrying suspended matter which might tend to cause build-up.

Flow turndown of 10:1 is acceptable.

Annubar element shall meet the following minimum requirements:

Accuracy:	1,0% of actual value
Repeatability:	0,1% of actual value
Mounting:	Universal bracket suitable for horizontal or vertical support

GPIS 5.3 Pressure Elements

Directly connected instruments shall be diaphragm, Borden or bellows type elements depending upon the service requirements.

In general, diaphragm elements shall be used in the range of 0 to 100kPa vacuum or pressure, bellows type element for range of 0 to 1000 kPa and Borden tube element for range higher than 1000 kPa.

Primary element material shall be corrosion resistant to process fluid or chemical seals must be provided for protection.

Primary element material shall provide good creep and fatigue resistance, and low hysteresis.

Proof pressure shall be at least twice the maximum system pressure.

GPIS 5.4 Temperature Elements

The primary elements for temperature services shall consist of resistance thermometers or thermocouples or radiation pyrometers, depending upon the range of measurement.

The following types of elements shall be used for stated ranges:

Type	Temperature Range °C
Pt-Rh (10%) Pt	0 - 1500 Type S
Chromel – Alumel	0 – 1100 type K
Copper resistance Element	-50 to +100
Platinum resistance Element Pt100	0 to +600

Whenever specified, duplex thermocouple shall be provided.

Thermocouple/emf calibration shall conform to the International Practical Temperature Scale of 1968 (ITS).

Gas-tight mineral insulated type, reinforced with stainless steel protective tubes shall be used for thermocouples. Preferred outside diameter shall be 6mm. Lengths to fit standardised thermo-wells shall be used.

Resistance thermometer shall be of three lead connection system to the instrument and shall be gas-tight internal insulated type, reinforced with stainless steel protective tubes shall be used for thermocouples. Preferred outside diameter shall be 6mm. Lengths to fit standardised thermo-wells shall be used.

The resistance/temperature relationship shall conform to British Standard 1904 Table 1, 1979 revision or with DIN 43760.

Thermo-wells shall be used for all temperature elements under pressure application. Construction material for thermo-wells shall be suitable stainless steel, unless some other material is required due to process conditions.

GPIS 5.5 Radiation Pyrometers

Radiation pyrometers shall be used when:

- Temperatures are above practical operating range of thermocouple.
- Environment will contaminate or seriously limit the life of thermocouples.
- The target is not easily accessible.
- Where plant requirements make them impractical.

Radiation pyrometers shall be of solid state circuitry type and shall, for standard application, respond to 98% of target temperature changes within 2 seconds.

The burner flame detector applications, radiation pyrometers shall be designed for use with self-checking flame self-guard controls.

GPIS 5.6 Filled Systems

Filled systems shall not be used unless otherwise specified.

GPIS 6 INDICATOR DESIGN

GPIS 6.1 Flow Indicators

Flow indicator shall be rotameter or differential pressure type.

Rotameters, when used, shall preferably be of metal type with magnetic indicator extension. Glass type rotameters shall be used for purge or auxiliary services.

Differential pressure type, when used, shall in general be of dry type complete with equalising valve manifold.

Indicators shall have suitable body material and packing of process fluid being monitored.

Scales shall be linear or square root direct reading.

Accuracy shall be 1% of full scale or better and repeatability at least 0,255 of full scale range.

Proof pressure shall be at least 200% of maximum static process pressure at maximum process fluid temperature.

GPIS 6.2 Pressure Indicators

Pressure gauges shall generally be 150mm diameter. Case and movement – stainless steel.

Scales shall be white with black lettering. Accuracy shall be 1% of full scale range or better.

Scale ranges shall be selected so that normal process pressure is approximately 50% of full scale.

Rotary geared stainless steel movements shall be used.

Gauges for steam service shall be connected with pigtail siphon. Dampers shall be provided for all pulsating fluids.

Draft gauges shall be diaphragm type or fluid filled manometers.

GPIS 6.3 Temperature Indicators

Temperature indicators shall generally be 100mm dial, bi-metallic or fluid type with thermo-well suitable for application.

Material of construction for thermo-well shall be suitable stainless steel, unless some other material is required due to process conditions.

Fluid filled type indicators, when used, shall be either rigid stem or capillary tubing type.

Capillary tubing shall be armour protected.

Stem or bulb shall be suitable stainless steel with welded joints.

Indicator shall be provided with automatic ambient temperature compensation.

Accuracy shall be 1% of full scale range or better.

GPIS 6.4 Level Indicators

6.4.1 Sight level glasses or dial type or float type level indicators shall be used.

6.4.2 Each sight glass shall be complete with a pair of offset valves, valves shall have union level connection, flanged tank connection, vent and drain plugs.

If float type indicators are used, cable must be made of braided stainless steel.

Dial type indicator shall be of differential pressure type having accuracy of 1% of full scale or better.

GPIS 7 SWITCHES AND CONTROLLERS

GPIS 7.1 Mechanical Switches

Pressure, flow level, temperature etc. type switches shall be provided with enclosures of a type to suit individual area environment.

Actuating switches shall be either hermetically sealed mercury type or snap action micro-switches. Contacts shall have a minimum rating of 3A inductive braking at 220V AC.

All switches shall have two parallel contacts normally open/closed and the on-off

differential switches shall be adjustable. Adjustable range shall be suitable for switch application, actuation set point shall be adjustable over full scale range.

All switches shall have an accuracy of 1% or better of full scale range.

Level switches shall be in general resonating or displacer type. Standard material shall be suitable for process and ambient conditions. Material of the displacer shall be stainless steel.

Conductivity level switches shall be either single or double type with contacts changeable to minimum/maximum closed safety circuit. Electrodes shall be heavy version, either single or three rod types, material shall be preferable of special steel.

Position switches shall be of inductance or capacitance proximity sensors with single or dual potential free contacts.

GPIS 8 ACTUATORS

GPIS 8.1 General

Actuators shall be either pneumatic diaphragm or pneumatic piston type.

All actuators shall have a stall torque rating of at least 150% of maximum required torque for the driven element.

All actuators shall have a minimum repeatability of 0,5% of full travel. Hysteresis effect shall not exceed 1,0% of full scale travel.

Manual over-ride facilities shall be provided.

A mechanical shaft position indicator shall be standard on all actuators.

Actuators shall have a totally enclosed housing to provide complete protection for all moving, pneumatic and electronic parts. Construction material shall be suitable for ambient and process conditions.

Unless specified otherwise, actuators be of spring return type for fail-safe operation.

GPIS 8.2 Pneumatic Actuators

Actuators shall be of diaphragm or cylinder type for either rotary or linear version depending upon specific application and shall be reversible for air-to-open or air-to-close action.

Actuator shall operate on 600 kPa, cylinder shall be able to withstand a line pressure of 1500kPa. Positioner shall operate on 20 to 100 kPa.

Corrosion, endangered parts such as cylinder wall, piston rod, torque plug, etc. shall be manufactured of hard wearing and rustless metal, with high lubricity.

Actuators shall be provided complete with line filter, lubricator, positioner, manual operating handle and air lock-up system, unless otherwise specified.

For actuator position remote indication the provision for two limit switches attachment shall be provided.

GPIS 8.3 Electric Actuators

Actuators shall be fitted with a 3 phase 400 squirrel-cage motor.

If two speeds are required a pole-changeable motor may be used.

Output force of the motor shall be transmitted through a stage of spur gears, a spring-balanced worm with axial bearings, a worm wheel, and a clutch stage to the output shaft.

All actuators shall be fitted with a double torque-dependent switch.

For remote position indication of actuators fitted to modulating valves, provision for an analogue 4-20 mA attachment shall be provided. For isolation valves two limit switches shall be provided. All actuators must be able to communicate via Modbus TCP/IP

Provision for manual operation shall be made by means of a hand wheel – the mechanically independent hand-wheel shall be engaged by means of a clutch, which also de-clutches the motor drive from the output shaft.

Actuators shall be fitted with a mechanical position indicator.

Technical specifications:

Torque and travel dependent switches:

No, NC or change-over:	10A at 30V AC, 5A at 250V AC 5A at 30V DC, 0,4V at 250V DC
Mechanical life time:	± 106 cycles
Suitable for ambient temperature	-20 to +80°C
Electronic position indicator:	
Supply voltage:	15 to 30V smoothed
Output:	4-20 mA load R: 500 ohm at 15V, 1250 ohm max. at 30V
Current consumption:	Max. 40 mA at 20 mA output signal
Linearity deviation:	±1% from 5 to 95% of measuring range
Suitable for ambient temperature	-25 to +90°C
Adjustment:	Independent for span or better
Linearity:	0,1% of span
Hysteresis:	0,2% of span
Accuracy:	0,5% of span or better
Case:	Dust-tight for general application

GPIS 8.4 Control Valves – General

Control valves for modulation services shall be pneumatically operated.

Flange facing and drilling shall be according to either BS or equivalent DIN standard.

Control valves of size 40mm and above shall have flanged end connections.

In general control valves of size 40mm and below shall have screwed connection.

Valve size shall be based on specified allowable pressure drop at 130% of normal process design flow conditions.

Valve top-works shall be sized so that the valve will operate properly when upstream pressure is 10% above maximum inlet pressure and downstream pressure is atmospheric.

Isolating valves and by-pass valves shall in general be provided for each control valve application. Isolating valves shall be of line size whereas by-pass valves shall be of control valve size.

Seals and liner material used for valves in boiler gas lines shall be made of VITON.

Nylon shall not be used unless otherwise specified.

Close attention shall be given to the selection of valve body, line and diaphragm material depending upon specific application, however, Engineer approval is required prior to order.

GPIS 8.5 Diaphragm Valves

Diaphragm valves shall be used where process control quality requirements are comparatively poor and a low pressure drop across the valve is required or where the valve function is restricted to on-off control

Diaphragm valves shall be used for aggressive fluids such as weak sulphuric acid, corrosive, slurry and sludge which contain solids in suspension.

For application with high control frequency another valve type shall be considered.

Material construction:

Body:	Cast Iron
Liner:	Hard rubber, Soft rubber, Butyl
Diaphragm:	Depending on application.

GPIS 8.6 Globe Valves

Globe valves shall be used in the majority for conventional control application.

For water, steam, gas and air control applications, a cast steel valve body with stainless steel trim shall be provided.

In case of special treated water, selection of stainless steel body may become necessary.

For oxygen control application, a bronze valve body with monel-metal trim and a PTFE Chevron packing shall be provided.

Trim material shall normally be of 316 stainless steel, for special applications stellite shall be used.

Extended bonnets and graphite laminate/filament packing shall be used for operating temperature higher than 200°C up to 530°C.

GPIS 8.7 Butterfly Valves

Butterfly valves may be used for modulating service but shall not be used for shut-off service if the maximum differential pressure across the valve exceed 500 kPa.

Butterfly valves shall be used for high control performance and where low process pressure loss with high recovery is required.

For water, gas and air application, a cast steel valve body with stainless steel disk shall be provided. Packing shall be of PTFE Chevron up to 100°C and graphite laminate/filament packing for high temperatures. In case of special treated water, selection of a stainless steel body may become necessary.

For acid application polypropylene valves shall be provided.

Close attention shall be paid to the selection of valve body, disk and packing material depending upon specific application; however, Engineer approval is required prior to order.

GPIS 8.8 Ball Valves

Ball valves shall be used for modulating and shut-off service where high control performance with low process loss and high recovery as well as tight shut-off function is required.

For water, gas and air application, a stainless steel valve body with stainless steel disk shall be provided. Packing shall be of PTFE Chevron up to 100°C and graphite laminate/filament packing for higher temperatures.

GPIS 9 ANALYTICAL INSTRUMENTS

GPIS 9.1 General

Instruments measuring pH-value, Dissolved Oxygen, Conductivity, Concentration or other properties of process streams shall consist of a suitable design primary element to convert or transform the measured variable into an electrical signal which shall be fed to a control system.

Analyser shall be capable of operating under the ambient conditions prevalent in the specific plant area and to maintain calibration within 0,5% during a 24-hour period while

subject to temperature variations between 10°C and 50°C.

Analysis time shall not exceed 30 seconds.

Reproducibility of analysers shall be 1% of span or better and sensitivity shall be 0,5% of full span.

For calibration purposes, analysers shall be provided with one year supply of a certified calibration sample as well as calibration curves.

All necessary accessories including nozzles, valves and fittings shall be provided. For high temperature applications, sample coolers shall be provided. Sampling accessories shall be of material suitable for each specific application.

GPIS 9.2 pH Measurement

For pH-measurement, reference electrode shall be of rugged and sealed construction moulded in glass coupled polypropylene. Electrical connection shall be made directly onto the outer end of the element ensuring first class electrical performance of the electrode.

Measuring pH-electrode shall be of toughened all purpose glass type giving accurate Ph reading with long electrode life.

In applications where variations in sample temperature may occur, automatic temperature compensation device shall be provided.

The reference and glass electrode including the automatic temperature compensator shall be housed in a compact sensor holder assembly provided with terminal block, cable glands, silica-gel desiccator and screened top cap to prevent against spurious pick-up.

Electrodes assembly materials shall be of glass couples polypropylene and the assembly shall be provided with either flow through type or immersion type, depending upon specific application, complete with all associated accessories and mounting bracket.

pH-transmitter shall be electronic two wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy:	0,5% of span or better
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Measuring range:	0-14 pH
Temperature Compensation:	Glass electrode 0° to 130°C
Cycle:	max. 1,5 seconds
Output:	Preferable 4 to 20 mA DC
Relay Output:	Alarm contact 220 V AC 5A NC
Mounting:	Universal type bracket

GPIS 9.3 Conductivity Measurement

Cell electrode material shall be carbide lined high grade steel or platinum black coated nickel and the cell range shall be selected to suit the required measurement.

Cell shall be equipped with semiconductor temperature sensor for temperature compensation.

Cell shall be either of flow through type or immersion type, depending upon specific application, complete with all associated accessories and mounting bracket.

Conductivity transmitter shall be electronic two wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements;

Accuracy:	2% of span or better
Measuring range:	0,1 to 100 μ S/cm depending on used cell type
Reproducibility:	1% within range or better
Temperature Compensation:	Semi conductor 0° to 130°C
Cycle:	max. 1,5 seconds
Output:	Preferable 4 to 20 mA DC
Relay Output:	Alarm contact 220 V AC 5A NC
Mounting:	Universal type bracket

GPIS 9.4 Oxygen in Combustion Measurement

Cell electrode material shall be of Zirconia.

Cell shall be equipped with semiconductor temperature sensor for temperature compensation.

Cell shall be direct insertion type, complete with all associated accessories and mounting brackets.

Oxygen analyser transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirement:

Accuracy:	1,0% of span or better
Measuring range:	0 to 5, 0 to 10 or 0 to 20 vol % O ₂
Reproducibility:	1% within range or better
Temperature Compensation:	0° to 1400°C
Response rate:	90% response within 5 sec when gas introduced from calibration gas inlet
Warm up time:	max. 15 minutes
Output:	Preferable 4 to 20 mA DC
Relay Output:	Alarm contact 220 V AC 5A NC
Mounting:	Universal type bracket
Calibration:	One-touch calibration using calibrated memory

GPIS 9.5 Dissolved Oxygen Measurement

The measuring sensor shall be of the Luminescent type – LDO technology.

The sensor shall be equipped with a hermetically sealed cable suitable for direct immersion. The cable end shall be fitted with a quick disconnect plug.

The sensor shall be mounted on a manufactured extension bracket for immersion in an open tank application to allow easy access for cleaning purposes.

The DO transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy:	0,2% of span or better
Measuring range:	0-20.0 ppm or 0-20 mg/L
Temperature Range	0 to 50°C
Response time:	90% in less than 40 sec.
Power Supply:	220 V AC
Output:	4 to 20 mA DC
Mounting:	Universal type bracket

GPIS 9.6 Turbidity Measurement

The measuring sensor shall be of the self cleaning type with wiper blade

The sensor shall be equipped with a hermetically sealed cable suitable for direct immersion.

The cable end shall be fitted with a quick disconnect plug.

The sensor shall be mounted on a manufactured extension bracket for immersion in an open tank application for ease of maintenance.

The Turbidity transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy:	0.001 NTU
Measuring range:	0.001 – 4000 NTU
Temperature Range	0 to 50°C
Power Supply:	220 V AC
Output:	4 to 20 mA DC
Mounting:	Universal type bracket

GPIS 9.6 Suspended Solids Measurement

The measuring sensor shall be of the self cleaning type with wiper blade

The sensor shall be equipped with a hermetically sealed cable suitable for direct immersion.

The cable end shall be fitted with a quick disconnect plug.

The sensor shall be mounted on a manufactured extension bracket for immersion in an open tank application for ease of maintenance.

The Suspended Solids transmitter shall be electronic four wire type, with alphanumeric operator interface, manual and automatic calibration facilities, and shall meet the following minimum requirements:

Accuracy:	< 5% of reading
Measuring range:	0.001 – 50 mg/l
Temperature Range	0 to 50°C
Power Supply:	220 V AC
Output:	4 to 20 mA DC
Mounting:	Universal type bracket

GPIS 9.7 Tank or Hopper Mass Measurement

If mass content measurement of a vessel is required, the vessel shall be supported on load cells.

The mechanical design shall make provision for load cell protection against overload, shock load and plant vibration. It shall also take into consideration the prevention of excessive shear loads being transmitted to the load cell without affecting the accuracy of the scale.

Jacking facilities shall be provided to enable the load cell to be removed without taking the vessel out of service.

Copper braiding shall be connected across load cells to protect them against welding currents.

Continuous weight monitoring shall be achieved by the load cells weight detectors, weight transmitters and suitable indicators. An electrical signal, preferable 4 to 20 mA, shall be provided to be fed to a control system.

Load cells shall be of robust hermetically sealed stainless steel construction and shall meet the following minimum requirements:

Temperature Compensation:	0 to 55°C
Temperature Effect:	Not to exceed 0,5% of maximum span per 10°C change
Accuracy:	0,5% or better
Overload:	200% of nominal load
Rated Output:	1mV/V

Load cell cable joints are to be soldered according to manufacturer's instruction.

GPIS 10 INSTRUMENT PANELS AND CABINETS

GPIS 10.1 Construction

Panels shall be free standing type and shall be fabricated from cold rolled sheet steel of thickness not less than 2mm with welded construction throughout. All welds shall be ground smooth, all corners to be ground and all weld spatters shall be cleaned.

Surface of panels shall be painted and free from all marks and defects.

Mounting angle, flush with bottom of panel, shall be provided. All panels shall be supported on suitable sized vibration isolators, designed for bolting to panel frame and flooring.

Accessories such as swing rack mounting frames, circuit breaker panels and covers, base gland plates, etc, shall be standardised.

Front doors shall be fitted with suitable armoured glass cut-out and rubber gasket and shall be hinged door lockable. Rear doors shall be of solid construction and lockable.

All instrument cut-outs and drillings shall be straight and true. If provisions are to be made for further instrument installation, cut-outs shall be made and suitable blanks shall be provided. Blanks shall be painted with same colour as panel and a minimum of four anchors shall be used to attach them to panel board.

Instruments mounted on panels shall be spaced to provide access for adjustment and removal of equipment.

Removable eye bolt lifting lugs shall be furnished and installed on all panels.

GPIS 10.2 Field Junction Boxes

Boxes shall be constructed of 304SS and painted with hinged and lockable door. Mounting plate and bottom gland plate suitable for electric and pneumatic process connection shall be standardised.

All instrument cut outs and drillings shall be straight and true. If provisions are to be made for further instrument installation, cut outs shall be made and suitable blanks shall be provided.

Instruments mounted on boxes shall be spaced to provide access for adjustments and

removal of equipment.

The degree of protection shall comply with IP 65. Construction material shall be suitable to resist the conditions prevalent in the specific plant area.

Field boxes are to be fitted with knife type termination, indicating fuse holders are to be used where power is supplied to solenoids or any other secondary field instrument.

All cables should be properly glanded and all cores will be terminated PLC connections are to be terminated at the left and field connections terminated at right.

All terminals to display an identification number according to the numbering standard as applied.

GPIS 10.3 The panel wires should be as per table below

Wire	Colours
220/110 volt AC control : Orange	Orange
AC neutral wires : Black	Black
24-50 volt AC control : Red	Red
24-50 volt AC neutral : Pink	Pink
24-50 volt DC control : Purple	Purple
Zero volts DC : Blue	Blue
PLC wiring : Gray	Gray
Telemetry wiring : Yellow	Yellow
Earth wires : Green yellow	Green Yellow
CT's to ammeters : White	White

SECTION B

PIIS: PROCESS INSTRUMENTATION INSTALLATION SPECIFICATION

PIIS 1 INTRODUCTION

This standard specification furnishes information and sets out requirements for the installation of instrumentation equipment.

All equipment and material shall be of a quality and type approved by the Engineer.

No equipment or material shall be installed unless it complies with the requirements of this specification.

All equipment and material shall be checked for suitability, quality and adherence to this specification. Every approval must be obtained by the Contractor prior to installation.

Any installation or installation procedure which is in contravention to this specification shall be made good or replaced, to the satisfaction of the Engineer, and all costs for making good or replacement shall be for the contractors account.

Failure to adhere to the requirements of this specification may result in the equipment or material being rejected by the Engineer.

PIIS 2 STANDARD OF WORK

The complete instrumentation installation shall be carried out by skilled, competent and qualified operatives to the highest standard of safety and workmanship, using the correct tools for the operations and best quality materials.

A clean, orderly and safe environment shall be maintained in the Instrumentation Contractor's workshop, the stores and offices and in the construction areas.

Cabling and wiring shall form a neat and functional appearance.

Work shall be planned such that access to equipment for the current installation or future maintenance shall not be obstructed.

The completed installation including supports, brackets, wiring, cabling and piping shall present a clean, tidy appearance and shall conform to good engineering practice.

The contractor shall install instruments and other equipment in accordance with the manufacturers instructions, and the project drawings, taking due cognisance of the Standards and Codes listed in this Specification.

The standards and codes which shall apply to this project are those issued by the following organisations:

- British Standard Institution (BSI)
- Deutsche Industrie Normen (DIN)
- American National Standards Institute (ANSI)
- The Instrumentation, Systems and Automation Society (ISA)
- South African Bureau of Standards (SABS)

PIIS 3 INSTRUMENT LOCATIONS

General locations of the instruments are shown on the instrument location drawing. It may however be necessary to make minor changes on site. In the interests of the prevention of rework, confirmation of the exact location shall be obtained by the contractor from the site representative before the work is carried out.

Where no instrument location drawing is available the instrument shall be positioned as close as possible to the process monitoring point.

The instrument shall be mounted in an easily accessible position to facilitate maintenance and removal.

The contractor shall avoid, where possible, locating instruments in locations subject to leaks and spills. Where an instrument is unavoidably located where exposure to the above mentioned is likely, a splash guard shall be provided over or around the instrument.

Field mounted instruments, excluding in-line and close-coupled devices shall be mounted so that the centre line of the housing, chart or scale is approximately 1,400mm above grade, floor or platform, unless otherwise specified on an installation drawing.

Instruments must not be mounted where there is excessive vibration.

Instruments must be mounted away from steam lines and other sources of heat.

Instruments are not to be mounted on hand rails or process parts of the plant (e.g. pipe lines).

Transmitters or local controllers shall be located as close to the primary process connection as possible but instrument accessibility must be maintained.

Instruments shall be installed so as not to cause any obstruction to walkways, headroom or access to other plant items.

Instruments are not to be mounted near or in the way of sections of the plant that are regularly removed.

Direct mounted dial thermometers, pressure switches, pressure gauges and thermo wells shall be plainly visible and accessible from floor or adjacent platform.

PIIS 4 SUPPORTING BRACKETING AND FIXING

The drilling of holes in structural steelwork is not permitted except with the prior written approval of the engineer.

The drilling of holes in vessels or pipe work is expressly prohibited.

Explosive type fixing devices shall not be used.

Instrument pipe stands where required are to be manufactured according to the drawings. All stands should be floor mounted unless otherwise stated. Fixing bolts, nuts and washers must not be cadmium plated. They shall be hot dipped galvanised or stainless steel.

Mounting brackets must be hot dipped galvanised.

Instrument supports and mounting brackets shall be of a suitable strength and rigidity to ensure proper operation of the instrument. Careful attention shall be given to ensure that instruments are not mounted on or attached to equipment or structures which are subject to vibration. All proposed locations must be approved by the Engineer before installation.

Brackets shall in general, be made of mild steel flat bar, angle or channel. All brackets shall be hot dipped galvanised.

PIIS 5 INSTRUMENT PIPING AND TUBING

The instrument primary process connection is defined as the connection after the first isolation valve on the process pipeline, duct, vessel, or tank. The isolation valve will be supplied and installed by others unless specifically stated otherwise in the instrument installation/wiring diagram.

Piping from the primary process connection to the instrument shall be as short as possible and shall be installed so that no pockets or traps can occur. Where such pockets are unavoidable, drain valves and pots shall be provided at the lowest points. All such piping shall be properly supported to relieve all connections points of strain, and where expansion is likely, suitable offsets should be incorporated.

Instrument piping impulse lines shall be 12mm seamless stainless steel, except in specific high pressure temperature applications where the process conditions will dictate the material. Process connection tubing shall be 12mm seamless stainless steel and 10mm or 6mm seamless stainless steel for signal lines, depending on application.

Air supply manifolds are to be made of stainless steel. Drain valves must be fitted to the lowest point of the manifold. Each take-off point must have an isolation ball valve. Each take-off point shall be labelled with the instrument reference number. An allowance must be made for 20% spare take-off points. All take-off points not utilised must be plugged after the isolation valve.

Air supply tubing from manifolds to air regulators or solenoid operated valves shall be 12mm seamless stainless steel.

Air supply tubing from regulators and solenoid operated valves to actuators, positioners, etc. shall be 10mm seamless stainless steel.

All tubing fittings shall be Gyrolok, or an approved equivalent.

Isolation valves, other than those intended for use with an orifice carrier, are not normally the responsibility of the instrument section, but are supplied as part of the plant pipe work.

Valves shall be accessible for operation from floor and operating platforms unless otherwise approved by the Employer. Valves or equipment shall not obstruct passageways.

All instrument piping entering or leaving a control cubicle, box or panel shall do so via a bulkhead coupling.

In cases where pipe penetration openings are not provided in gratings which are installed by others, openings shall be field cut and the grating banded. The contractor shall then paint the cuts and welds according to the paint specification. This must be avoided at all times where possible.

Capillary tubing for filled system temperature instruments, diaphragm level transmitters and the like, shall be supported and protected by running the tubing in angle iron or 'Unistrut' channel for the entire exposed length of the capillary. Excess capillary tube shall be neatly coiled and secured. Minimum bend radius for capillary tube shall be 75mm.

Piping within plant building shall be carried on overhead racks attached to the building frame or other supports. Piping racks shall be separate from cable racks. Existing piping racks may be used after permission is obtained from the Engineer.

Every pipe installed on racking in a building or on a supporting structure shall be supported in such a manner that there is no undue mechanical strain on any termination.

PIIS 6 CABLE RACKS AND SUPPORT

Cable rack/tray shall follow the building or mechanical construction line to which they are attached, with as few direction changes as possible.

Cable racks shall be mounted in the vertical plane and shall be positioned so as to avoid obstruction to walkways and access routes. Racks shall not be mounted in the horizontal position without the prior written permission of the Engineer.

Cable rack/tray bends and tees will be constructed as to allow all cables within trays to have a bending radii of not more than the manufacturer's specifications. No right angle jointing of rack/tray will be allowed.

Cable rack/trays shall be properly aligned and supported and the completed installation should have no visible deflection and be devoid of any distortion, kinks or sags.

The maximum distance between centres of adjacent supports shall be 2 metres. Additional supports shall be located at the joints of straight tray lengths and at every change in direction.

Supports shall be attached to permanent members of the building.

Cable racks to be fabricated mild steel and hot dipped galvanised similar or equal to the 'O' line support system unless specified otherwise in the document

Touching up after fabrication shall be by cold galvanising.

Single angle cable supports may be used under the following conditions:

- Up to no more than 3 cables may be run on an angle iron support
- The size of the angle iron shall be such that in cross section, no part of any cable shall project beyond the square of which the angle iron forms two sides
- The minimum size angle iron to be used shall be 25 x 25 x 5mm and maximum size 40 x 40 x 6mm

Where required, any cable in danger of mechanical damage will be protected by using galvanised pipe or channel.

Cable rack/trays shall be installed in accordance with the route diagram. Minor deviations in routing to avoid interference may be allowed subject to the approval of the Engineer. Where no cable routing drawing is available the cable routes shall be "site" determined in conjunction with the Engineer.

All cables run on racking or angle iron supports shall be fully supported to within 150mm from the gland entry on the equipment serviced or as cable size dictates.

PIIS 7 CABLING AND WIRING

Cable sizes, number of cores and cable number shall be as indicated on the cable schedules.

Cables shall be tested per drum length on delivery to site prior to installation. Results shall be documented.

Cable drums shall be rolled in the proper direction to prevent loosening of the cable. Cable shall be drawn into position using a sufficiency of rollers and cornering apparatus to avoid damaging the cable by excessive bending or dragging.

Cable shall be stored in dry areas.

Where cables pass through a floor, they shall be protected by a metal pipe or suitable mechanical protection, extending from 50mm to 350mm above floor or ground level.

The contractor shall observe the manufacturer's recommendations for minimum bending radius but shall never use less than the following radii:

- Unarmoured cables: 5 times the overall outside diameter of the cable
- Armoured cables: 10 times the overall outside diameter of the cable

Clips, saddles or clamps for securing of cables shall have smooth and rounded edges and shall not damage the cable sheath or serving. The type of saddle or clamps shall be approved by the Engineer before installation commences.

Instrument signal and electric power may not run bunched in the same rack/tray. A minimum distance of 300mm shall separate such racks/trays. If instrument cables are required to run on the same cable rack as electrical cables, then there must be at least a 300mm gap between the electric and instrument cables.

To avoid interference arising from electrical power supply voltage dips or spikes, instrument signals and electrical power cables shall only cross at right angle to each other.

On no account will instrument signal and electrical power wiring be transmitted in the same multi-core cable. Solenoid coils of 24V or less may be run with instrument switching signals.

Instrumentation cables may only be installed a maximum of 2 deep on racks if approved by the Engineer.

Joints in cables are permitted only where the length of the run exceeds the standard manufactured length of cable available on a drum. In these cases, the joints will be made

in a junction box. No through jointing of cables will be permitted on cable racks/trays or in any cable way.

Coaxial cable for data highways shall be run individually in 20mm conduit as per 7.16. Conduits used for this purpose shall be installed a minimum of 300mm from electrical cables.

All cables shall be labelled at each end and at 10m intervals along its length with a strap on plastic marker tags bearing the cable number as shown on the cable schedule. (Black letters on a yellow background).

All cables shall be mechanically anchored at the position of termination by the use of flanges of the correct size, as follows:

- Where equipment supplied is provided with cable entries having DIN, NPT, etc., threads, the contractor shall provide all necessary adapters to permit the use of standard ISO Metric thread cable glands.
- Where glands are to be used with non-threaded clearance holes, a heavy duty lock-but, together with suitable weatherproofing gaskets shall be provided. Holes with a tolerance greater than 1.5mm larger than the gland size will not be accepted.
- Cables shall always be made off according to the gland manufacturers recommendations.
- When glanding off SWA cables in non-conducting enclosures the gland shall be provided with an internal earthing washer and connected to a suitable earth connection.

Where wiring is specified to be run in conduit, the following shall be observed:

- The conduit used shall be heavy gauge seamless metal conduit with galvanised finish. Flexible conduit shall be of the PVC sheathed variety.
- The conduit shall have a smooth bore. The smallest size to be used shall be 20mm and the largest 50mm nominal diameter.
- All conduit joints and entries shall be screwed a minimum of 20mm and made tight and weatherproof. Conduit threads shall be protected from corrosion by the application of an approved cold galvanising paint.

- Draw-in boxes shall be installed after every second bend or a combination of sets and bends which equal 180 deg. or after every 7,5m of straight run. All boxes shall be supplied with gaskets for weatherproofing.
- Where the possibility of condensation exists, the conduit shall be installed with a slope of approximately 3 in 100 and a 3mm diameter drain hole shall be drilled at the lowest point.
- Metal conduits shall be bonded and earthed. Conduit bends, boxes, flexible conduits, etc., shall not interrupt the earth continuity.
- Conduit must not be used as an earth continuity conductor.
- The minimum bending radius of conduit shall be 6 times the conduit diameter.
- Conduit shall be fixed with clips or saddles at a pitch not exceeding 1,5m.

PIIS 8 CABLE AND WIRE TERMINATIONS AND CONNECTIONS

All instruments, control panels, junction boxes, etc., shall be wired in accordance with the relevant project drawings.

Each conductor shall be fitted with an insulated double crimp lug of the correct size. Pin lugs shall be used for pressure type terminals. Ring or spade lugs shall be used for post type terminals.

A proprietary type of wire stripper must always be used. The stripping tool must be checked regularly and is subject to inspection by the Engineer. The termination of stranded conductors where one or more strands have been damaged or broken is expressly prohibited.

The crimping tool used for attaching termination lugs shall be of the ratchet type which requires a specific amount of pressure prior to release, recommended by the manufacture of the crimp lugs.

All wires are to be terminated. Spare terminals shall be provided for unused pairs or cores. All spare terminals of field multi-cores shall be connected together and bonded to instrument earth.

Terminated wires shall be arranged neatly and loomed where necessary using cable ties. Spiral lacing shall be used for flexible or semi flexible looms.

Each wire shall be numbered with the respective terminal number by means of interlocking slip-on plastic ferrules of the correct size. Split or clip on ferrules are not acceptable. The ferrules shall be a tight or interference fit on the wire.

Cable colours:

- Normal signal cables - black outer sheath
- Earth cables - green

Conductors to be 0,5mm flexible stranded twisted copper wire for normal instrument signals and 1,5mm to solenoid valves.

Nylon washers shall be put on all cable glands and cable gland adapters on weatherproof boxes.

Cables must not be trapped in lagging.

Cables to field instruments must have at least 30cm slack which should be neatly looped before the instrument.

Cables incorporating shields or screens shall have the shield or screen isolated for electrical earth throughout its length and it shall be earthed only at the point indicated on the drawing.

Only cable in the following standard sizes shall be used:

- | | |
|------------|----------|
| • 1 pair | 1 triad |
| • 2 pairs | 2 triad |
| • 4 pairs | 4 triad |
| • 8 pairs | 8 triad |
| • 12 pairs | 12 triad |
| • 16 pairs | 16 triad |
| • 24 pairs | 24 triad |
| • 36 pairs | |
| • 50 pairs | |

For field instrumentation power supply only 3 core S.W.A. or Dekobon cable shall be used.

The approved cable is Dekobon type M855 single pair, M877 multi pairs and M865, M887 respectively for triads. The conductor size shall be 0,5mm² for instrumentation signals unless specified otherwise in the instrument cable schedule.

A variation from this type of cable must have the permission of the engineer.

Instrument cabling identification

Cables are to be labelled according to the cable schedule. The numbering will be made up as follows:

Field instrument to JB or marshalling:

- analogue = IA + instrument tag number
- digital = ID + instrument tag number
- power = IP + instrument tag number

JB to marshalling:

- marshalling terminal strip number

PIIS 9 JUNCTION BOXES

Junction boxes must be numbered on the door or lid with an engraved plastic type label having numbers at least 5mm in height. (Refer section 12 Instrument Labels).

Terminal rails and individual terminals shall be numbered.

An earth plate or rings for the cable glands shall be put in the bottom of each junction box, where required.

Cables must enter from the bottom of the junction box.

Spare holes for cable glands must be plugged with the approved type of plugs.

Boxes with pneumatics inside must have a vent at the bottom of the box and shall be fitted with a port protector/silencer.

Shield wires must be strapped together.

The box must be classified IP65 or better.

The box must be mounted securely.

Junction boxes shall be polycarbonate. Painting or other colouring is not required.

PIIS 10 INSTRUMENT INSTALLATION – SPECIFIC REQUIREMENTS

PIIS 10.1 Flow Meters

The in-line element of the flow meter will be installed by others. It is the responsibility of the instrumentation contractor to check that the correct element is installed and that it is correctly installed and is undamaged before accepting the installation for his part of the work.

The flowmeter/d.p. cell shall be installed and piped up according to the instrument installation diagram.

Orifice plates shall be clearly stamped with the orifice diameter, direction of flow and tag number.

The minimum slope of lines to instruments situated above or below the primary element shall be 25mm per metre.

If seal-pots are used, they shall be located as close as possible to the orifice taps and shall be installed so that both seal-pots are the same elevation.

DP cells must not be mounted where there is excessive vibration. On steam applications, the measuring element and isolation valves must be below the orifice tapping points.

Magnetic flow meters shall be installed such that the product lines remain full when flow occurs and when flow is zero.

Magnetic flow meters mounted on lined pipes shall have earthing rings mounted on the upstream and downstream flanges. Earth bonding trays shall be installed as per manufactures instructions and/or the instrument installation diagrams.

PIIS 10.2 Control Valves

Control valves shall be mounted by others so that the direction of flow indicator (if any) on the valve body is compatible with the direction of flow of process fluid in the pipe. It is the responsibility of the instrumentation contractor to check that the correct valve is installed and that it is correctly installed and there is no damage visible before accepting the valve for hooking up to pneumatics or electrics.

The control valve shall be installed and piped up according to the instrument installation diagram.

A bulkhead plate will be provided where stainless steel/dekabon lines end and flexible lines start.

Flexible lines are to be tidy and are not to be in contact with any hot surface.

The position of the limit switches on a valve should be made adjustable.

PIIS 10.3 Level Measuring Instruments

Ultrasonic transducers shall be mounted in such a way that any vibration present at the site of installation cannot be mechanically transmitted to the transducer housing. In this respect, the manufacturer's instructions must be strictly adhered to.

Flange mounted ultrasonic transducers must be mounted on a thick gasket of soft resilient material and lightly secured with PVC or nylon nuts and bolts. Under no circumstances shall the bolts be over tightened, finger tightening is sufficient.

Differential pressure type level transmitters shall be installed onto instrument stands unless they are of the flange mounted type. Connections shall be as per hook-up drawings.

PIIS 10.4 Temperature Elements

A thermo well must be inserted first to protect sensor against damage from corrosion, erosion, abrasion and high pressure processes.

The elements used to measure temperatures will be either thermocouples, platinum resistance temperature bulb (R.T.D.) or capillary filled local indicators.

The element must be installed in such a way that it is easily accessible for inspection and

replacement.

The tip of the measuring element must reach and be in contact with the end of the thermo well.

Positions of detecting elements shall be such to facilitate easy removal without fouling.

Capillary lines are to be protected.

PIIS 10.5 Pressure

All pressure points shall be fitted with ½ inch N.P.T. isolation cocks unless flush mounted diaphragms are used.

If the fluid to be measured is toxic or corrosive, a drain or vent shall be provided to discharge the fluid to a safe location.

Where the pressure pulsates heavily, suitable damping shall be fitted.

Gauges more than 3m from their impulse points shall have an additional isolation valve at the gauge.

If the unit is not flange mounted and the process fluid is dangerous, a valve must be fitted for releasing the pressure in the impulse line.

Gauges shall be mounted in a vertical position.

PIIS 11 INSTRUMENT LABELS

Each instrument shall be fitted with a label giving the function and tag number as detailed in the label schedule. Field mounted instruments including final control elements shall have labels mounted on a bracket which is fixed independent of the instrument and stays in position if the instrument is removed. The label must be in a clearly visible location.

Labels shall be made of laminated trafolite and have black letters on a white background.

The size of the labels shall be:

Type 1	Field Instruments/ Transmitters/ Control Valves	80mmW x 30mmH
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Type 2	Cabinets/ Field Junction Boxes	200mmW x 30mmH
Type 3	Terminal Rails	39mmW x 18mmH
Type 4	Power Supplies	70mmW x 20mmH
Type 5	Power Rails	15mmW x 10mmH
Type 6	Marshalling Cubicles	150mmW x 50mmH
Type 7	Distribution Boards	150mmW x 50mmH

Type number will be included in the label schedule with the letter size.

PIIS 12 INSTRUMENT NUMBERING

The instrumentation shall be tagged according to the following system:

Prefix :	MCC area code
Instrument type :	Modified ISA abbreviation
Instrument number :	Sequential number

e.g. 02-LT-02

MCC 2, level transmitter, 2nd instrument in that area.

PIIS 13 ACCEPTANCE OF INSTRUMENTATION

When all the testing and flushing on an instrument loop has been completed the contractor shall notify the Engineer in writing and request inspection. Defects attributable to the contractor shall be punch listed and shall be rectified at the contractor expense. The Engineer shall accept equipment in a particular area on a loop by loop basis in writing, but the contractor shall retain responsibility for the loop until the complete area is handed over and accepted in writing by the Engineer.

SECTION C

INDUSTRIAL AUTOMATION AND NETWORK SPECIFICATION

IAN 1 PROGRAMMABLE LOGIC CONTROLLERS (PLCS)

IAN 1.1 PLC HARDWARE & ENGINEERING

New Modicon M580 PLC's shall be supplied, installed, programmed, tested and commissioned for the complete control and operation of the respective existing and new plant installed. The PLC's and the required components shall be supplied as specified in the EWS standardised preferred equipment list.

The Contractor's engineering design shall include for all cubicles and hardware required for PLC control, and shall include comprehensive equipment lists, cubicle GA drawings and Control Centre drawings, I/O schedules and functional descriptions.

Provision shall be made for PLC control of all items require, plus allowance for expansion.

The Contractor shall furthermore ensure that the complete design, installation, commissioning shall include all necessary cabling, interfacing, connections, mountings etc. to ensure that the final product is complete, functional and to a good engineering standard.

The Contractor shall provide the following documentation to the integrator to enable the integrator to complete his scope. Documentation shall be at "For Construction" revision.

- Plant P&ID's
- IO Lists including:
 - instrument ranges;
 - alarm setpoints;
 - IO allocations per PLC system/rack/card;
- Plant network layout
- SCADA Hardware specifications

On completion of electrical and control panel manufacture, the contractor shall complete a Factory Acceptance Test (FAT) of all panels at his premises before delivery to site. The contractor shall inform the engineer that panels are ready for FAT and a team including the employer, the engineer, and the integrator shall attend and witness the FAT.

Acceptance of the FAT shall require acceptance by the employer, the engineer and the integrator.

The integrator has then accepted the panels for site tests and commissioning.

IANS 1.2 SOFTWARE ENGINEERING

IANS 1.2.1 PLC Software

The integrator shall utilise the latest revision Unity Pro Software Program for the programming of the PLCs. The integrator shall provide their own computer for the programming and software engineering and on completion of the project the engineered software shall be transferred to the Employer. The software shall remain the property of the Employer with all copies kept by the Integrator during the course of the contract transferred to the Employer on completion of the Contract. No password protected codes will be accepted.

The integrator shall use information provided by the contractor and the EWS representative to develop the Function Design Specification (FDS) for approval by the EWS representative, prior to detailed software development.

Additional information shall be provided to the integrator in the form of the Process and Control Description which will assist with the FDS development.

The software engineering shall be developed in accordance with the final design P&ID and the FDS, which will include information from the Process and Control Description and sample FDS.

All control loops in the software engineering shall be based on an island control basis for the various process sections.

Software engineering shall be done using a structure format of function blocks to facilitate program simplicity and fault finding.

Certain standard programming function blocks might be provided by EWS to the successful tenderer to facilitate standardisation and shall be incorporated when programming the PLC and HMI for each section.

The integrator shall however be required to develop new function blocks in consultation with the Employer and the Engineer for approval prior to implementing the program.

The integrator shall allow for a minimum of three reiterations of the PLC program for changes as may be requested by the Employer and EWS representative without their pricing for this work.

IAN 1.3 I/O LIST

The Process and Control Description is to be read in conjunction with the P&ID drawings and single line schematic diagrams.

The Contractor, on completion of design, shall submit to the EWS representative comprehensive I/O lists for the new PLC in the form of a I/O list. This list shall be the expansion of the instrumentation index supplied at tender stage and shall include information listed in section 1.2 above.

The resultant I/O's shall be forwarded to, and used by the integrator for configuration of the respective process PLC's and to provide the necessary input to the overall HMI system to be installed under this Contract.

IAN 2 HUMAN MACHINE INTERFACES (HMI'S)

IAN 2.1 HARDWARE

For the local interaction and control of the respective plant areas the contractor shall supply and install Schneider Magelis 15" Graphic Terminal (HMI) (model number) units.

Each MCC shall be fitted with an HMI.

IAN 2.2 SOFTWARE

Integrator Scope

The integrator shall use the latest revision Vijeo Designer Software Program for programming the HMIs. The integrator shall provide his own computer for the programming and on completion of the project transfer the software and licence to the Employer.

The software engineering shall be developed in accordance with the final design P&ID, the Process and Control Description and sample Process Control Philosophy. All control loops in the software engineering shall be based on an island control basis for the various process sections.

Software engineering shall be done using a structure format of function blocks to facilitate program simplicity and fault finding.

Certain standard programming function blocks and graphics might be provided by EWS to the successful tenderer to facilitate standardisation and shall be incorporated when programming the PLC and HMI for each section.

The integrator shall however be required to develop new function blocks in consultation with the Employer and the Engineer for approval prior to implementing the program. The new developed software shall however be required to follow the standard EWS display format.

The integrator shall allow for a minimum of three reiterations of the HMI program and display graphics and trending for changes as may be requested by the Employer and Engineer without their pricing for this work.

IAN 3 CONTROL NETWORK

The network design provides for a Modbus on Ethernet communication backbone which has been designed to support two systems namely:

- eThekweni Electrical MV Gear and Standby generator on site.
- eThekweni Water and Sanitation, PLC and SCADA data and control communications.

IAN 3.1 NETWORK HARDWARE

The Contractor shall supply and install ethernet switches, which shall be high quality industrial grade.

Network switches utilised in the design shall be the standard preferred model managed switches as specified in the Schedule of Quantities.

The switches shall have the option to accept both fibre and copper cable in order to reduce the number of media convertors required. Configurable ports are preferred for flexibility.

The manufacturing details in respect of the panels to house the network switches is covered under the Motor Control Centres.

IANS 3.2 NETWORK CONFIGURATION

Integrator Scope

The integrator shall configure each switch for maximum efficiency of the data transfer between his configured PLC's and SCADA systems.

IANS 3.2.1 Documentation

The integrator shall include design drawings & documentation to the SCADA system and allow for retrieval of documentation or drawings from the operator accessible system help screens.

Available documentation shall include:

- Process & Control Description
- Functional Design Specification

Available drawings shall include:

- Control Network Overview Layout
- Power Distribution Schematics & Drawings
- PLC Card Wiring Diagrams
- Loop Sheets
- MCC Schematics
- Instrument Data Sheets

PSC 2019/007: EWS PREFERRED EQUIPMENT LIST

DATE: 05 December 2023

REV NO. 00

Revision Description:

Rev00 - Issued for Concept Design

1.0 PREFERRED EQUIPMENT – INSTRUMENTATION AND INDUSTRIAL NETWORKS		
No.	Equipment Type	Equipment Brand
1.1	Power supply	Siemens / SITOP series
1.2	Relays	Omron, ABB
1.3	Terminal relays	Weidmuller , Klippon
1.4	Terminals	Klippon, Weidmuller, Phoenix
1.5	Cable glands	Pratley Envirogland
1.6	Junction box	York enclosures, CCG
1.7	Ultrasonic level meter	Siemens
1.8	Ultrasonic Flow Meter (OCM)	Siemens
1.9	Area Velocity Flow Meter (OCM)	Pulsar
1.10	Radar level meter	VEGA
1.11	electromagnetic flow meter	Krohne, Siemens, Flowmetrix Safmag
1.12	Other flow meters (Ultrasonic- Clamp)	Krohne,
1.13	Coriolis Flowmeter	Krohne,
1.14	Flow switches (LED Indicators)	EGE, IFM
1.15	Pressure Transmitter (Gauge & Differential Pressure)	Siemens, VEGA, Rosemount
1.16	Orifice Flow Element	Siemens, EPC, Emerson
1.17	Chlorine gas leak detectors	Siemens, Grundfos
1.18	Residual chlorine meter	Siemens, Grundfos
1.19	Dissolved oxygen meter	Hach LDO type,

1.0 PREFERRED EQUIPMENT – INSTRUMENTATION AND INDUSTRIAL NETWORKS		
No.	Equipment Type	Equipment Brand
1.20	Turbidity meter	Hach, Endress & Hauser
1.21	Temperature measurement	Wika, Siemens
1.22	Pressure gauges	Wika
1.23	Air flow meters-Thermal resistance type	Endress & Hauser
1.24	Proximity switch	efector (Shorrock Automation), IFM
1.25	Limit Switches	Omron, Cutler and Hammer
1.26	Solenoid operated valves- Stainless Steel	Bürkert , Asco
1.27	Pneumatic actuators	EI-O-Matic, Festo
1.28	Electrical Valve actuators (Modbus TCP)	Auma , Rotork
1.29	Surge Protection	Surgetek: Signals : BCT BE24 Line: DEHNguard 275 Neutral: DEHNgap B Mains: DehnVentil 255
1.30	UPS (30 Min)	APC , Eaton,
1.31	SCADA	Aveva Plant SCADA (Citect) & GeoSCADA
1.32	PLC	Schneider Modicon M580 ePAC and M340
1.33	HMI	Schneider Magelis STU with 15” touch-screen or the latest
1.34	Industrial Ethernet network switch	Managed / Unmanaged –Hirschmann

2.0 PREFERRED EQUIPMENT – MECHANICAL		
No.	Equipment Type	Equipment Brand
2.1	Screenings washer/compactor	Huber / WAP/ S A M E
2.2	Grit washer/separator	Huber / Coanda
2.3	Variable speed (multi stage) pump system	Lowara / Hydrovar
2.4	Multiple bags in-line water filter	CWC
2.5	Mechanical Screens (Front Rake, Band Screen)	S A M E, Circuit, Huber, Meva
2.6	Digester heaters	Hydrotherm - Hamworthy water heaters
2.7	Submersible / Immersible pumps (sewage)	Grundfos, Xylem Flyt , KSB, Robot
2.8	Progressing cavity pumps	Netzch, Seepex, Mono, Orbit
2.9	Dry well self-priming centrifugal pumps (sewage)	Cornell, Gorman Rupp
2.10	Dry well centrifugal end suction pumps (sewage)	Cornell, KSB
2.11	Dry well centrifugal pumps (water)	Grundfos, Xylem Flyt , KSB
2.12	Macerator pumps	Vaughan, Tsurumi
2.13	Macerator/Grinders	JWC, Franklin Miller
2.14	Chemical dosing pumps	Grundfos
2.15	Sludge Screw Press	Huber / Rotamat
2.16	Filter Belt Press	Bellmer
2.17	Gravity Belt Thickener	Bellmer
2.18	Flame arrestors	Macroblaze,
2.19	Gas flare	Macroblaze
2.20	Vacuum/Pressure relief valves gas	Macroblaze
2.21	Cast Iron RS gate valves	Hawle, Ainsworth
2.22	Cast iron wedge gate valves	VOSA
2.23	Cast iron diaphragm valves	Saunders Type KB

2.0 PREFERRED EQUIPMENT – MECHANICAL		
No.	Equipment Type	Equipment Brand
2.24	Butterfly valves	Amri, JMC
2.25	Non return valves swing check with weighted lever.	VOSA
2.26	Knife gate valves	SKG, Insamcor
2.27	Air valves	Ventomat
2.28	Flow Control Valves	Bermad, Claval
2.29	Aerator gearboxes	Hansen
2.30	Other gearboxes	Hansen, Flender, Bauer
2.31	Blowers (Positive displacement)	Robuschi
2.32	Air compressors	Ingersoll Rand / Atlas Copco
2.33	Chlorination equipment	Grundfos
2.34	Flocculant preparation plant.	Prominent, Grundfos
2.35	Electrical hoists and travelling gantry	Morris, Demag
2.36	Industrial ventilation equipment	Luft, Donkin
2.37	Bearings	SKF, FAG

3.0 PREFERRED EQUIPMENT – ELECTRICAL		
No.	Equipment Type	Equipment Brand
3.1	Isolators	ABB Stromberg
3.2	Circuit Breakers	Merlin Gerin, ABB
3.3	Contactors, indication lamps	ABB, Telemecanique, Moeller
3.4	Emergency stop -lockout	Cutler Hammer
3.5	Relays, fuses, motor protection relay	Omron
3.6	Control switches, selector switches	Krause and Naimer, ABB, Telemecanique, Moeller
3.7	Electronic Motor Controller	ABB, Schneider, Siemens
3.8	Ammeter, voltmeter, current transformer, operations counter, hour meter.	Hartmann and Braun
3.9	Cables, Wire	Aberdare
3.10	Cable tray, cable ladder, trunking, rack.	Cabstrut, O-line
3.11	Soft Starters and Variable Speed Drives (Low Harmonic) MV&LV	WEG, ABB, Schneider, Siemens
3.12	Cable glands	Prately Envirogland
3.13	Terminals	Klippon Polyamide
3.14	HRC fuses and holders	G.E.C.
3.15	DC Power Supplies	Siemens SITOP series, ABB
3.16	Electrically operated solenoids	Festo, Asco, Burkert
3.17	PLC's	Modicon Quantum series
3.18	Level Control	Siemens Milltronics Multiranger MR200 DP 6R, Siemens stainless steel echo max transducer brackets SMS310.

3.0 PREFERRED EQUIPMENT – ELECTRICAL		
No.	Equipment Type	Equipment Brand
3.19	Surge Arrestors	Dehnguard 275 and 1 No. DehnGap
3.20	Power Montior	ABB, Schneider,Siemens
3.21	MV Switchgear	ABB, Schneider,Siemens
3.22	LV/MV Motors	ABB,,Siemens,Weg

MEMORANDUM

To : Manager: Treatment Works

From : Vis Naidoo

Date : 22 June 2017

**SUBJECT : SPECIFICATION FOR ARCHITECTURAL FINISHES RELATING TO
ADMINISTRATION BUILDINGS AND ABLUTIONS AT TREATMENT
WORKS**

A. PLASTERING

Sand for plaster shall consist of sands conforming to Table 1 - External plaster and high strength mortar of S.A.B.S. 1090.

All plaster work, unless otherwise stated, shall consist of 1 part cement to 5 parts sand, 15mm thick in one coat floated to a smooth finish.

The whole of the plastering shall be executed in the most workmanlike manner, to straight and even surfaces. All internal and external angles are to be perpendicular or level as required, all circular work is to be properly trammed, and all arrises are to be rounded with a 25mm radius.

Every precaution is to be taken to avoid excessive or undue floating and to prevent plaster work from drying too quickly.

All brickwork to be thoroughly wetted before plaster is applied.

All concrete surfaces to be plastered shall be thoroughly hacked to form an adequate key and before plastering the surface is to be well slushed with 2:1 cement paste.

Plaster sand shall be supplied from a source approved by the Environment Planning and Climate Protection Department of the Ethekwini Municipality and a certificate of approval shall be produced.

The unit of measurement shall be square metre (m²).

The tendered rate shall include for:-

- (a) raking out joints in brickwork, hacking of concrete surfaces to form a key, wetting and slushing surfaces with grout;
- (b) the supply and application of plaster to all surfaces as indicated on the contract drawings, includes making good around all items built in, all internal angles of walls and reveals and forming of 'V' joints at interface with concrete elements.

A.1 PRELIMINARY TREATMENT OF NEW PLASTER

If necessary on all new walls where traces of free lime or alkali appear, these walls must be neutralised by the application of vinegar or in severe cases by the application of a wash coat compound of 1kg zinc sulphate crystals to 4 litres of water. Prior to painting, all surfaces are to be prepared and all loose particles removed and dusted down. Where walls are to be painted and

sealers” are specified, they are to be approved sealers as recommended by the paint manufacturer for application to plastered walls before painting.

B. WOODEN DOORS

Internal wooden doors shall be semi-solid with core made of hardboard strips, flush panel doors with plywood veneer facing.

The tendered price shall include for all materials, labour and tools required for the complete installation of the wooden doors.

The tendered rate shall include for the supply and installation complete, including frames, building frames into brickwork, sealing and beading.

Doors and frames to be primed and painted in a matt enamel paint, colour range to be in a rich shade of **DEEP MAHOGANY RED**.

B.1 IRONMONGERY

All ironmongery specified shall be type supplied by ‘Union’ or approved similar. Each lockset shall have two keys and shall be clearly marked with consecutive numbers and each key shall be punched with the corresponding number of the relative lock and shall have an identity key tag when handing over on completion of the works.

Fixing of ironmongery shall be to manufacturers requirements and in accordance with good practice.

C. FINISHES

C.1 CARPET TILE FLOOR COVERING FOR OFFICES AND BOARDROOM

The carpet tiles shall be laid in accordance with S.A.B.S 0186.

All adhesives used shall be as recommended by the manufacturer of the material being used.

Carpet tiles shall be 500 x 500 woven pile carpet tiles, type ‘Flor Point Earth’ by “Van Dyk’ or approved similar. Colour of carpet tiles should be a **DARK SHADE OF GREY OR CHARCOAL**.

The unit of measurement shall be square metre (m²) and the tendered rate shall include for all materials, labour and tools required for the complete installation of the carpet tiles.

Skirting for carpet flooring to be 12mm x 70mm meranti hardwood with quadrant – all painted to match doors.

C.2 CERAMIC / PORCELAIN FLOOR AND WALL TILES FOR HIGH TRAFFICABLE AREAS INCLUDING LABORATORIES, KITCHEN, CANTEEN AND ABLUTIONS

Prior to the application of the tiles, the surfaces of concrete, brickwork etc. shall be thoroughly cleaned, chipped, wetted, slushed with a polymer modified cement slurry etc. as necessary to form a proper bond.

The Contractor shall be held entirely responsible for the proper and adequate preparation of the surfaces and any work which results in failure in this regard shall be made good at the Contractor's expense to the satisfaction of the Engineer.

Tiles shall be first grade tiles of even shape, size and of uniform colour, free from cracks, twists or blemishes and fixed with an approved tile adhesive with all joints straight, continuous and tightly fitted and pointed in an approved grouting compound.

All exposed corners of tile butt joints shall have an approved natural anodised heavy duty aluminium edging strip to floor tiles and an approved pvc tile trim to wall tiles.

Tiles shall be of size 500 x 500 or 400 x 400 with a 'PEI' wear rating of 4 for floors. Floor tiles shall be chosen to have good traction under foot. Use floor tile to walls as well as required in canteen and ablutions. Tile colour to be in the **IVORY OR LIGHT GREY** range without patterns. Tiles to have a textured look and feel. No dark colours to be used anywhere.

The unit of measurement shall be square metre (m²) and the tendered rate shall include for all preparatory work, materials, labour and tools required for the complete installation of the ceramic wall and floor tiles.

Skirting for tile flooring to be cut in 75mm height from the same floor tile. Canteen and ablutions to have 200mm high tile skirting

C.3 PAINTING

Stopping (filling) is to be carried out with a suitable compound such as "polyfilla" or other similar approved. Exterior grade only to be used.

All materials for paintwork for which S.A.B.S. specifications have been published shall comply with the requirements of such specifications and shall bear the standardisation mark of the S.A.B.S. on the container or packing. Materials for paintwork for which no S.A.B.S. specifications are available shall be of the best quality.

Materials for paintwork shall be delivered to site in unopened containers and applied in accordance with the manufacturer's instructions.

Materials shall be suitable for application to the surfaces concerned. Only materials suitable for external work shall be used externally.

Unless specifically instructed by written direction from or agreed to by the Engineer, no paints are to be thinned but are to be used as supplied by the manufacturer direct from the tins. Where special brands of paint are to be used the manufacturer's "priming" and all subsequent coats of paint suitable for the particular brand are to be used in accordance with the manufacturer's instructions.

Each coat of paint is to be of a distinctive colour. Sample colours are to be prepared in all cases for the final coat and all work must be finished to the approved colours. Colours will be selected in accordance with S.A.B.S. 1091. The contractor must allow for all cutting in etc.

Paintwork is to be carried under all furnishings to joinery such as escutcheons, rim locks, etc., the paintwork to be touched up to approval of the Engineer after the final fixing of such furnishings.

All enamel paint shall be lightly rubbed down with fine sand paper and cleaned between coats.

Plastered wall and ceiling will be scheduled separately for painting:-

All other items such as timber doors, frames, steel and cast iron fittings which are specified as requiring painting in the relevant material section, then the tendered rate for their supply shall include for their painting.

The type of paint shall be **MID SHEEN, WASHABLE & STEAM RESISTANT PAINT SIMILAR TO THE "DULUX LUXURIOUS SILK RANGE OF PAINTS.**

COLOUR SHALL BE IN IVORY / OFF-WHITE / EGG SHELL RANGE OF STANDARD COLOURS.

No darker shade or colours that deviate from this range of colours to be used.

The unit of measurement shall be square metre (m²).

The tendered rate for painting shall include for all preparatory work, supply of materials, painting and any touching up and guarantee of paint for a period of 12 months.

SUMMARY OF FINISHES	
FLOOR	WALLS
Ceramic or porcelain tiles shall be of size 500 x 500 or 400 x 400 with a 'PEI' wear rating of 4 for floors. Floor tiles shall be chosen to have good traction under foot. Tile Colour to be in the IVORY OR LIGHT GREY range without patterns. Tiles to have a textured look and feel. No dark colours to be used. ----- Carpet tiles shall be 500 x 500 woven pile carpet tiles, type 'Flor Point Earth' by "Van Dyk" or approved similar. Colour of carpet tiles should be a dark shade of grey or charcoal.	Ceramic / Porcelain tiles to door height (2.1m) and paint above. Use same tile as specified for the floor. ----- Paint to be mid sheen, washable & steam resistant paint similar to the "Dulux Luxurious Silk" range of paints. Colour shall be in the IVORY / OFF-WHITE / EGG SHELL range of standard colours.
CEILING	SKIRTING
Gypsum Board - Painted acrylic PVA white / suspended ceiling tiles replaced to match existing or painted acrylic PVA white	75mm high Ceramic / Porcelain tiles / meranti hardwood with quadrant painted to match doors.
WOODEN DOORS	WINDOWS
As specified above and with a matt enamel paint, Colour: DEEP MAHAOGANY RED	Refer to Design Branch where replacement is required that differs from the original

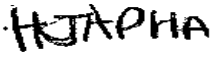
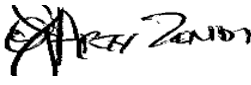
REINFORCED CONCRETE FINISHES EXTERNALLY

All reinforced concrete beams, slabs etc. shall **NOT** be painted. Dirty / stained concrete surfaces to be high pressure washed to return all concrete surfaces to its natural state.



ETHEKWINI MUNICIPALITY Occupational Health & Safety Unit

BASELINE RISK ASSESSMENT

Document Title	Baseline Risk Assessment
Client	eThekwini Municipality –Water and Sanitation
Project	Tongaat Water Treatment Works Functional Upgrade
Contract Number	WS7382
Compiled by (Safety Officer)	Name and Surname: Hlengiwe Njapha Signature:  Date: 03/02/2025
Approved by (Safety and Risk Manager)	Name and Surname: Arty Zondi Signature:  Date: 03/02/2025
Revision Number	BRA 267/02/2025

BASELINE RISK ASSESSMENT

1. INTRODUCTION: In accordance with the Occupational Health and Safety Act, (Act 85 of 1993) the Legislator places specific requirements on an Employer. One of these is prescribed in Section 8(i) of the Act where it requires the Employer to ascertain the risks and dangers which may occur within the workplace or section of the workplace and then goes on to establish working procedures or practices.

2. PURPOSE: This is conducted to create a benchmark of the potential risks that apply to the whole project or business operation.

3. SCOPE: This assessment could be approached on a site, regional or national level concerning any facet of the business operation or process or activity.

4. REVIEW AND MONITORING PLAN

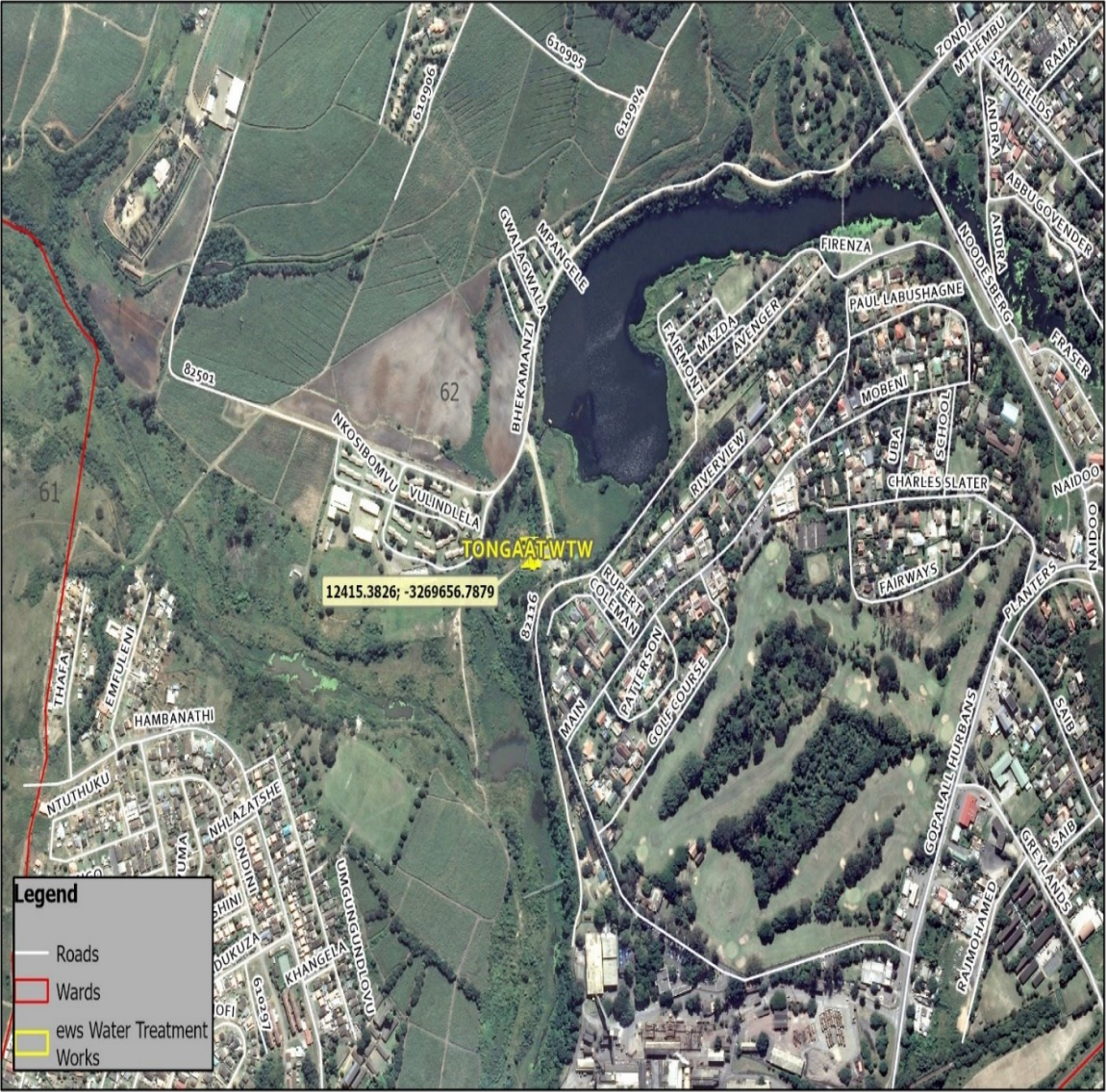
The risk assessment form part of the health and safety plan to be applied on the site and must include the following:

- (a) The identification of the risk and hazards to which to which persons may be exposed.
- (b) An analysis and evaluation of the risks and hazards identified based on a documented method

5. REFERENCES

- (a) Tender document WS7382
- (b) Occupational Health & Safety Act and its Regulation

6.LOCALITY PLAN



7.SCOPE OF WORKS

The scope of works to be carried out under this Contract is shown on the drawings and described in the specifications and may be described as comprising but not limited to the following (detailed scope defined in the specifications and the BOQ):

New Head of Works

- Isolating valve
- Flow metering
- Flow rate control
- Automated screening
- A manual screen bypass that enables maintenance of the automated screen and additionally provides an emergency overflow in the event of a malfunction of the automated screen
- Backup flow measurement at V-notch weir
- Automated coagulant dosing facility with gravity flash mixing immediately upstream of the flocculation tanks
- Pre-chlorination dosing facility
- Turbidity, pH, and conductivity monitoring

New Dual Flocculation Channels

- Construction of new dual flocculation channels, each equipped with 4 mechanical mixers to ensure optimal mixing and flocculation

Existing Dortmund Clarifiers (6No)

- Refurbishment of the 6 existing Dortmund clarifiers
- Automation of sludge removal to enhance efficiency and reliability

Existing Rapid Gravity Filters (6No)

- Refurbishment of the 6 existing rapid gravity filters
- Automation of the backwash sequence to improve operational efficiency
- Upstream monitoring of chlorine concentration to ensure water quality

Potable Water Reservoir

- Incorporation of upstream post-chlorination
- Continuous monitoring of:
 - Water level
 - Turbidity
 - pH
 - Chlorine concentration

Backwash Pumps

- Installation of backwash pumps in a Duty: Duty: Standby configuration

- Installation of blowers in a Duty: Duty: Standby configuration

Backwash Recovery System

- Implementation of a system to recover and reuse backwash water

Sludge Disposal System

- Establishment of a system for the efficient disposal of sludge

Metering

- Installation of metering systems to monitor various parameters and ensure accurate data collection

Cross Connection

- Creation of a cross-connection between the residue disposal system and the backwash recovery system to enhance operational flexibility and efficiency

Electrical and Instrumentation

- Disconnection and removal of existing equipment, including actuated valves, flow meters, control panels, and transformers
- Installation of a new 200kVA 400V transformer and new MCCs for mixers, screens, conveyors, clarifiers, filters, and sludge pumps
- New control panels for automatic backwash and air blower sequencing
- Automation of chemical and chlorine dosing systems with integration to the new SCADA system
- Installation of new electrical actuators for inlet flow control, clarifier de-sludge valves, and filter backwash valves
- New ultrasonic flow meters and level sensors for various applications
- Relocation and integration of existing telemetry and PLC/HMI systems to the new control room
- Comprehensive earthing and lightning protection systems for all new structures and buildings
- New site lighting and power installations for the administration building and guard house
- Testing, commissioning, and certification of the entire electrical and instrumentation installation

C3.1.3

TEMPORARY WORKS

The Contractor shall carry out such temporary work, including the necessary access and construction roads, shoring of trenches and excavations etc., as he may require enabling the permanent work to be constructed. He shall allow for the cost of all temporary works, including design and their removal, in his tendered rates.

Temporary works are expected to include:

- Necessary site access and deviations for traffic where the proposed works will disrupt traffic.
- Shoring, dewatering and related temporary works required during excavation of trenches and excavations as required to enable the permanent works to be constructed. The design of the lateral support is to be undertaken by the Contractors Professional Engineer and included in the tendered rate. The design of the lateral support solution will be dependent on the technique used by the contractor to perform the excavation, as well as programmed to fit into the Contractors construction programme. The Contractor is to submit the detailed design for the approval and acceptance of the project geotechnical engineer.
- Any temporary support structures required to protect and maintain services.
- Any temporary pipe specials and fittings.
- The pipework to the clarifiers will have to be temporarily supported during the filling of the structure for the drop test. Backfilling around the structure will only take place after successful completion of the drop test.

1. RISK ESTIMATION AND EVALUATION

RISK CLASSIFICATION USING A RISK SCORE TECHNIQUE

Exposure (E) How frequently does the hazardous event occur		Risk classification
Continuously		10
Frequently (daily)		6
Occasionally (weekly)		3
Unusually (monthly)		2
Rarely (few a year)		1
Probability (P) The probability of a loss when the hazardous event does occur		Risk classification
Frequent (happens often)		10
Probable (quite possible)		6
Occasional (unusual, but possible)		3
Remotely possible (has happened somewhere)		1
Improbable (practically impossible)		0.5
Severity (S) Consequences of the hazardous event		Risk classification
Catastrophic many fatalities; or interruption of longer than 2 weeks; or asset or environmental damage (or both) exceeding R100m		100
Disaster (few fatalities; or interruption between one and 2 weeks; or asset or environmental damage (or both) exceeding R10m)		40
Very serious (one fatality; or interruption of 6 days; or asset or environmental damage (or both) exceeding R100,000		7
Important (temporary disability; or interruption between 6 and 24 hours; or damage exceeding R10,000		3
Noticeable (first aid needed; or interruption of less than 6 hours; damage exceeding R1000)		1
Risk classification (Risk score = E x P x S)		
Risk score	Risk classification	
Over 400-----5	Very high risk – discontinue operation or activity	
200 to 400 ----- 4	High risk – immediate correction needed	
70 to 200----- 3	Substantial risk – correction needed	
20 to 70----- 2	Possible risk – attention needed	
Under 20 ----- 1	Risk accepted	

BASELINE RISK ASSESSMENT WORKSHEET: IDENTIFYING EXISTING & POTENTIAL RISKS

1	Site Access								
	Activity	Hazard	Risk	Risk Evaluation			Risk Score	Risk level	Risk Rank
				E	P	S			
	Accessing the site using construction vehicles or walking to site. Delivering of equipment and material to the site	Excessive speed, head on collusion, employees knocked by moving vehicles. Road blocked off due to community protest. Manual Handling and excessive lifting.	Accidents, damage to equipment or severe injuries or death. Back injuries,	6	6	7	252		4
2	Site Establishment								
	Manual and mechanical clearing of the land. Off-loading and positioning of offices by mobile crane. Fencing. Installation of temporary water supply, electricity, ablution facilities,	Dust, Snakes, Bees & Wasps. Incompetent operator. Poor connection of temporary services.	Poisoned and death. Collision/impacts of mobile lifting equipment, loads and dropped loads with process plant, pipe work, electrical cables and people. Water leaks, Electrocution, improper connection	6	6	7	252		4
3	Drainage/Sewage								

	Lay, bed and joint of pipes	Unsafe access to excavation Manual handling of pipes Possible pinch of fingers Engulfment of excavation	Personal injuries. Possible pinch Death/ body injury	6	6	3	108		3
4	Excavation Work & Back Filling								
	Mechanical and manual excavation. Back filling mechanical and manual	Incompetent operator. Machine running out of control. Open excavation. Dust. Operating mobile plant next to open excavation. Unsafe tools, damage of pipes by stone Back fill material.	Personal injury/possible disabling injuries. Property to damage Respiratory problem.	6	6	3	252		4
5	Existing Services								
	Identify the existing services	Snakes Unforeseen hazards	Poisoned and death. Personal injuries.	6	6	7	252		4
6	Removal of rubble								
	Mechanical and manual loading of rubble Removal of rubble	Dust, Mobile plant came into contact with trucks. Incompetent operator and lack of planning.	Respiratory problem. Damage to equipment. Damage to property. Motor Vehicle Accident.	3	6	7	126		3

		Reckless driving.							
7	Compaction								
	Operating a Bomag roller, wacker etc.	Incompetent operator. Noise. Vibration.	Personal injuries and damage to property. Noise Induce. Hearing loss. Kidney problem. Body pain.	6	6	3	108		3
8	Construction Mobile Plant and Equipment								
	Use of Plant & Equipment on site	Incompetent operator Unsafe plant & equipment. Collusion with other vehicles. Petrol and oil spillages.	Personal injuries. Motor vehicle accident. Environmental contamination.	6	6	7	252		4
9	Emergency Management								
	Development and Implementation of an Emergency Management Plan	Failure to have a basic, site specific emergency management plan. Workers not trained in the Emergency Plan. Insufficient or no emergency equipment or personnel.	Injury or damage to property. Inability to respond to emergencies. Insufficient or no emergency equipment.	6	6	3	108		3

10	Community Risk Management								
	Managing community risk	Failure to adequately monitor and manage the multi-faced social issues.	Violent protests. Injury to employees and property damage.	6	6	3	108		3
11	Subcontractor Management								
	Managing subcontractors	Failure to adequately assess subcontractors S.H.E Management System before work commences and at regular intervals. Inadequate Supervision. Utilizing incompetent Subcontractors.	Injury and non-compliance to legislation. High level of employee unsafe behavior. Accidents and property damage.	6	6	3	108		3
12	Block work and Brick work								
	Block work and mixing mortar.	Manual handling of blocks. Mortar inhalation. Mortar contact with body.	Injury to hands. Respiratory problem. Skin problems.	6	6	7	252		4
13	Working in elevated positions and scaffolding works								

	Working in elevated positions. Erection and dismantling of scaffolding.	Falling from elevated positions. Poor/ no edge protection. Unsafe scaffolding. Incompetent erectors.	Broken borne, death, disability and amputation. Broken borne, death, disability and amputation. Broken borne, death, disability and amputation.	6	6	7	252		4
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NAIDU
CONSULTING



**PROJECT PARTICULAR SPECIFICATION:
WATERWORKS EQUIPMENT MANUAL**

PS WW

**Functional Upgrade of Tongaat Water Treatment
Works - Work Package 1**

Contract No. 31302-5W

Rev 0

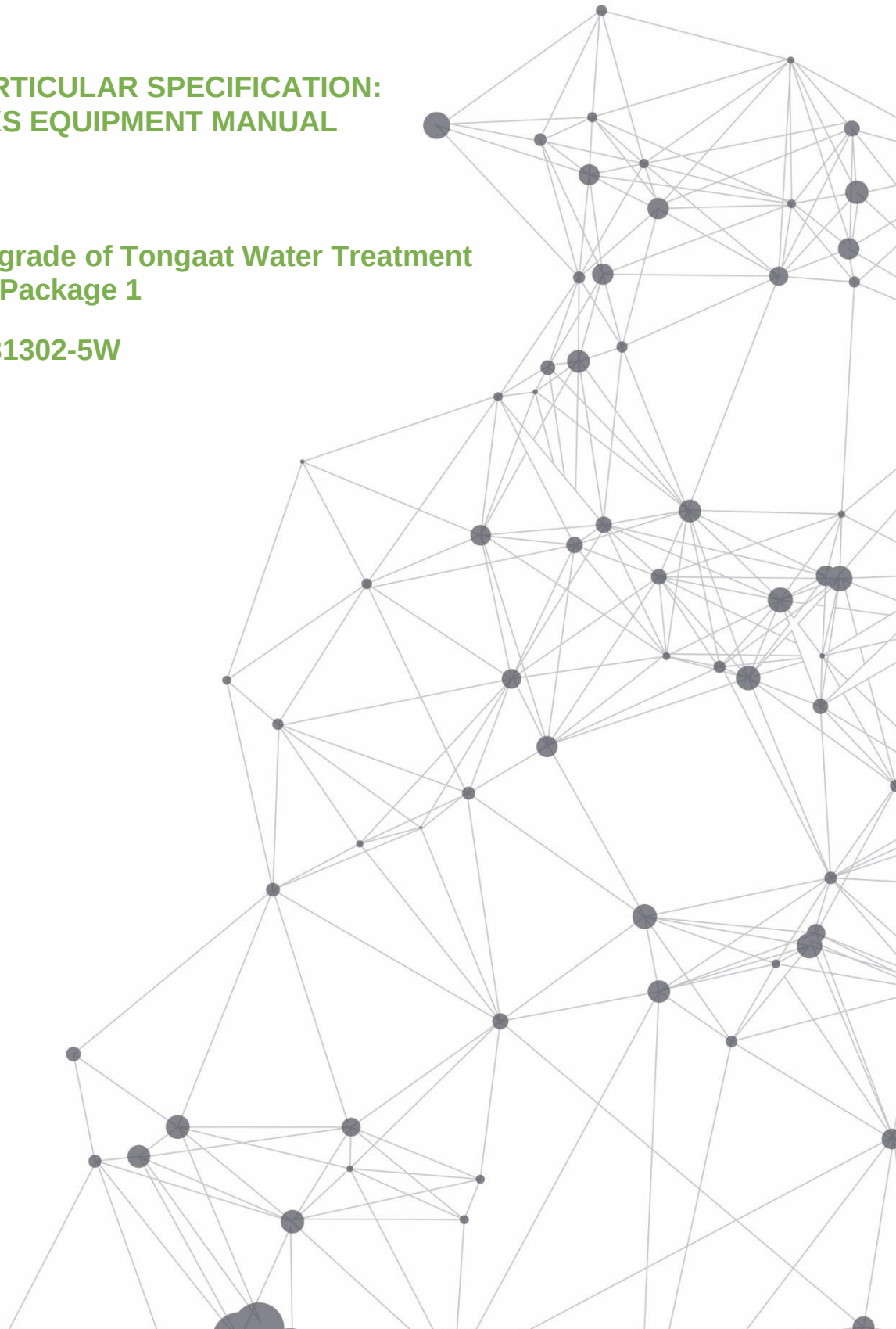


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PREAMBLE

This Project Specification forms an integral part of the contract. This specification shall be read in conjunction with all Project, Client and Particular Specifications.

PS WW 1 NOMENCLATURE

All plant and equipment dealt with in this portion of the specification shall hereinafter be referred to as Equipment.

PS WW 2 SCOPE

This specification, as described below, includes for the design (where applicable), supply, fabrication and installation of water works equipment associated with the rehabilitation and upgrade of the Tongaat Waterworks (TWW). This specification shall be read in conjunction with the relevant drawings and Piping and Instrumentation Diagrams (PID). Associated electrical equipment is specified and scheduled elsewhere unless otherwise stated.

The rehabilitation and upgrade of the Tongaat WW will enable the works to reliably and sustainably treat the raw water to SANS 241 standard at all flow rates ranging from 14ML/d to the ultimate capacity of 21 ML/d.

At the commencement of the contract, the Contractor shall install a pressure transducer complete with logger upstream of the existing control valve on the existing offtake under live conditions (hot tap or other approved installation method) and shall monitor the pressure of the system for a minimum period of 2 weeks. This pressure logging is to accurately inform the sizing of the new flow control valve and other aspects of the **Agreed Inlet Works Configuration. (AIWC)**.

The “Head of Works” portion of the works quantified in the Civil BoQ includes a provisional sum for the implementation of the “**Agreed Inlet Works Configuration**” for the connection between the existing DN600 steel raw water pipeline and the proposed new screening structure. Scheduled items included within this portion of the works are referenced thus “**AIWC**”. The Contractor is required to design, in consultation with the PSP, and implement this portion of the works making optimal use of his resources to minimise disruption during implementation, noting that no shutdown will be permitted to connect to the existing DN600 raw water pipeline. All bends included in the preferred option that are required for incorporation into an offtake line upstream of the screening structure shall be long radius and must include an inspection eye with a blank flange and ball valve, with precast manhole, to enable manual cleaning of snagged debris.

NOTE: Options 1 and 2 were discarded as viable options	
OPTION 3: HOT TAPPING TECHNOLOGY	
• Description: The Contractor will utilize hot tapping technology (~DN500) to tie into the existing 600mm diameter steel raw water pipeline. This method will allow the connection to be made without requiring a shutdown or disruption of the water supply. • Primary Supply: The newly connected pipeline will serve as the main supply line to the plant and the new screening structure. To include metering chamber as indicated. • Bypass Arrangement: The existing supply will be rerouted to the new screening structure as a bypass, ensuring continuity of operations.	
OPTION 4: NEW PIPELINE WITH ISOLATION (PREFERRED OPTION)	
• Description: A new steel pipeline will be laid from a point immediately after the existing offtake isolation valve to the new screening structure. This will allow for complete isolation from the 600mm diameter raw water supply line during the tie-in process, further mitigating any potential disruption. • Primary Supply: The new pipeline will serve as the main supply to the screening structure. To include isolation valve and metering chamber as indicated. • Bypass Arrangement: The existing supply will be rerouted to the new screening structure as a bypass.	
OPTION 5: UTILIZING EXISTING OFFTAKE	
• Description: A new steel pipeline will be laid from a point immediately after the existing offtake isolation valve to the new screening structure. This will allow for complete isolation from the 600mm diameter raw water supply line during the tie-in process, further mitigating any potential disruption. • Primary Supply: This option uses an alternate offtake from the main supply, with a new pipeline extending to the screening structure. To include isolation valve and metering chamber as indicated. • Bypass Arrangement: A new offtake for the bypass will be laid from an existing mixing structure.	

New Head of Works incorporating:

- DN500*PN10 manual operated wedge gate isolation valve with rising spindle
- DN400*PN10 electro-magnetic flow meter.
- DN500*PN10 electrically actuated knife gate valve.

New Inlet Screen Installation incorporating:

- Automated inclined stainless steel raked screen complete with shaftless screw conveyor to convey screenings to skip for off-site disposal.
- Inclined manually raked stainless steel screen as a standby screening system.
- 500mm * 500mm stainless frame and penstock to isolate the standby bypass from the existing inlet

- Stainless frame and penstock to enable switching between the automated (normal operation) and manual (standby) screening systems.
- Ultrasonic depth measuring device complete with DN500 stilling well.
- SS304L weir plate for inlet level control and backup flow metering.

Hydraulic Flash Mixing and Dual Channel Mechanical Flocculation Installation incorporating:

- Streaming Current Detector (SCD) complete with sample pump.
- Aluminium frames and handstops located at the inlets to the dual channel flocculation tanks.
- Stainless frames and penstocks located at the outlets from the dual channel flocculation tanks.
- Vertical stainless-steel impeller-type mechanical flocculation mixers.
- Lifting jib to facilitate maintenance of the mechanical mixers and aluminium handstops.

Rehabilitation of 6No Dortmund Type Clarifiers incorporating:

- Cleaning of Dortmund clarifiers.
- Removal of asbestos cement DN200 launder pipes by specialist and disposal in accordance with legislated requirements (8No / clarifier).
- Supply and installation of suspended conical sludge hoppers complete with flexible draw off pipes (1No / clarifier).
- Supply and installation of stainless-steel V-notch open channel clarified water launders on insulated mild steel support structure (8No/clarifier).

Rehabilitation of 6No Rapid Gravity Filters incorporating:

- Replenishment of filter media (Provisional).
- Filter media depth indicator plaques.
- Rehabilitation of filter inlet clack valves (Provisional)

Modification To The Polymer Storage Facility incorporating:

- Design, supply and installation of 2 No. new 5000 litre LDPE polymer tanks to the repurposed chemical house (measured elsewhere).
- Design, supply and installation of new DN80 polymer pipe and valve work from the delivery point to the polymer tanks.
- Design, supply and installation of new DN50/25 solvent welded uPVC pipe and valvework from LDPE polymer tanks to existing polymer dosing pumps.
- Design, supply and installation of new DN50/25 solvent welded uPVC pipe and valvework polymer dosing pipework from existing polymer dosing pumps to the new flash mixer complete with sparge pipe to the Contractor's design.
- Design, supply and installation of new streaming current detector (SCD) sampling point.
- Supply and delivery to site of new "Shelf standby" streaming current detector (SCD) to match the existing.

The Contractor's design shall enable full operational flexibility of the use of either of the 5000 litre LDPE polymer storage tanks and all dosing pumps on a Duty: Standby basis. All exposed pipework shall be secured to wall with PVC holderbats in accordance with the Code of Practice.

Upon completion, the polymer dosing pipework shall be colour coded in accordance with the specification

New Standby Chlorination Dosing System From Existing Chlorine Dosing Installation

New chlorinator at the existing gas abstraction chlorination facility. The original standby chlorinator has been re-purposed to enable pre-chlorination.

The standby chlorinator shall be similar to the existing chlorinators and shall be plumbed to enable standby for both pre-chlorination and post disinfection.

On-Line Analysers

The following on-line analysers shall be provided:

PARAMETER	RAW WATER	POTABLE WATER
Turbidity	X	X
pH	X	X
Conductivity	X	X
Free and Total Chlorine		X

PS WW 3 STANDARDS

All plant and equipment shall comply with the following standards and specifications:

- All plant and equipment shall be SABS approved (or other recognized international specification) and comply with this specification.
- It is noted that this specification, in order of precedence, is supported by the following specifications that form part of this tender:
 - Project Particular Specifications.
 - EWS Standard Specifications.
 - All plant and equipment shall be installed in accordance with the relevant Code of Practice
 - Unless otherwise indicated:
 - Motors and electric actuators shall be 400V.
 - Gearboxes Service Factor ≥ 4 , where the Gearbox Service Factor is defined as the ratio of the gearbox rated torque to the applications required torque.

PS WW 4 EMPLOYER'S PREFERRED EQUIPMENT

Unless otherwise indicated in the tenderer's submission, all equipment supplied shall comply with the "Employer's Preferred Equipment List

PS WW 5 DESIGN BY CONTRACTOR

The Contractor will be responsible for the selection, rating and performance of mechanical and electrical equipment to suit his selected equipment and the requirements of this specification.

The tendered rates for equipment will be deemed to include for any and all design associated with selection of equipment to suit the requirement of the specification.

PS WW 6 REVIEW OF THE EMPLOYER'S AGENT DRAWINGS

This is a multi-disciplinary contract for the construction of the rehabilitation and upgrade to the Tongaat Water Works.

It is the Contractor's responsibility to review the Employer's Agent's drawings and highlight, in writing to the Employer's Agent whether any minor adjustments to the Employer's Agent's drawings are required to accommodate proprietary mechanical and/or electrical equipment supplied by the Contractor.

Any lack of fit or incompatibility between the Employer's Agent's design/drawings (as amended above if necessary) and equipment supplied by the Contractor shall be rectified by the Contractor at his expense and to the Employer's Agent's satisfaction.

The rates tendered rates for equipment will be deemed to include for the Contractor's review service as specified.

PS WW 7 AUTHORIZATION OF DRAWINGS

The Contractor shall submit his shop and proprietary drawings to the Employer's Agent timeously for authorization. The Contractor shall allow in his programme a period of 20 working days for the Employer's Agent to authorize drawings for construction. It is noted that authorization of drawings in no way relieves the Contractor of his contractual obligations or design liability.

Fabrication of mechanical and electrical equipment shall not commence until all relevant fabrication /shop drawings and Quality Control Plans have been authorized for manufacture and installation by the Employer's Agent.

The rates tendered rates for equipment will be deemed to include for the development of shop and proprietary drawings as specified.

PS WW 8 NEW HEAD OF WORKS**PS WW 8.1 INLET GATE VALVE (DWG 60398/054)**

The nominal bore and pressure rating (DN500 * PN10) shall be as indicated in the BoQ (Dwg Item 2).

The Inlet Gate Valve shall be lockable, epoxy coated and lined clockwise closing wedge gate valve in accordance with the Particular Specifications VS.

PS WW 8.2 ELECTRO-MAGNETIC FLOW METER (DWG 60398/054)

The nominal bore and pressure rating (DN * PN) shall be as indicated in the BoQ (Dwg Item 6).

The electro-magnetic flow meter shall be in accordance with the Particular Specifications WM and in addition:

- Shall be suitable for use on raw water.
- Shall be supplied complete with SS316 earthing rings, 12m cable to the signal converter, gasketing and insulated bolts as specified.
- The converter shall have an IP 67 enclosure rating and the flow meter an IP 68 enclosure rating. Local flow shall be displayed on the signal converter.
- The flowmeter shall be suitable for use in pipelines that are cathodically protected.
- A primary head simulator shall be offered as an option.
- Empty pipe detection shall be included.
- Electrical and instrumentation requirements are specified elsewhere.
- EWS preferred equipment: Siemens, Fuji, Krohne, Endress & Hauser.

PS WW 8.3 ELECTRICALLY ACTUATED KNIFE GATE VALVE. (DWG 60398/053)

The nominal bore and pressure rating (DN * PN) shall be as indicated in the BoQ (Dwg Item 2).

Body

- The body shall be cast iron.
- The body shall be of the wafer style cast monoblock design, internally machined up to the specified diameter, with reinforced ribs in larger diameters for extra body strength.
- The internal machining shall reduce build-up of solids that could prevent the valve from closing.
- The valve design shall have full port on all sizes for greater flow capacity and minimal pressure drop.
- The gate shall be guided on the whole stroke to ensure bi-directional shutoff.
- EPDM O-ring on both valve flanges shall be provided for sealing.

Gate

- The gate shall be 316 Stainless Steel. The gate shall be polished on both sides for a greater seal between the gate with both packing and seat. The gate shall be fully guided in the body allowing for bi-directional service.

Packing

- The packing shall be PTFE impregnated synthetic fibre with an EPDM O-ring.
- The design of the valve shall enable packing adjustment whilst in service.

Stem

- The stem shall be 316 Stainless Steel.

Actuator Support

- The actuator support shall be fusion bonded epoxy (DFT = 500µm) mild steel. The design shall be compact and suitable for use in robust conditions. The actuator should have a local override operation to assist with manual opening for purging when/if required whilst being monitored by the operator. This manual purging operation shall be added to the SOP.

Corrosion Protection

- The body shall be fusion bonded epoxy coated (DFT= 500µm).

Gate Safety Protection

- The design of the valve shall prevent any objects from being caught accidentally while the gate is moving.

Resilient Seat

The resilient seal shall be EPDM. The joint shall be seated on the body, fitted with a metallic core and in contact with the gate all over its perimeter to provide an adequate watertightness and seamless liquid flow on both directions whilst avoiding any build-up of solids that would prevent the valve from closing. The seal shall be protected by the valve body.

PS WW 8.4 ELECTRIC ACTUATOR

The electric actuator for the knife gate valve specified in PWW 8.3 shall be suitable for modulation.

The electric actuator shall be in accordance with Particular Specifications ACT.

Electrical and instrumentation requirements are specified elsewhere.

PS WW 9 NEW INLET SCREEN INSTALLATION (DWG 60398/053)**PS WW 9.1 AUTOMATED INCLINED STAINLESS STEEL RAKED SCREEN COMPLETE WITH SHAFTLESS SCREW CONVEYOR**

The automated inclined stainless-steel screen shall be designed by the Contractor to suit the application and satisfy the requirements of the specification. The screen shall:

- Have a fully automated raking mechanism.
- Not require a bottom step in the channel for effective operation.
- Be of robust construction and fabricated from SS316L.
- Have minimal headloss and shall be able to operate up to a differential headloss of 500mm.
- Incorporate ultrasonic headloss monitoring and an alarm condition for excessive headloss.
- Incorporate a load cell for torque safety overload.
- Have a high level of operating reliability.
- Effectively screen vegetative matter from the incoming raw water with an aperture size of 10mm +/- 1mm.
- Have cleaning elements, comprising a rack and comb, that shall be independently replaceable.
- Incorporate a real time detection system to identify potentially damaging contaminants and stop the screen and alarm of an abnormal situation.
- Be a compact design with low installation height above the channel.
- Must have a bottom turn-about system (not a sprocket system).
- Shall have a self-supporting folding stainless-steel profile that can be easily lifted out of the channel.
- Have a simple and easy to access chain tensioning unit.
- Have all parts in contact with medium (except the pinion, drive and bearing) made

from immersion pickled stainless steel (SS316L) including the steel chains and chain wheels.

- Have an automatic scraper mechanism with no service water requirement.
- On completion of fabrication, all stainless steel shall be pickled and passivated.
- Power requirements shall be determined by the Contractor taking due cognisance of the Employer's motor sizing specification.
- The associated electrical and instrumentation requirements for this item is specified and scheduled elsewhere.

The shaftless screw shall:

- Be fully automated.
- The screw shall be manufactured from Grade S355 mild steel and the trough from SS316L stainless steel. On completion of fabrication, all stainless steel shall be pickled and passivated.
- Incorporate a load cell for torque safety overload.
- The motor drive to the shaftless screw shall incorporate a 90o gearbox to enable a vertical motor shaft due to ergonomic constraints.
- Power requirements shall be determined by the Contractor taking due cognisance of the Employer's motor sizing specification.
- The associated electrical and instrumentation requirements for this item is specified and scheduled elsewhere.

PS WW 9.2 INCLINED MANUALLY RAKED STAINLESS STEEL SCREEN

The manually raked inclined stainless-steel screen shall be designed by the Contractor to suit the application and satisfy the requirements of the specification. The screen shall:

- Not require a bottom step in the channel for effective operation.
- Be of robust construction and fabricated from SS316L.
- Have minimal headloss and shall be able to operate up to a differential headloss of 500mm.
- Effectively screen vegetative matter from the incoming raw water with an aperture size of 9-11mm.
- Include a SS316L manual rake that meshes with the screen and a shovel to transfer the screenings to the shaftless screw.
- Have a counter weighted swivel mechanism extending above the platform for easy lifting out of channel and raking onto platform.
- On completion of fabrication, all stainless steel shall be pickled and passivated.

PS WW 9.3 STAINLESS FRAME AND PENSTOCK

Penstocks

- Penstocks shall have a clear opening as indicated in the BoQ or on the drawings and shall be manually operated or fitted with an electric actuator as indicated in the BoQ or on the drawings. The penstocks shall be of the standard invert type unless otherwise indicated in the BoQ or on the drawings.

Applicable Standards

- All structural members shall be of robust and rigid construction and comply with DIN 19704.

Type and Size

- The penstocks shall be suitable for wall mounting and the size shall be as indicated in the drawings or Schedule of Quantities. The sizes indicated refer to the aperture size in the wall and the clear gate opening shall not restrict this aperture.

Frame and Gate

- The frame and gate shall be constructed from SS304L.
- If required to prevent buckling, SS304L wall brackets incorporating bronze bush spindle guides shall be provided at suitable centres to be determined by the manufacturer.
- On completion of fabrication, all stainless steel shall be pickled and passivated.

Rising Spindle

- The rising spindle shall be fabricated from 316 stainless steel and shall have square cut thread.
- The rising spindle shall be fitted with a bronze stop collar to prevent over-run.
- A UV resistant transparent polycarbonate removeable cover tube shall be fitted over the spindle to protect the shaft.

Head Stock

- The head stock (pedestal) shall be fabricated from cast iron and shall be epoxy coated.

Seals

- The seals shall be neoprene and the design of the seal shall be of the “music note” of “J-type”.
- The gate shall seal near drip-tight (< 1.24 litres/minute) in an off-seating condition under 2mWG.

Bearing Strips

- Low friction bearing strips (HDPE or Vesconite ®) shall be fitted to the gate by approved means to minimize friction under hydraulic thrust.

Handwheel

- If manually operated, the handwheel shall be fabricated from spheroidal graphite iron and shall incorporate a bronze lifting nut. The thread pitch and handwheel diameter shall be determined by the manufacturer to ensure that the handwheel rim effort does not exceed 150N undue the design duty.
- If actuated, the actuator shall comply with the requirements of the EWS Standard Specifications.

Fasteners

- The frame and headstock shall be bolted to the concrete with 304 stainless steel fasteners (Hilti LKD or similar approved).
- The frames shall be secured to the concrete with stainless steel fasteners and shall be grouted in position using an approved non-shrink grout.

PS WW 9.4 ALUMINIUM FRAME AND HANDSTOP

The size of the handstop shall be as indicated in the BoQ or on the drawings.

The frame and handstop shall be designed by the Contractor to satisfy the requirements of the specifications and the following criteria:

- The hand stops and frame shall be fabricated from aluminium plate
- Minimum plate thickness shall be 6.
- The frame shall have fishtails at 300mm c/c.
- The handstop shall include continuously welded stiffening ribs if necessary to limit deflection under a head of 1.5mWG to 1: 300.
- The handstop shall include 2 handle fabricated from 12mm round bar and continuously welded to the gate.

PS WW 9.5 ULTRASONIC DEPTH MEASUREMENT (60398/051)

The ultrasonic depth measuring device shall comply with the Electrical, Control and Instrumentation Particular Specification and in addition shall have:

- IP68 enclosure rating.
- The associated electrical and instrumentation requirements for this item is specified and scheduled elsewhere.
- Shall be mounted on a robust SS304L stainless steel frame with the unit 850mm above the weir level and centrally over the stilling well.
- The stilling well shall comprise:
- DN500 * 1500mm long μ PVC pipe mounted vertically on the chamber wall with stainless steel brackets.
- The top of the stilling well shall be flush with the top of the chamber wall.
- The centre of the stilling well shall be 500mm behind the weir.

PS WW 9.6 WEIR PLATES

Weir plates shall be fabricated from SS304L unless otherwise indicated to dimensions and level tolerances indicated on the drawings.

Where indicated, weir plates shall be bolted to concrete structure using Hilti LKD fasteners or similar approved.

Sealing between the concrete and the plate shall be achieved using a closed cell foam strip suitable for potable water.

PS WW 10 HYDRAULIC FLASH MIXING AND DUAL CHANNEL MECHANICAL FLOCCULATION INSTALLATION SCREEN**PS WW 10.1 VERTICAL STAINLESS STEEL IMPELLER TYPE MECHANICAL FLOCCULATION MIXERS**

The upgraded Tongaat WW will operate at flow rates ranging from 14ML/d to 21 ML/d. The flocculation zone as indicated on the drawings comprises a dual channel system. Under normal operating conditions, the total flow rate (from 14ML/d to 21 ML/d) will be routed through both channels. Under maintenance conditions, the total flow rate (from 14ML/d to 21 ML/d) will be routed through a single channel with a concomitant reduction in retention period and loss of efficacy of the flocculation process.

It is noted that:

- The Plant Capacity is 21ML/d and the plant will be required to operate at flow rates ranging from 14 to 21 ML/d.
- The site is space constrained and a retention period of ~600 seconds has been applied when both channels are in operation.
- Each channel has a capacity of ~ 75m³.

The Contractor shall design a flocculation system based upon 8No vertical mixers (4No mixers per bay) to align with the following requirements:

- The process requirement is that the mixers, each fitted with a VSD, shall achieve a combined G-value of 50 to 150 s⁻¹ over the flow range of 14 to 21 ML/d when operating under normal conditions (both bays in operation). Motors shall be fitted with 220V fixed speed fans to enable operation at low speeds.
- Gearbox bearings shall be of the roller or needle type.
- Gearbox seals shall be of the lip, O-ring type or mechanical seal type.
- Gears shall be manufactured from bronze.
- Gearbox lubrication shall be oil or grease. A transparent lubrication inspection port shall be provided for oil lubrication.
- The gearbox shall incorporate a load cell with high torque overload protection transmitted to the

- motor control for emergency shut-off.
- All gears, gear components and bearings in the drive shall be selected for a minimum continuous service life of 20 years.
- The Gearboxes Service Factor ≥ 4 , where the Gearbox Service Factor is defined as the ratio of the gearbox rated torque to the applications required torque.
- The mixers shall be of the vertical type with a single impeller.
- The shaft and impeller shall be SS304L.
- The impeller shall be coated with Soft Natural Rubber (SNR) with a minimum coating thickness of 1500µm.
- The shaft shall protrude ~100mm below the impeller.
- A tripod, fabricated from SS304L and incorporating a Vesconite® bush to stay the protruding shaft, shall be affixed to the floor with Hilti LKD SS M12 fasteners.
- The motors and 220V fixed speed fans shall have IP68 protection.
- The motor, gearbox and mild steel support structure, exposed to the elements, shall have a UV resistant polyurethane coating (Minimum DFT = 500µm) colour coded to Particular Specification CLR.
- Power requirements shall be determined by the Contractor taking due cognisance of the Employer's motor sizing specification.
- The associated electrical and instrumentation requirements for this item is specified and scheduled elsewhere.

PS WW 11 DORTMUND TYPE CLARIFIERS

PS WW 11.1 CLEANING OF DORTMUND CLARIFIERS

There are 6No Dortmund Type Clarifiers. Each clarifier shall be drained. It is noted that whilst scour valves are fitted to each clarifier, the scour pipework exits at an elevated level and pumping will be required to drain the clarifiers.

The clarifiers shall be high pressure cleaned, with the resultant residue also disposed of in accordance with the EMPr.

With the proviso that all residue is removed from the clarifiers to the satisfaction of the Employer's Agent, disinfection of the clarifiers prior to re-commissioning will not be required. Rather, a slightly elevated pre-chlorination will be practiced.

PS WW 11.2 REMOVAL OF REDUNDANT EQUIPMENT INCLUDING ASBESTOS CEMENT DN200 LAUNDER PIPES

Each of the 8No clarifiers have 8No DN200 asbestos cement launder pipes across the full width of the clarifier. The launder pipes are supported on a mild steel support structure.

For removal of the asbestos cement launder pipes the Contractor shall:

- Appoint a licenced specialist asbestos removal contractor.
- Obtain all necessary approvals and permits for the removal and disposal of the asbestos launder pipes to ensure compliance with the Construction Regulations and other pertinent legislation.
- Develop an asbestos removal plan.
- Take all necessary precautions for the removal and disposal (to an approved disposal site) of asbestos pipes in accordance with the EMPr.
- The removal and disposal plan to be prior approved by the Safety Agent.

All other redundant equipment including et al sludge hoppers, mild steel frames shall be removed to EWS store or disposed of in accordance with the EMPr.

PS WW 11.3 STAINLESS STEEL V-NOTCH OPEN CHANNEL CLARIFIED WATER LAUNDERS AND SUPPORT STRUCTURE (DWG 60398/055)

The asbestos cement launder pipes shall be replaced with the stainless-steel V-notched open channel launder system (8No launders per clarifier) insulated from and supported

on an epoxy coated mild steel support structure as detailed and indicated in the BoQ.

The open channel launder channels are shown on Dwg 60398/055.

PS WW 11.4 FITMENT OF NEW SUSPENDED CONICAL SLUDGE HOPPERS (DWG 60398/055)

A single sludge hopper in compliance with the specification shall be fitted to each clarifier as illustrated below.

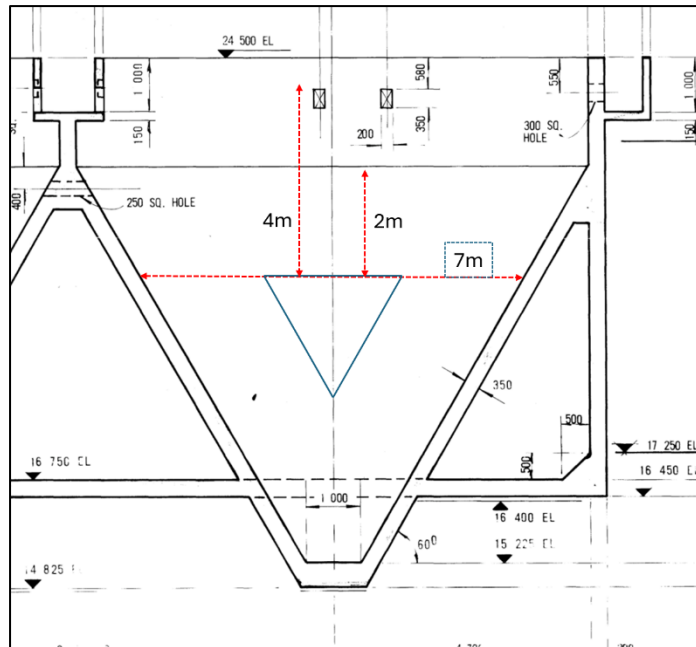


Figure 1: Section of Clarifier showing suspended hopper.

De-sludging of clarifiers shall be affected via sludge cones, manufactured from μ PVC fabric suspended in the sludge blanket of the clarifier. These cones shall be symmetrically located in the clarifiers as indicated in order to ensure an even sludge blanket.

Each sludge cone shall have a diameter of 2.5m (collector surface area of 4.9 m²) and a side angle (measured from the cone vertical axis of not greater than 30°. The sludge cone shall comply with the following requirements:

- The sludge cone shall be robust and fabricated from flexible uPVC material that shall have brass eyelets at 150 centres along the base of the cone. All seams shall be quadruple stitched with polypropylene thread that shall not degrade in water or in UV.
- The cone ring shall be fabricated from epoxy coated (DFT = 500 μ m) mild steel 32DN heavy duty pipe and shall be planar and free of warps.
- The uPVC cone material shall be lashed (blanket stitch) to the cone ring with 3mm polypropylene cord.
- A conically shaped cast iron anti-buoyancy fitting complete with 80DN swage nipple to connect to the desludge pipe and eyelet shall be located at the apex of the uPVC cone. This fitting shall have a 20mm hole in order to drain the cone should the clarifier be inadvertently emptied.
- A UV stable heavy duty flexible pipe shall be connected to the 80DN swage nipple and the existing desludge pipework with robust adaptors as necessary. This pipe shall be sufficiently long to enable it to be lifted from its normal height (approximately 2000mm below water level) up to the launder level and through the full operational height of the hopper as per the lifting equipment design.
- The swage nipple offtake shall incorporate a tee with a duckbill valve so as to drain the hopper in the case when the clarifier is being drained and the desludge valve is not opened, to prevent tearing of the hopper.
- The cone shall be suspended with as indicated on the drawings or indicated in the

BoQ. It shall be possible to adjust the cone suspension level from the clarifier walkway.

- A sludge agitator cord shall be affixed to the eyelet on the conical cast iron fitting and via a pulley system on the sludge cone support bracket to a cleat on the walkway to enable periodic agitation of the sludge cone.
- See Dwg 60398/055 for the support and lifting mechanism for each cone.

PS WW 12 RAPID GRAVITY FILTERS

PS WW 12.1 PERSPEX COVERS TO FILTER CLEAR WELLS

The filter clearwells are currently exposed to the elements and there is a risk of chlorine loss and contamination (Dust, birds and insects).

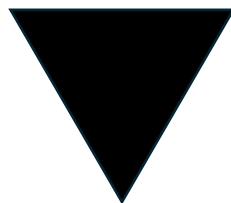
The clear wells, each measuring ~2m *2m, shall be fitted with FRP/Clear Perspex covers. The covers shall:

- Have a slightly dome shape to prevent the ponding of water.
- Be removeable and fit loosely over the clearwell, with side downturns (on three of the sides) extending 100mm below the top of the clearwell.
- Against the filter wall, the cover shall have a 100mm raised stiffener. A 25mm thick closed cell foam strip shall be secured to the stiffener to ensure a snug fit against the filter wall.
- A raised hinged viewing port fabricated from clear perspex, measuring at least 300mm * 300mm shall be provided for internal inspections.

PS WW 12.2 FILTER MEDIA DEPTH INDICATOR PLAQUES

An SS304 plaque (300mm * 150mm) engraved as per detail shall be affixed with SS304 expanding fasteners to the internal wall of each of the 6 No filters indicating the top of filter media as per the detail below.

TOP OF FILTER MEDIA



PS WW 12.3 REPLENISHMENT OF FILTER MEDIA

Provision has been made in the BoQ for topping up of filter media by means of a Provisional Sum.

PS WW 13 CHEMICAL STORAGE AND DOSING

PS WW 13.1 MODIFICATION TO THE POLYMER STORAGE AND DOSING FACILITY

Currently the polymer storage tanks are not bunded and located outside of the chemical house. The polymer storage and dosing facility shall be upgraded/modified in the

following manner:

- Supply and install 2 No new 5000 litre polymer tanks (GRP or LDPE to the Contractor's design) with a DN600 man access port and appendages as specified below. The tanks to be located at the repurposed alum storage tanks which shall form the bunds for the new tanks (modifications to the alum storage tanks detailed and measured elsewhere). It is noted that the bottom of the tanks will be located at a level that ensures that, in the event of a leak, the contents of the tanks will drain to a level below the bottom of the tank. Delivery pipework may thus be located through cored holes in the concrete tanks at a level corresponding to the bottom of the tanks.
- Supply and install DN63 *PN12 µPVC vermin proofed vent pipes to each of the 5000 litre polymer storage tanks.
- Supply and install DN50 *PN12 µPVC outlet and scour valves to each of the 5000 litre tanks.
- Supply and install DN63* PN12 (µPVC solvent welded) polymer transfer pipework from the delivery point (complete with DN50 camlock connection) to both polymer tanks with isolating valves to each tank, to the Contractor's design.
- Supply and install float valve to inlet pipework.
- Supply and install DN50/25 *PN12 solvent welded µPVC pipework from polymer tanks to existing polymer dosing pumps to the Contractor's design.
- Supply and install graduated measuring vessels to each storage tank on the suction side of the polymer tanks to check dosing pump performance. The existing cylinders may be used if this suits the Contractor's design.
- Supply and install DN25 * PN 12 clear PVC sight glasses on the concrete walls outside of the existing concrete tank. The clear PVC pipes shall be secured in 50*50 stainless steel protective angles and shall be graduated at 100 litre intervals from the tank draw off level.
- Supply and install ultrasonic level sensor to each tank with level transmitter panel mounted externally near filling point to IP65. Levels to be transmitted to SCADA.
- Supply and install DN50 * PN12 solvent welded µPVC interconnecting pipework near tank bottoms for cross connecting tanks through bund wall, including ball valve for tank isolation.
- Supply and install DN50/25 *PN12 µPVC polymer dosing pipework from existing polymer dosing pumps to the new flash mixer complete with connection to motive water pipework and elevated sparge pipe to the Contractor's design.
- Valvework shall align with the PID.
- All valves and other fittings shall have double unions for ease of dismantling.
- All exposed pipework shall be securely mounted with proprietary holderbats in accordance with the Code of Practice.
- Upon completion, all exposed µPVC pipe shall be colour coded to specification utilizing 2 coats of best quality UV resistant Poly Vinyl Emulsion (Exterior). The final surface shall be run, drip and blemish free.

PS WW 13.2 STREAMING CURRENT DETECTOR (SCD)

The streaming current detector will be used for the control of coagulant dosage. The streaming current detector shall be supplied complete with charge analyser, pipework and sampling pump to be located downstream of the flash mixer as specified below.

- The SCD shall be equal or similar to that supplied by Lechnitech ®.
- Valvework shall align with the PID.
- All valves and other fittings shall have double unions for ease of dismantling.
- All exposed pipework shall be securely mounted with proprietary holderbats in accordance with the Code of Practice.
- Upon completion, all exposed µPVC pipe shall be colour coded to specification utilizing 2 coats of best quality UV resistant Poly Vinyl Emulsion (Exterior). The final surface shall be run, drip and blemish free.
- Valvework shall align with the PID.
- All valves and other fittings shall have double unions for ease of dismantling.
- All exposed pipework shall be securely mounted with proprietary holderbats in accordance with the Code of Practice.
- Upon completion, all exposed µPVC pipe shall be colour coded to specification

utilizing 2 coats of best quality UV resistant Poly Vinyl Emulsion (Exterior). The final surface shall be run, drip and blemish free.

Associated electrical and instrumentation requirements are measured elsewhere.

PS WW 13.3 NEW STANDBY CHLORINATION DOSING SYSTEM FROM EXISTING CHLORINE DOSING INSTALLATION

The existing gas chlorine dosing facility does make provision for pre-chlorination and final disinfection. The existing facility shall be modified in accordance with the Contractor's design to allow for a standby chlorinator to be able to serve either of these disinfection points:

- a) A new chlorinator complete with a 0 to 5kg/h measuring tube shall be provided in the chlorine facility.
 - b) New DN50 *PN12 µPVC pre-chlorination dosing pipework from the chlorinator to a submerged sparge pipe at the new Head of Works.
- Valvework shall align with the PID.
 - All valves and other fittings shall have double unions for ease of dismantling.
 - All exposed pipework shall be securely mounted with proprietary holderbats in accordance with the Code of Practice.
 - Upon completion, all exposed µPVC pipe shall be colour coded to specification utilizing 2 coats of best quality UV resistant Poly Vinyl Emulsion (Exterior). The final surface shall be run, drip and blemish free

The pre-chlorination rate shall be set by the operator from the SCADA depending upon flow rate and environmental conditions.

A provisional sum has been allowed for the assessment, testing, report, recommendation, rehabilitation/servicing of the existing chlorine dosing system. The intent is to redo the pipework for the chlorinators on the outside of the chlorine room by moving it to the inside of the chlorine dosing vacuum room. The provisional sum also allows for the testing, servicing, and calibration of the existing load cells for the 1t chlorine tanks.

Associated electrical and instrumentation requirements are measured elsewhere...

PS WW 14 ON-LINE ANALYSERS

The following on-line analysers shall be provided as specified below:

PARAMETER	RAW WATER	POTABLE WATER
Turbidity	X (Range 0 to 1000 NTU)	X (Range: (0 to 5 NTU)
pH	X	X
Conductivity	X	X
Free and Total Chlorine	X	X

All on-line analysers described below shall be supplied with a self-priming sampling pump, pipework loop, bubble catchers (if/where applicable), isolation valves, in-line rotameter, mounting equipment, etc. complete (unless otherwise indicated under the specific section), including transmission to local and SCADA display for the analyser. The Contractor shall submit the equipment and on-line analyser required flow rate and associated pump and meter as a complete design solution for approval...

PS WW 14.1 RAW WATER TURBIDITY

The Turbidity Meter requirements are indicated in PWW 14.11 below and particular requirements are as follows:

- The turbidity meter range shall be 0 to 1000NTU with an accuracy of 1NTU.
- The turbidity meter shall be installed in an IP65 weatherproof and UV resistant polycarbonate housing. The housing shall be at an operator convenient location, mounted on a DN100*2.1m long GMS pole embedded 400mm in concrete (Top of Housing above NGL = 1.7m)
- The turbidity shall be measured in the chamber immediately upstream of the flash mixer (Dwg 60398/051).
- An air bubble trap shall be provided on the sample line to the turbidity meter.
- A suitably rated peristaltic sample pump complete with all necessary pipework shall be provided.
- The turbidity meter shall report to SCADA.

Associated electrical and instrumentation cabling requirements are measured elsewhere.

PS WW 14.2 RAW WATER PH

The pH Meter requirements are indicated in PWW 14.12 below and particular requirements are as follows:

- The pH probe shall be located in the chamber immediately upstream of the flash mixer (Dwg 60398/051).
- The pH meter shall be installed in an IP65 weatherproof and UV resistant polycarbonate housing. The housing shall be at an operator convenient location, mounted on a DN100*2.1m long GMS pole embedded 400mm in concrete (Top of Housing above NGL = 1.7m)
- The pH meter shall report to SCADA.

Associated electrical and instrumentation cabling requirements are measured elsewhere.

PS WW 14.3 RAW WATER CONDUCTIVITY

The Conductivity Meter requirements are indicated in PWW 14.13 below and particular requirements are as follows:

- The conductivity probe shall be located in the chamber immediately upstream of the flash mixer (Dwg 60398/051).
- The conductivity meter shall be installed in an IP65 weatherproof and UV resistant polycarbonate housing. The housing shall be at an operator convenient location, mounted on a DN100*2.1m long GMS pole embedded 400mm in concrete (Top of Housing above NGL = 1.7m)
- The conductivity meter shall report to SCADA.

Associated electrical and instrumentation cabling requirements are measured elsewhere.

PS WW 14.4 CLARIFIED WATER FREE CHLORINE

The chlorine analyser requirements are indicated in PWW 14.14 below and particular requirements are as follows:

- The chlorine analyser shall be located in the control.
- The installation shall include a suitably rated sample peristaltic sample pump that shall abstract clarified water at the combined clarified water channel immediately upstream of the rapid gravity filter channel.
- The chlorine analyser shall report to SCADA.

Associated electrical and instrumentation cabling requirements are measured elsewhere.

PS WW 14.5 CLARIFIED WATER TURBIDITY

The Turbidity Meter requirements are indicated in PWW 14.11 below (or as superseded below) and particular requirements are as follows:

- The turbidity meter range shall be 0 to 100NTU with an accuracy of 0.1NTU below 10NTU.
- The turbidity meter shall be installed in an IP65 weatherproof and UV resistant polycarbonate housing. The housing shall be at an operator convenient location, mounted on a DN100*2.1m long GMS pole embedded 400mm in concrete (Top of Housing above NGL = 1.7m)
- The turbidity shall be measured in the chamber immediately upstream of the flash mixer (Dwg 60398/051).
- An air bubble trap shall be provided on the sample line to the turbidity meter.
- A suitably rated peristaltic sample pump complete with all necessary pipework shall be provided.
- The turbidity meter shall report to SCADA.

Associated electrical and instrumentation cabling requirements are measured elsewhere.

PS WW 14.6 FILTERED WATER TURBIDITY

The Turbidity Meter requirements are indicated in PWW 14.11 below (or as superseded below) and particular requirements are as follows:

- The turbidity meter range shall be 0 to 5NTU with an accuracy of 0.01NTU below 2NTU
- The turbidity meter shall be installed in an IP65 weatherproof and UV resistant polycarbonate housing. The housing shall be at an operator convenient location, mounted on a DN100*2.1m long GMS pole embedded 400mm in concrete (Top of Housing above NGL = 1.7m)
- The turbidity shall be measured in the chamber immediately upstream of the flash mixer (Dwg 60398/051).
- An air bubble trap shall be provided on the sample line to the turbidity meter.
- A suitably rated peristaltic sample pump complete with all necessary pipework shall be provided.
- The turbidity meter shall report to SCADA.

Associated electrical and instrumentation cabling requirements are measured elsewhere.

PS WW 14.7 POTABLE WATER TURBIDITY

The Turbidity Meter requirements are indicated in PWW 14.11 below and particular requirements are as follows:

- The turbidity meter range shall be 0 to 5NTU with an accuracy of 0.01NTU below 2NTU
- The turbidity meter shall be installed in the potable water / backwash pump station.
- The turbidity shall be measured in the potable water reservoir at the end opposite the inlet to the reservoir.
- A suitably rated peristaltic sample pump complete with all necessary pipework shall be provided to abstract potable water from the potable water reservoir. The abstraction point shall be to Contractor's detail carried out under live conditions.
- An air bubble trap shall be provided on the sample line to the turbidity meter.
- The turbidity meter shall report to SCADA.

Associated electrical and instrumentation cabling requirements are measured elsewhere.

PS WW 14.8 POTABLE WATER PH

The pH Meter requirements are indicated in PWW 14.12 below and particular

requirements are as follows:

- The pH probe shall be located in the potable water reservoir at the end opposite the inlet to the reservoir.
- The coring through the wall of the potable water reservoir, to the Contractor's detail, may be above top water level but will be carried out under live conditions.
- The pH meter shall report to SCADA.

Associated electrical and instrumentation cabling requirements are measured elsewhere.

PS WW 14.9 POTABLE WATER CONDUCTIVITY

The Conductivity Meter requirements are indicated in PWW 14.13 below and particular requirements are as follows:

- The conductivity probe shall be located in the potable water reservoir at the end opposite the inlet to the reservoir.
- The coring through the wall of the potable water reservoir, to the Contractor's detail, may be above top water level but will be carried out under live conditions.
- The conductivity meter shall report to SCADA.

Associated electrical and instrumentation cabling requirements are measured elsewhere.

PS WW 14.10 POTABLE WATER FREE CHLORINE

The chlorine analyser requirements are indicated in PWW 14.14 below and particular requirements are as follows:

- The chlorine analyser meter shall be installed in the potable water / backwash pump station.
- The chlorine concentration shall be measured in the potable water reservoir at the end opposite the inlet to the reservoir.
- A suitably rated peristaltic sample pump complete with all necessary pipework shall be provided to abstract potable water from the potable water reservoir. The abstraction point shall be to Contractor's detail carried out under live conditions.
- The chlorine analyser shall report to SCADA.

Associated electrical and instrumentation cabling requirements are measured elsewhere.

PS WW 14.11 TURBIDITY ANALYSER SPECIFICATION

The turbidity is measured according to the 90° scattered light method.

This is an optical method to measure the concentration of solids and the turbidity in a liquid. It is a complete system.

The system shall comprise:

- Measuring principle: ISO 7027
- Measuring range: 0 to 1000 NTU/FNU (Raw Water) and 0 to 10 NTU/FTU (Potable Water)
- Housing: Field housing, wall mounting
- Housing material: ABS
- Wetted parts: Nylon, borosilicate glass, silicon, polypropylene, stainless steel AISI 304
- Protection class: IP 66 / Nema 4x
- Process and ambient temperature: +1...+50°C / +34...+122°F
- Process pressure: 0,07...14 bar / 1...200 psi (built-in regulator set at 1 bar / 15 psi)

- Flow velocity:
- Minimum 0,1 l/min / 0,026 gal/min
- Maximum 1 l/min / 0,26 gal/min
 - Ambient pressure: Atmospheric, altitude up to 2000 m / 6600 ft
 - Display: Multi-line liquid crystal backlight display
 - Display: Multi-line liquid crystal backlight display
 - Current outputs: 1 x 4...20 mA, active, 15 VDC power source, max. load 600 Ω
 - Modus: Bi-directional, RS-485 Modbus RTU/ASCII
 - Relays: 2 x relay 120...240 VAC, freely programmable
 - Power supply: 100...240 VAC, 47...63 Hz
 - Cleaning: Automatic ultrasonic cleaning system
 - Operation language: English.

PS WW 14.12 PH ANALYSER SPECIFICATION

The pH shall be measured using a potentiostatic sensor.

The system shall comprise:

Converter / Transmitter

- Enclosure type: Field housing, wall mounting
- Enclosure material: Die-cast aluminium
- Protection class: IP 66 / 67 (Nema 4 / 4x)
- Ambient temperature: -15...55 °C / +5...131 °F
- Display: Backlighted graphic display 128 x 64 pixels
- Signal output: 3 x 0/4...20 mA, galvanic isolated
- Relays: None
- Power supply: 220V
- Operation language: English

Sensor

- Measuring range: 0...14 pH
- Sensor material: CPVC
- Diaphragm: PTFE
- Reference filling: KCl gel double junction
- Membrane glass: Multi purpose glass
- Process temperature: -5...+80°C / +23...+176°F
- Process pressure: Max. 5,9 bar bei 25°C / 85 psi bei 77°F
- Process connection: 3/4" NPT (male)
- Temperature sensor: Pt100
- Sensor length: 23 mm / 0,91"
- Electrical sensor connection: attached cable
- Cable length: 10 m / 33 ft.
- Documentation: English

Assembly: Immersion assembly: Telescopic rod

- Material: Fiber glass
- Process connection: Open channels; hand rail mounting kit
- Sensor connection: Holder for PH/ORP (3/4" NPT)
- Sealing material: EPDM
- Telescopic rod = 1.6m to 4 m.

PS WW 14.13 CONDUCTIVITY ANALYSER SPECIFICATION

The conductivity shall be measured using an analog measuring system for inductive conductivity in water.

Converter / Transmitter

- Enclosure type: Field housing, wall mounting
- Enclosure material: Die-cast aluminium
- Protection class: IP 66 / 67 (Nema 4 / 4x)
- Ambient temperature: -15...55 °C / +5...131 °F
- Display: Backlighted graphic display 128 x 64 pixels
- Signal output: 3 x 0/4...20 mA, galvanic isolated
- Relays: None
- Power supply: 220V
- Operation language: English

Sensor

- Measuring range: 0.5 ... 2000 mS/cm
- Material: PP (c = 6,25)
- Process temperature: -10 ... +80 °C / +14 ... +176 °F
- Process pressure: 10 bar bei 20°C / 145 PSI bei 68 °F
- Process connection: immersion version 2000 mm length
- Sensor options: Internal temperature sensor
- Sensor-cable-connection: Attached cable
- Cable length: 10 m (33 ft.)
- Cable options: core sleeve ends
- Documentation: English.

PS WW 14.14 FREE CHLORINE ANALYSER SPECIFICATION

The free chlorine shall be measured using a potentiostatic process. The signal converter shall compensate for the difference in potential measured between the measuring electrode and the reference electrode.

Converter / Transmitter

- Housing: Field housing, wall mounting
- Housing material: Die-cast aluminium (polyurethane coated)
- Protection class: IP 66 / 67 (Nema 4 / 4x)
- Ambient temperature: -15...55 °C / +5...131 °F
- Display: Backlighted graphic display 128 x 64 pixels
- Measuring: Free chlorine
- pH compensation: with pH-sensor
- Current outputs: 3 x 0/4...20 mA, all galvanic isolated
- Relays: None
- Power supply: 220V
- Operation language: English

Sensor

- Measuring range / Free chlorine: 0,03...20,0 mg/l Cl₂
- Sensor material: Glass
- Diaphragm: Ceramic
- Reference filling: Ag/AgCl/TepoxGel
- Measuring electrode: Gold
- Process temperature: -5 ... 70 °C / +23...+158 °F
- Process pressure: 6 bar / 87 psi
- Process connection: PG 13.5
- Temperature sensor: Pt100
- O-Ring: EPDM
- Electrical sensor connection: M12

Sensor

- Measuring range: 0...14 pH
- Sensor material: Glass
- Diaphragm: Ceramic
- Reference filling: Ag/AgCl/TepoxGel
- Membrane glass: AH glass
- Process temperature: -5 ... 70 °C / +23...+158 °F
- Process pressure: 2 bar / 29 psi (absolute)
- Process connection: PG 13.5
- O-Ring: EPDM
- Electrical sensor connection: S8 plug

Flow through assembly of the system

- Material:
 - Flow cell: Acrylic glass
 - Float /Temperature sensor: PVC
- Process temperature: 0...+50°C / +32...+122°F
- Process pressure: 6 bar at 20°C / 87 psi at 68°F
- Process connection: Tube connection DN6/8
- Sensor connection: PG 13.5
- Sealing: EPDM

General

- Protection class: IP 65 / Nema 4
- Flow rate: ≥ 30 l/h / 7,93 gal/h
- Min. conductivity: ≥ 200 µS/cm
- Cleaning: Automatic Sensor Cleaning (ASR)
- Documentation: English
- All components are complete mounted on a panel. The customer only has to install the power supply, the signal cable and the sample connection.

NAIDU
CONSULTING

DGI Consulting



**PROJECT PARTICULAR SPECIFICATION: PUMPING
EQUIPMENT**

PS WPE

**TONGAAT WATER TREATMENT WORKS
FUNCTIONAL UPGRADE**

Contract No. WS7382

Rev 1



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PREAMBLE

This Project Specification forms an integral part of the contract. This specification shall be read in conjunction with the following specifications:

- 1) Project Particular Specification for Control Panel, Instrumentation and Electrical Installation
- 2) eThekweni Municipality PLC_Specification_Rev06
- 3) eThekweni Municipality Telemetry and Instrument Install Specification_Rev00
- 4) eThekweni Municipality Quality Control Specification_Rev02
- 5) EWS Standard Specifications, GS1 - Standard Specifications for DB's and Motor Control Centres
- 6) EWS Testing & Commissioning Sheets
- 7) EWS Standard Mechanical Specifications

PS WPE 1 SCOPE

This scope defined below is the applicable mechanical works information for all works associated with the assessments, repairs, supply, fabrication, construction, delivery, installation, testing and commissioning of the pumps, motors and associated equipment as specified hereunder.

PS WPE 1.1 PUMPS

- a) Disconnect and remove pumps and transport to EWS workshop.
- b) Supply and install new pumps.
- c) Install pumps, laser align with motor, fit coupling and coupling guards.
- d) Testing and commissioning as per specifications.

PS WPE 1.2 MOTORS

- a) Isolate, make safe, disconnect and remove all motors & deliver to EWS workshop.
- b) Supply and install new 525V and 400V motors as specified.
- c) Testing and commissioning of new motors.

PS WPE 2 ASSESSMENTS**PS WPE 2.1 EXISTING EQUIPMENT INFORMATION**

The Contractor is at liberty to check the information on the on the existing pumps and motor.

PS WPE 2.2 PUMP & MOTOR PLINTHS

The Contractor is to assess the existing pump & motor plinth and confirm all applicable remedial works to the Engineers approval. The Contractor is to thereafter undertake all remedial works required to the plinth.

PS WPE 3 GENERAL**PS WPE 3.1 STANDARDS**

All plant and equipment shall be SABS approved (or other recognized international specification approved by the Engineer). In addition, the plant & equipment shall comply with the relevant portion of this project specification as well as the Electrical, Control & Instrumentation specifications included in this document as relevant. The terms particular and standard specifications are used interchangeably. In the event of conflict, this project specification shall take precedence over the standard or particular requirements.

PS WPE 3.2 PROPRIETARY MATERIALS

Where the term "or similar approved" is used in connection with proprietary materials or articles, it is to be understood that approval shall be at the discretion of the Employer.

Where brand or trade names are referred to in the Specification and Bills of Quantities, these shall indicate the quality and type of material or fitting required and substitution of materials so specified will only be permitted where the authority of the Employer has been obtained in writing before tender closes or with the submission of alternatives as part of the tender submission. No substitution will be allowed once the contract is awarded.

PS WPE 3.3 STANDARD TYPE AND MAKE OF EQUIPMENT

Once installation has commenced with the appropriate approvals for using any type and make of article or equipment, the same type and make of article or equipment shall be used throughout the project for that specific application unless otherwise specified.

PS WPE 3.4 STANDARD OF MATERIALS

All materials and equipment supplied and/or installed under this contract shall be new and the best of their respective kinds and shall comply with the requirements specified in the latest editions of the relevant SANS or BS standards and their amendments and with the requirements of this specification.

The Contractor shall be responsible for choosing materials for pump manufacture which are compatible with the pumped fluid and suitable for the intended duty under service conditions. The materials specified herein shall generally be acceptable for water, and prior approval will be required for the use of other materials.

PS WPE 4 DESIGN

PS WPE 4.1 OPERATIONAL HEALTH & SAFETY REQUIREMENTS

In addition to the safety requirements specified in the EWS OHS specifications & BRA (Basic Risk Assessment), the Contractor is responsible for ensuring that all equipment supplied and the complete installation complies with the Occupational health and Safety Act, Act 85 of 1993, and the regulations promulgated thereunder.

Installations which do not comply with the OHS Act shall be corrected by the Contractor at no cost to the Employer.

Equipment which are potentially dangerous shall be designed in accordance with an approved relevant South African or international Standard.

Hazards must be avoided or guarded to the satisfaction of the Engineer. Nip points shall be guarded. Sharp corners shall be rounded off. Items such as operating handles, supports and protrusions shall be kept clear of access ways or marked accordingly.

The Contractor shall cover all unsafe gaps and openings left in structures after installation.

Each motor driven device shall be provided with an emergency stop station in an appropriate position.

PS WPE 4.2 DESIGN PRINCIPLES

Mechanical engineering design shall ensure safety, robust construction, reliability, durability, prevention of avoidable corrosion, neatness as well as ease of maintenance and operation.

The design shall, where applicable, be based on the following:

- a) The full range of duties which can be reasonably anticipated;
- b) The maximum pressure or vacuum which can be produced by pumps, blowers and compressors under all conditions including blocked or closed inlet and outlet circuits;
- c) Conservative service and safety factors based on approved standards;
- d) Twenty four hour per day operation (unless specified otherwise).
- e) A minimum life of 24 months for large items of equipment before repair or major part replacement;
- f) Prevention of serious damage from normal operational problems such as blockages, blinding, jamming, seizure, malfunction and, as far as is practical, maloperation (assuming that these occurrences cannot be avoided by good design).

- g) The power and torque transmitted by the driver system under full load and stalled conditions;
- h) Machines with non-overloading characteristics shall be selected wherever possible; eg: motors shall be sized so that they cannot be overloaded by the driven machine.

PS WPE 4.3 MOUNTING AND ARRANGEMENT

The arrangement and general design shall take the following requirements into consideration:

- a) Lifting eyes, lugs, hooks, etc., shall be provided on heavy or large items to facilitate handling.
- b) Castings or fabrications shall have machined pads for seating and be mounted on either soleplates or baseplates as appropriate.
- c) Where accurate alignment is required, positioning pins and/or jacking screws shall be provided.
- d) The needs of operation and maintenance including neatness, access, working space, safety, cleaning, adjustment, handling, assembly, alignment, disassembly, removal, etc.
- e) With plant and equipment to be mounted on or against concrete or brick structures built by others, provision shall be made for adjustment in the mechanical design. Any special accuracy requirements must be specified on the Contractor's Documents.
- f) Guide rails for submersible pump applications.

PS WPE 5 WELDING

PS WPE 5.1 STANDARDS

Standards complying with good modern practice, and acceptable to the Engineer, shall be adopted. These include the following:

BS EN 1011	Arc welding carbon and carbon manganese steelwork.
BS 4677	Arc welding austenitic stainless steel pipework.
BS 2633	Class 1 Arc welding of steel pipework.
BS 2971	Class II Arc welding of steel pipework.

Welders shall be experienced artisans approved in accordance with BS 4872 or equivalent.

PS WPE 5.2 CONTINUOUS WELDING AND ELIMINATION OF CREVICES

Welding shall be continuous on all sides of any joint.

Crevice, including those arising from welding on one side only, shall be eliminated. This requirement applies to the welding of all metals and welding procedure shall be designed to prevent unacceptable deformation.

Welds which are only accessible from one side shall be prepared so that the root run provides an acceptable profile and prevents the formation of crevice. Pipework shall be designed so that such welds can be inspected and, where applicable, pickled and passivated.

In special cases only, non-continuous welding might be approved in writing by the Engineer. The resulting crevice shall be sealed with a two part solvent free epoxy which can be applied at thicknesses of up to 600 µm and above such as Sigmeline 523 or Corrocoat Zip E or Sigmacover 1000 or equivalent.

PS WPE 5.3 WELD APPEARANCE

Welding shall be free of blowholes, projections, pinholes, splatter and undercuts and all welding flux, weld spatter and other sharp imperfections shall be removed. Weld beads with a surface irregularity exceeding 3 mm or with sharp crests having a radius under 2 mm shall be ground.

PS WPE 5.4 SITE WELDING

Site welding shall be kept to a minimum and shall only be undertaken with the approval of the Engineer.

PS WPE 5.5 WELDING OF STAINLESS STEEL AND 3CR12 – ADDITIONAL REQUIREMENTS

Fabrication of austenitic stainless steels and 3CR12 shall comply with the recommendations in "The Stainless Steel User Manual", "The 3CR12 Fabrication Guide" and the general welding requirements in "Pocket Guide – Stainless Steels" issued by Columbus Stainless. Compliance with publications from equivalent authorities will be acceptable.

Stainless steels to be welded shall be of the low carbon grade; e.g. 1.4306 rather than 1.4301 and 1.4404 rather than 1.4401.

The welding rods used shall be the most suitable for the metal and purpose. Only welders experienced with welding stainless materials shall be used. Welds which are accessible from only one side shall be executed in a manner to prevent heat tint or shall be post-weld treated in order to remove all traces of heat tint.

Type 316 stainless steel welding rods shall be used for welding 3CR12 unless otherwise approved in writing. 3CR12 shall be welded as recommended in "The 3CR12 Fabrication Guide" issued by Columbus Stainless.

All possible steps shall be taken to ensure maximum corrosion resistance and strength of the welds and welded material. Special care shall be taken to avoid prolonged heating. Welds shall be passivated. Discolouration and steel contamination must be removed by pickling or electro cleaning as approved by the Engineer but should rather be avoided by taking the appropriate measures.

PS WPE 5.6 INSPECTIONS

The Contractor shall arrange for all fabrications to be inspected by the Engineer prior to transport from the fabrication workshop

PS WPE 6 MECHANICAL PUMP EQUIPMENT**PS WPE 6.1 SCOPE**

This is the mechanical and works information for the supply, fabrication, construction, servicing, delivery, installation, testing and commissioning of the pumps and associated equipment as specified hereunder.

In particular this specification includes for the following pumps:

Pump Description	No.
Backwash Channel Pump (self Priming)	2 off
Residue Disposal Pump (Submersible Type)	2 off

PS WPE 6.2 PUMP DESIGN, MATERIALS AND MANUFACTURE

PS WPE 6.2.1 Pump Casings

The pump casings shall be manufactured in normal SG Iron or cast Iron to grade GGG or stronger non- corrodible approved material.

No welding, burning, filling or plugging of defective castings shall be permitted without the Engineer's permission in writing, following an inspection of the defects.

The inspection and testing of castings and test bars shall be in accordance with the Engineers instructions.

All pump casings shall be hydrostatically tested at the Manufacturer's workshop and in the presence of the Engineer or his Representative.

Particular care must be exercised in designing a pump casing which will resist the tendency to crack through the cutwater or guide passage walls during the pressure tests and the Contractor is to indicate clearly in his tender the design features incorporated in his pump to ensure that this requirement is satisfied.

PS WPE 6.2.2 Impellers

All impellers shall be cast in stainless steel with stainless steel shaft as indicated by the Engineer. Alternative materials may be considered subject to the approval by the Engineer.

The castings shall be free of blow-holes and other defects. No welding, burning, filling or plugging of defective castings shall be permitted without prior approval being obtained from the Engineer in writing, following an inspection of the defects.

Impeller shrouds and blades shall be of adequate thickness after they have been dressed, the minimum thickness being equal to : 7,00 (mm) for impeller diameters less than 350 mm and $0,00625 \times \text{diameter of impeller (mm)} + 5 \text{ mm}$ for impeller diameters equal to or greater than 350 mm.

All water passages are to be finished smooth to a template or NC machine finished.

All impellers shall be fitted with replaceable wearing rings of stainless steel or bronze. These rings, which shall be "L" cross-section, shall be secured to the impeller with non-corroding screws and mechanically locked.

Each impeller shall, after final machining and dressing, be independently statically balanced and the completely assembled rotating element with coupling half shall be dynamically balanced.

The critical speed of the rotating element shall be considerably higher (25%) than the running speed.

PS WPE 6.2.3 Pump Shaft, Sleeves and Diffusers

Pump shafts shall be of an approved material, to EN26 or equivalent and of sufficient dimensions to transmit the power to which they will be subjected without undue torsional or bending stresses and deflection.

The shafts shall be stress-relieved after initial machining, and ground to final size. The manufacturer shall take special care to avoid sharp radii. Shaft failures due to corrosion are common and the manufacturer shall indicate which steps he has taken to prevent the occurrence of pitting corrosion in pump shafts.

The shafts shall be suitably designed for the reception of the impeller which shall be adequately secured to the shaft in such a manner as to be readily removable without damage to either the shaft or the impeller.

The Contractor shall ensure that both the critical speed and torsional oscillation characteristics of the combined pump and motor rotating elements are satisfactory for all possible conditions of operation.

The shafts shall be adequately protected with replaceable sleeves of an approved stainless steel or other similar approved non-corrodible material at all areas where wear and/or corrosion could possibly be expected. These sleeves shall be readily removable without causing damage to either the shaft or the sleeves.

If separate diffusers are used, they shall be cast in an approved zinc-freestainless steel and finished smooth all over.

PS WPE 6.2.4 Bearings

The bearings shall be either grease or oil-bath lubricated, or water lubricated for submersible pumps. Where grease is used, a high-quality bearing grease of lithium-soap base, free of resins and acids with an anti-corrosive effect, shall be used. The grease shall have a penetration figure of between 2 and 3, and a drip point of not below 175°C.

A thrust bearing shall be provided to accommodate the end thrust of the impellers. The bearing numbers shall be given for all bearings in the pumps to facilitate replacement. The lubrication points of the bearings shall be situated in a safe accessible position, so that lubrication can be done without taking the pump out of operation. Thrust bearings for vertical pumps may be located in the drivers.

Bearing housing closures of the labyrinth type slinger are required on horizontal pumps at each point where the shaft projects through a bearing housing, except that a mechanical oil seal is acceptable at the coupling end of the bearing housing. A non-labyrinth type slinger is acceptable on the stuffing box end of a bearing housing when it is combined with a mechanical oil seal. All bearings shall be suitable for shaft rotation in both directions. Bearing housings on vertical centrifugal pumps shall have equally adequate protection.

PS WPE 6.2.5 Stuffing Boxes

All pumps shall be equipped, unless otherwise specified, with soft-packed stuffing boxes of ample depth. Lantern rings shall be used in all pumps with a liquid or grease seal and these shall be provided with inlet and outlet connections.

Stuffing boxes shall have not less than four rings of packing plus the lantern ring and renewable-type non-ferrous throat bushings. Stuffing box glands shall be easily removable and must permit replacement of packing without removal or dis-assembly of any other part of the pump. Glands shall preferably be made with completely enclosed bolt holes. Slotted holes open at one side are acceptable only if studs are provided for securing glands. Gland leakage from the pumps shall be led through suitable tubing to a point immediately outside the pump house or to the nearest floor drain.

PS WPE 6.2.5.1 Mechanical Seals

Alternatively, to stuffing boxes or where ordered, mechanical seals complying with (a), (b) or (c) below, shall be used. The design shall be such that the static head on the pump discharge induces a closing action on the seal to ensure that no leakage occurs during pump shut-down.

a) Treated and Filtered Water

A single self-aligning balanced mechanical seal manufactured in 316 stainless steel and fitted with ceramic on carbon seals.

b) Raw Water

A single self-aligning balanced mechanical seal manufactured in 316 stainless steel and fitted with a least matched solid tungsten carbide (or other approved) rotating and stationary faces shall be supplied.

An external flush shall be provided to ensure heat dissipation through circulation. Where raw water is being pumped, a cyclone separator (or external

clear water source) shall be fitted.

c) Abrasive Liquids

A double self-aligning mechanical seal manufactured in 316 stainless steel and fitted with at least either carbon or ceramic (for water lubrication) or carbon on Ni-iron (for oil lubrication) shall be supplied. Should the Contractor consider it necessary, more robust materials shall be fitted.

An independent fresh water (or oil) flush shall be provided where required. Care shall be taken to ensure that the pressure of the flushing fluid is at least 100 kPa greater than the pressure of the liquid on the inboard side of the seal.

PS WPE 6.2.6 Base Plates

PS WPE 6.2.6.1 General

Equipment and drivers shall not be mounted directly onto a concrete base without the use of either a baseplate or soleplate.

Driven equipment and their drivers shall be mounted on common cast iron or fabricated steel baseplates of rigid construction. Common baseplates shall be provided for direct coupled and for belt driven machines.

In applications where baseplates are not practical, machined soleplates, suitably fixed and grouted into the concrete plinths, shall be provided.

The Contractor shall provide the baseplate, anchor fasteners and chemical anchor for securing the fasteners.

PS WPE 6.2.6.2 Design Requirements

Baseplates shall prevent pooling of water and shall be grout filled or shall be provided with drain holes in all side members.

The baseplate shall incorporate machined mounting pads at the support and fixing positions of each item of plant and equipment to be mounted on the baseplate. On fabricated baseplates this machining shall be done after fabrication, stress relieving (if applicable) and hot-dip galvanizing are complete. The thickness of the mounting pads shall be not less than 1,25 times the diameter of the holding down bolts. The pads shall not be provided with threaded holes for machine screws but shall be drilled for inserting through bolts and adequate provision shall be made for reaching the nut with a suitable spanner. In the period between machining and installation of the equipment, the machined surface shall be protected against corrosion by a removable coating. After installation, a non-hardening compound, Tectyl or equivalent, shall be applied to exposed machined surfaces and to the crevice formed at the foot of the equipment. The above design may be suitably modified if the Contractor uses a pourable resin based chocking system. Such chocks shall be at least 15 mm thick.

At least two diagonally opposed jacking screws shall be provided for belt tensioning in the case of belt driven units. Direct coupled motors above 10 kW shall be provided with jacking screws for horizontal alignment and direct coupled motors above 150 kW shall be provided with jacking screws for vertical alignment as well. Jacking screws shall be galvanised mild steel or better. Drilled and tapped flat plate is not acceptable for jacking points. A jacking point shall consist of a suitable hot rolled steel section welded to the baseplate and with a captured machine nut to accept the jacking screw.

PS WPE 6.2.6.3 Fabrication

Baseplates shall be manufactured of either:

- hot rolled steel sections.
- bent plate (with the overall length not more than 200 x plate thickness).

Practical requirements for providing accessibility for surface preparation and coating shall be taken into consideration. Inaccessible pockets shall be avoided. Hollow spaces which cannot be accessed by blast and spray equipment shall be avoided or shall be welded closed. All such hidden surfaces shall not be permitted.

Inspections of carbon steel fabrications will generally be done after fabrication is complete.

PS WPE 6.2.6.4 Materials

Baseplates shall be fabricated from Grade X42 steel.

PS WPE 6.2.6.5 Corrosion Protection

Steel baseplates shall be hot dip galvanized in an approved factory specialising in hot dip galvanising.

PS WPE 6.2.6.6 Fasteners

Anchor fasteners shall be galvanised mild steel or similar approved.

A minimum of six anchors shall be provided for pumps with an inlet of DN 150 and smaller or to suit the existing mounting arrangement. Eight or more anchors shall be provided for pumps with an inlet larger than DN 150 or to suit the existing mounting arrangement.

Pumps with an inlet of DN 100 or smaller shall have anchor bolts of at least 12 mm or to suit the existing mounting arrangement. Pumps with an inlet larger than DN 100 shall have anchor bolts with a diameter no less than $12 + (\varnothing - 100)/25$ or to suit the existing mounting arrangement.

PS WPE 6.2.6.7 Installation

Not more than three shims may be used at any point and these must be made of a corrosion resistant material.

Concrete surfaces under baseplates shall be scabbled before the baseplate is placed and shall be blow clean using compressed air immediately before grouting.

Baseplates shall be designed and grouted to eliminate collection points for water or dirt. Except where otherwise approved in writing by the Engineer, all baseplates on concrete plinths shall be fully grouted in. Grouting holes must be provided on baseplates having a continuous top plate. Tapped holes and fixing setscrew protrusions shall be suitably protected. The material used for grouting shall be a non-shrink, cementitious grout (ABE DuragROUT 1000, or equivalent). ABE Epidermix 324, or equivalent, is acceptable if the Contractors' design requires an epoxy grout to be used. The initial grouting shall be overseen by the grout supplier's technical representative.

Preliminary alignment of equipment mounted on baseplates shall be done at the factory to ensure that the baseplate has been correctly manufactured, but final alignment shall always be done on Site after installation and grouting has been completed. Alignment shall be accurate and to the approval of the Engineer and a final alignment check witnessed by the Engineer must be carried out by the Contractor prior to start up.

PS WPE 6.2.6.8 Inspections

The Contractor shall arrange for the Engineer to inspect the fabrication of the baseplate before it is hot dip galvanised.

PS WPE 6.2.7 Auxiliary Pipe Systems

Recirculating piping systems for gland oil, lubrication oil and accessories such as

gauges and valves, shall be provided by the Contractor, fully assembled to facilitate easy maintenance.

Material used for all auxiliary piping and valves shall be suitable for the designed duty of the pumps, and all items shall be properly cleaned before assembly. They shall be installed in a manner which prevents vibration of the pump.

PS WPE 6.2.8 Pressure Gauges

Glycerine-filled pressure gauges ("Wika or similar approved") with a dial at least 120 mm in diameter and with a full-scale reading of 1.5 times the maximum pressure shall be provided on each pump suction and discharge. Gauges shall be supplied with SANAS accredited calibration certificates.

Gauges connected on the delivery pipework on suitable half inch BSP welded socket and an in-line stopcock/bleeder-valve shall be provided before each pressure gauge to isolate it from the mains.

Pressure gauge installation shall comply in all respects to the standard specification.

PS WPE 6.2.9 Pump Vent and Drain Fittings

Stainless steel vent cocks shall be provided and fitted at all local high points on each pump casing. These cocks shall be of adequate size to enable the entrapped air to be released freely. Copper/Stainless Steel drain pipes shall be neatly led from priming cocks, gland and casing drain points to a suitable discharge point/drain. Galvanised drainage pipework of adequate size shall be provided and installed to collect the waste water from each pumpset and to lead it to the pumphouse sump. Drain pipework shall be fitted with T sections at every bend to enable rodding in the event of a blockage occurring.

PS WPE 6.2.10 Drip Tray

Each pump shall be equipped with a condensate drip pan manufactured from 3CR12 sheeting. The pan shall be installed on the bedplate of the pump and shall be big enough to cover the drip area under the pump.

A drain connection shall be installed at the bottom of the drain pan and a drain pipe shall be run from each drain connection to a discharge point/channel/sump.

PS WPE 7 COUPLINGS

Shaft couplings shall be selected to reduce transmission of misalignment forces and of torsional oscillations between the driving and driven machine. Couplings shall, wherever practical, be of the rubber tyre or rubber compression type, keyed to the shafts.

Elastomeric elements shall be urethane based. Flexible metallic elements shall be of stainless steel. Couplings shall not require lubrication.

Spacer couplings shall be used in all cases where this will assist maintenance.

PS WPE 7.1 GENERAL

The pumps and motors shall be direct coupled with a suitable type of coupling which will take up minor misalignment or off-setting of the motor and pump shaft satisfactorily. Couplings shall be statically and dynamically balanced.

The coupling shall be designed in such a manner that no axial or radial loads will be imposed on the motor and pump bearings in excess of the loads approved by the motor and pump manufacturers respectively for the installation offered. Spacer couplings shall be provided with pumps of the back pull out type or where frequent maintenance is likely to be required.

The couplings shall be robust, shall be readily dismantled and reassembled, and shall have a service factor of at least 1,5.

Elastomeric elements shall be urethane based. Flexible metallic elements shall be of stainless steel. Couplings shall not require lubrication.

Coupling guards shall comply with the requirements of the OHS Act and shall be to the approval of the Engineer.

Pulley belts are to comply in accordance with the OHS Act 85 of 1993 and are to be approved by the Engineer. Pulley belts are to be a like for like replacement or/and to comply with industry standards. Tensioning and lining of belt to be completed as per the Engineers instruction.

After installation, the alignment of all couplings shall be checked by the Contractor in the presence of the Engineer or a person delegated by him. Laser Alignment shall be accurate and to the approval of the Engineer.

PS WPE 7.2 MACHINE GUARDS

Guards shall comply in all respects with the Occupational Health and Safety Act of 1993 as amended and the following points shall also be noted:

Guards are required to cover all moving or revolving components of machinery. Guards which do not adequately cover moving protrusions such as keys, lock nuts, lockwashers, setscrews, etc., or irregularities such as keyways, will under no circumstances be accepted.

Guards shall be neatly and rigidly constructed and fixed and shall not vibrate or cause noise during operation.

Guards shall completely enclose drives and shall entirely prevent a person from touching any moving protrusion. Allowance must be made for adjustment on belt guards or where adjustment will be required. It shall be possible to remove the guard easily for maintenance purposes.

Guards shall preferably be fabricated of 1.6mm steel sheeting hot dip galvanized or 3CR12 epoxy powder coated (colour to be determined prior to painting). Guards are to be primed and painted. Fasteners shall be M10 or larger and shall be hot dipped galvanised.

PS WPE 8 SELF PRIMING PUMPS (BACKWASH RECYCLE PUMPS) PS WPE 8.1 PERFORMANCE CRITERIA

The pump manufacturer must be ISO 9001:2015 certified, with scope of registration including design control and service after sales activities.

The pump manufacturer must be registered to the ISO 14001 Environmental Management System standard and as such is committed to minimizing the impact of its activities on the environment and promoting environmental sustainability using best management practices, technological advances, promoting environmental awareness and continual improvement.

Pumps must be designed to handle raw, unscreened water. Pumps shall have 3" suction connection, and 3" discharge connection.

PS WPE 8.2 PUMP SET:

Make:	Gorman Rupp or similar and equal approved
Type:	T3C60SC-B/FM or similar and equal approved
Impeller and shaft :	Stainless Steel
Free passage:	max. 63mm
Casing:	Cast Iron
Seal:	Cartridge, mechanical oil lubricating , double floating, self aligning

PS WPE 8.3 OPERATING DATA:

Fluid handled:	Water
Flow rate:	55.0 m ³ /h
Head:	5.8 m
Max. fluid temperature:	20 °C

PS WPE 8.4

DRIVE:

Nominal voltage:	400V
Nominal frequency:	50Hz
Starting method:	VSD
Enclosure:	IP65
Explosion protection:	Without
Max. fluid temperature:	20 °C
Thermal motor protection (thermistors):	Temperature bimetal switch
Efficiency class:	Equivalent min. IE3 to IEC Standard
Duty type:	S1 submerged
Nominal motor power P2:	TBC by pump supplier
Nominal motor power P1:	TBC by pump supplier
Motor efficiency:	TBC by pump supplier
Nominal current:	TBC by pump supplier
Speed:	TBC by pump supplier
Seal Cable gland Submersible motor:	n/a
Cable supplied with motor	n/a
Motor heaters	Yes 220Volts

PS WPE 8.4.1 Pump Performance Certifications

The pump is to be supplied with ERADICATOR™ or similar approved Solids Management System designed for management of sanitary wipes, plastic bags, feathers, hair, sludge, and all other types of stringy solids.

All internal passages, impeller vanes, and recirculation ports shall pass a 63.5mm spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted. Upon request from the engineer, manufacturer's certified drawings showing size and location of the recirculation port(s) shall be submitted for approval.

PS WPE 8.4.2 Reprime Performance

Consideration shall be given in which debris is expected to lodge between the suction

check valve and its seat, resulting in the loss of the pump suction leg, and siphoning of liquid from the pump casing to the approximate center line of the impeller. Such occurrence shall be considered normal, and the pump must be capable of automatic, unattended operation with an air release line installed.

During unattended operation, the pump shall retain adequate liquid in the casing to ensure automatic repriming while operating at its rated speed in a completely open system. The need for a suction check valve or external priming device shall not be required.

- a. The pump suction check valve shall be removed. No restrictions in the pump or suction piping will prevent the siphon drop of the suction leg
- b. Impeller clearances shall be set as recommended in the pump service manual.
- c. Repeatability of performance shall be demonstrated by testing five consecutive reprime cycles. Full pump capacity (flow) shall be achieved within five minutes during each cycle.
- d. Liquid to be used for reprime test shall be water.
- e. Upon request from the engineer, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, shall be submitted for approval prior to shipment.

PS WPE 8.4.3 Certified Pump Performance Test

Tests shall be conducted in accordance with Hydraulic Institute Standards 14.6.3.4 Acceptance Grade 2B at the specified head, capacity, rated speed, and horsepower. The performance tests will validate the correct performance of the equipment at the design head, capacity, and speed.

For pumps utilizing up to (13 HP) motors; but larger than (1.3 HP), tests shall be conducted in accordance with Hydraulic Institute Standards 14.6.3.4.1, as the specified head, capacity, rated speed, and horsepower.

PS WPE 8.4.4 OEM Warranty

1. The pump manufacturer shall warrant the pump equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.
2. All equipment, apparatus, and parts furnished shall be warranted for twelve (12) months, excepting only those items that are normally consumed in service, such as oils, grease, packing, gaskets, O rings, etc. The pump manufacturer shall be solely responsible for warranty of the pump equipment and all components.
3. Components failing to perform as specified by the engineer, or as represented by the manufacturer, or as proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer.

PS WPE 8.5 PUMP

PS WPE 8.5.1 General

1. The specifications and project drawings depict equipment and materials manufactured by The Gorman-Rupp Company or similar and equal approved which are deemed most suitable for the service anticipated. It is not intended, however, to eliminate other products of equal quality and performance. The contractor shall prepare his bid based on the specified equipment for purposes of determining low bid. Award of a contract shall constitute an obligation to furnish the specified equipment and materials.
2. After execution of the contract, the contractor may offer substitutions to the specified equipment for consideration. The equipment proposed for substitution

must be superior in construction and performance to that specified in the contract, and the higher quality must be demonstrated by a list of current users of the proposed equipment in similar installations.

3. In event the contractor obtains engineer's approval for equipment substitution, the contractor shall, at his own expense, make all resulting changes to the enclosures, buildings, piping or electrical systems as required to accommodate the proposed equipment. Revised detail drawings illustrating the substituted equipment shall be submitted to the engineer prior to acceptance.
4. It will be assumed that if the cost to the contractor is less for the proposed substitution, then the contract price shall be reduced by an amount equal to the savings.

PS WPE 8.5.2 Pump Design

Pumps shall be horizontal, self-priming centrifugal type, designed specifically for handling raw, unscreened, domestic sanitary sewage. Pump solids handling capability and performance criteria shall be in accordance with requirements listed under **PS WPE 8.1**.

The pump manufacturer must be ISO 9001:2008 revision certified, with scope of registration including design control and service after sales activities.

PS WPE 8.5.2.1 Materials and Associated Construction Features

PS WPE 8.5.2.1.1 Pump Casings

Pump casing shall be cast iron Class 30 with integral volute scroll. Casing shall incorporate following features:

- a. Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.
- b. Fill port coverplate, 3 1/2" diameter, shall be opened after loosening a hand nut/clamp bar assembly. In consideration for safety, hand nut threads must provide slow release of pressure, and the clamp bar shall be retained by detente lugs. A Teflon gasket shall prevent adhesion of the fill port cover to the casing.
- c. Casing drain plug shall be at least 1 1/4" NPT to insure complete and rapid draining.

PS WPE 8.5.2.1.2 Coverplate assembly

Coverplate assembly shall be cast iron Class 30. Design must incorporate following maintenance features:

- a. A lightweight inspection coverplate, retained by acorn nuts, for access to pump interior for removal of stoppages. Designs that require removal of complete coverplate assembly for access to the impeller will not be accepted.
- b. Retained by acorn nuts for complete access to pump interior. Back coverplate removal must allow service to the impeller, seal, wear plate or check valve without removing suction or discharge piping. Back coverplate shall incorporate an obstruction free flow path by combining four support posts into a two-point "webbed" plate design for increased durability, reduced clogging, and increased operational efficiency.
- c. Aggressive Self-Cleaning Wear Plate
 - i. A replaceable wear plate secured to the back cover plate by studs and nuts. Wear plate shall be self-cleaning design ensuring that debris is cleared away and does not collect on the impeller vanes.
 - ii. The nature of the conveyed medium poses significant challenges to the continuous operation of the pump. Of particular concern is the clogging of the

impeller by debris in the pumped medium including but not limited to long rags, fibers, and like debris which are able to wrap around the impeller vanes, stick to the center of the vanes or hub, or lodge within the spaces between the impeller and the housing.

- iii. The aggressive self-cleaning wear plate shall have integral laser cut notches and grooves in combination with a "tooth" designed to disturb and dislodge any solids which might otherwise remain on the impeller in dynamic operation. Wear plate is designed to clear the eye of the impeller constantly and effectively without the use of blades or cutters.
- d. In consideration for safety, a pressure relief valve shall be supplied in the inspection coverplate. Relief valve shall open at 75-200 PSI.
- e. One O-ring of Buna-N material shall seal inspection coverplate to back coverplate.
- f. Two O-rings of Buna-N material shall seal back coverplate to pump casing.
- g. Pusher bolt capability to assist in removal of inspection coverplate or back coverplate. Pusher bolt threaded holes shall be sized to accept same retaining cap screws as used in rotating assembly.
- h. Easy-grip handle shall be mounted to face of inspection coverplate.

PS WPE 8.5.2.1.3 Rotating Assembly

Rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, seal plate and bearing housing, must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate following features:

- a. Seal plate and bearing housing shall be cast iron Class 30. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities must be cooled by the liquid pumped. Three lip seals will prevent leakage of oil.
 - i. The bearing cavity shall have an oil level sight gauge and fill plug check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.
 - ii. The seal cavity shall have an oil level sight gauge and fill/vent plug. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the fill/vent plug.
 - iii. Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.
- b. Impeller shall be stainless steel or bronze, two-vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lock screw and conical washer.
- c. Shaft shall be AISI 4150 alloy steel unless otherwise specified by the engineer, in which case AISI 17-4 pH stainless steel or bronze shall be supplied.
- d. Bearings shall be anti-friction ball type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir. Pump designs which use the same oil to lubricate the bearings and shaft seal shall not be acceptable.
- e. Shaft seal shall be cartridge oil lubricated mechanical type. The stationary and rotating seal faces shall be tungsten titanium carbide alloy. Each mating surface shall be lapped to within three light bands flatness (35 millionths of an inch), as measured by an optical flat under monochromatic light. The stationary seal seat

shall be double floating by virtue of a dual O-ring design; an external O-ring secures the stationary seat to the seal plate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock (loads which cause shaft deflection, vibration, and axial/radial movement). Elastomers shall be Viton; cage and spring to be stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings.

- f. Pusher bolt capability to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same caps crews as used for retaining rotating assembly.

PS WPE 8.5.2.1.4 Adjustment of the impeller face clearance

Adjustment of the impeller face clearance (distance between impeller and wearplate) shall be accomplished by external means.

- a. Clearances shall be maintained by a four-point external shimless coverplate adjustment system, utilizing a four collar and four adjusting screw design allowing for incremental adjustment of clearances by hand as required. Each of the four points shall be lockable to prevent inadvertent clearance increases or decreases due to equipment vibration or accidental operator contact. The four-point system also allows for equal clearance gaps at all points between the impeller and wear plate. Requirement of realignment of belts, couplings, etc., shall not be acceptable. Coverplate shall be capable of being removed without disturbing clearance settings. Clearance adjustment systems that utilize less than four points will not be considered.
- b. There shall be provisions for additional clearance adjustment in the event that adjustment tolerances have been depleted from the coverplate side of the pump. The removal of stainless-steel shims from the rotating assembly side of the pump shall allow for further adjustment as described above
- c. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.

PS WPE 8.5.2.1.5 Suction Check Valve

Suction check valve shall be moulded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished through the coverplate opening, without disturbing the suction piping. Sole function of check valve shall be to save energy by eliminating need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.

PS WPE 8.5.2.1.6 Other

Spool flanges shall be one-piece cast iron, class 30 fitted to suction and/or discharge ports. Each spool shall have one 1-1/4" NPT and one 1/4" NPT tapped hole with pipe plugs for mounting gauges or other equipment.

PS WPE 8.5.2.2 Serviceability

- i. The pump manufacturer shall demonstrate to the engineer's satisfaction that consideration has been given to reducing maintenance costs.
- ii. No special tools shall be required for replacement of any components within the pump.

PS WPE 8.6 INSTALLATION

The following is to be undertaken by the Contractor, but not limited to:

1. Install, level, align, and lubricate pump(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the

manufacturer at time of delivery.

2. Suction pipe connections are vacuum tight. Fasteners at all pipe connections must be tight. Install pipe with supports and thrust blocks to prevent strain and vibration on pump piping. Install and secure all service lines (level control, air release valve or pump drain lines) as required in wet well.
3. Check motor and control data plates for compatibility to site voltage. Install and test the station ground prior to connecting line voltage to control panel.
4. Prior to applying electrical power to any motors or control equipment, check all wiring for tight connection. Verify that protective devices conform to project specifications. Verify line voltage, phase sequence and ground before actual start-up.
5. After all anchor bolts, piping and control connections are installed, completely fill the grout dam in the pump station base with non-shrink grout.

PS WPE 8.7 FIELD QUALITY CONTROL

Prior to acceptance of the installation by Engineer, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

After construction debris and foreign material has been removed from the wet well, contractor shall supply clear water volume adequate to operate station through several pumping cycles. Observe and record operation of pumps, suction and discharge gage readings, ampere draw, pump controls, and liquid level controls. Check calibration of all instrumentation equipment, test manual control devices, and automatic control systems.

PS WPE 9 SUBMERSIBLE PUMPS

Submersible pump to be a vertical submersible motor pump set for wet installation, single-stage, with three-phase motor to IEC standards. Temperature sensor for protection against overheating, oil and moisture leakage and contamination sensor in the motor space, power cable with resin-sealed, absolutely water-tight cable entry and service-friendly plug-type connection in the motor space.

PS WPE 9.1 PUMP SET:

Make:	KSB
Type:	Amarex ARX F 080-230G
Impeller:	Vortex Impeller
Impeller diameter D2:	150 mm
Free passage:	max. 80mm

PS WPE 9.2 OPERATING DATA:

Fluid handled:	Water
Flow rate:	31.2 m ³ /h
Head:	6.48 m
Power input:	1.06kW
Operating temperature:	max. 40 °C

PS WPE 9.3 DRIVE:

Nominal voltage:	400V
Nominal frequency:	50Hz
Starting method:	DOL (Future VSD)

Enclosure:	IP68
Explosion protection:	Without
Max. fluid temperature:	20 °C
Thermal motor protection:	Temperature bimetal switch
Moisture protection:	Yes
Efficiency class:	Equivalent min. IE3 to IEC Standard
Duty type:	S1 submerged
Nominal motor power P2:	1.67kW
Nominal motor power P1:	1.29kW
Motor efficiency:	51.6%
Nominal current:	3.71A
Speed:	1430rpm
Seal Cable gland Submersible motor:	Rubber sealing
Cable supplied with motor	10m power and sensor cabling

PS WPE 9.4**MATERIALS:**

Material Volute casing:	EN-GJL-250/A48 CL 35B
Material Impeller:	EN-GJL-250/A48 CL 35B
Material Inlet part suction side:	EN-GJL-250/A48 CL 35B
Material Shaft:	1.4021+QT800/20CR13+QT800
Properties Top Coat:	2-Component epoxy resin, high solid
Colour Top Coat:	RAL5002 Ultramarine Blue

PS WPE 9.5**SHAFT SEAL:**

Shaft seal type:	Double mechanical seal with unpressurised buffer fluid (tandem) – T
Mechanical seal type inboard:	MG1G36
Material shaft seal inboard:	Q1Q1PGG
Mechanical seal type outboard:	MG1G6
Material Shaft seal outboard:	BVPGG

PS WPE 9.6**DIMENSIONS AND CONNECTIONS:**

Nominal diameter, discharge side:	DN 80
Net pump weight approx.:	69.85 kg

PS WPE 9.7**INSTALLATION PARTS**

Duckfoot bend for twin guide rail arrangement
 Consisting of duckfoot bend, mounting bracket, screws/bolts and anchor bolts (guide rails supplied by the operator)
 Additional mounting bracket, middle support for installation depth > 6 m
 Guide rail shall be manufactured from stainless steel with stainless steel ligting chain and hooks.

PS WPE 9.8**LIFTING TACKLE / LIFTING PARTS**

Lifting tackle pump/mixer:	Chain
Length lifting tackle pump/mixer:	5m
Maximum load lifting tackle pump/mixer:	200 kg

PS WPE 9.9**MATERIALS:**

Material Elbow Outlet:	EN-GJL-250/A48 CL 35B
Material Claw, wet installation:	EN-GJL-250/A48 CL 35B
Material lifting tackle pump/mixer:	1.4404/A276 TP 316L

PS WPE 10 ELECTRIC MOTORS EQUIPMENT

This specification shall be read in conjunction with the Electrical, Control & Instrumentation Particular Specification.

PS WPE 10.1 SPECIFICATION FOR ELECTRIC MOTORS

The supply, installation and erection of all items of electrical equipment shall be carried out by qualified electrical contractors and shall conform to the Specification below and to be in accordance with the Code of Practice for the wiring of premises, SANS 10142: Latest Amendment.

Motors:

- a) Uninstall applicable pump with motors and transport to Employers workshop.
- b) Supply new motors integral with the pump to match existing as per specifications.
- c) Install new motors, align with pump, fit coupling and coupling guard. (where applicable)
- d) Testing and commissioning as per specifications.

PS WPE 10.2 GENERAL

Motors shall be AC squirrel cage induction type electric motors of the ratings specified or to match the pumping or other load. The motors shall be framed totally enclosed forced fan cooled with cooling fins. The motors shall be low voltage (LV) operation suitable for operation on a 525V 3 phase supply at a frequency of 50Hz. The motors shall be cast iron continuously rated drip proof IP54 rated, duty class S1. Motors shall comply with IEC/EN standards. The connection / cable termination boxes shall have an IP55 rating. Motors are to be WEG or similar approved or other approved motor supplied as an integral unit with the pump.

Preference will be for motors with a speed of 1500 r/min and below as agreed to by the Engineer.

The motors shall be capable of operating continuously under actual service conditions at their rated output without exceeding the specified temperature rises, determined by resistance, at any frequency between 45 and 52 Hertz, together with any voltage between $\pm 5\%$ of the nominal value.

Unless otherwise specified, the slip in speed of the motors at 80 percent (80%) of the nominal voltage at 50 Hertz shall not exceed the percentage stated by the manufacturer and the motors shall be capable of operating at this voltage for a period of five minutes without injurious heating.

Rotors shall be statically and dynamically balanced.

All motors shall operate with the least practicable amount of noise to the relevant IES/EN standards. Motors larger than 100 kW shall be subjected to sound level tests in accordance with IEC/EN 60034-9.

All dimensions and design parameters shall be in accordance with the International Metric System (SI).

The motor design and construction shall be such that no damage to the motor will result from a supply voltage recovery, following on a brief supply voltage interruption. The designer or manufacturer should bear in mind that the supply voltage may be 180 degrees out-of-phase with the rotor induced voltage when the supply voltage is restored. Special attention shall be given to effects of electrical and mechanical stresses imposed on the motor over this period.

The guarantee efficiency of each motor shall be determined in accordance with IEC/EN 60034-30.

All motors shall be premium efficiency (minimum IE3) to IEC60034-30-1. Preference will be given to IE4 motors.

PS WPE 10.3 REFERENCE SPECIFICATION, STANDARDS AND CODES

All electric motors shall comply fully with the relevant IEC/EN standard specifications.

PS WPE 10.4 ENCLOSURE

Motors shall be provided with suitable means of drainage to prevent accumulation of water due to condensation.

Motors shall be supplied with anti-condensation heaters suitable for 230 V AC supply. Heater terminal boxes shall be fitted in an approved position and shall have an approved cable gland. Cable termination or connection boxes shall be IP55 rated.

The motors shall be provided with two machined bosses each tapped for a bolt, of suitable size, for earthing purposes. The machined bosses shall be located on opposite sides of the motor frame. The motors and parts thereof including auxiliary equipment supplied under the Contract shall be provided with suitable arrangements for lifting.

Painting of the motor casings shall comply with industry standards and to RAL5009be electric orange (B26). The paint colour shall match pumping applications and must be confirmed with the Employer prior to painting.

PS WPE 10.5 MOTOR STARTING GENERAL REQUIREMENTS

The motors are to be suitable for Star Delta and VSD starting at full voltage and at 50 Hz frequency.

Additionally, the motors shall be capable of accelerating the load specified from zero to full speed when supplied with 0,9 p.u. of normal voltage at 50 Hz.

All motors shall be suitable for starting under specified load conditions with 75% of the rated voltage at the motor terminals

Motors shall be capable of the following minimum starting conditions:

STARTS	MINIMUM NUMBER OF CONSECUTIVE STARTS
Number of consecutive start-ups with initial temperature of the motor at ambient level (cold)	3
Number of consecutive start-ups with initial temperature of the motor at full load operating level (hot)	2

PS WPE 10.6 MOTOR WINDING DETAILS AND INSULATION

The winding insulation shall be Class H, with temperature rise limited to that specified for Class B insulation to IEC/EN 60034-1.

Details of the stator insulation shall be to the relevant standard approvals. The outside of all end windings shall be coated with oil resisting non-hygroscopic varnish or compounds, and the coils shall be supported to prevent injurious movement. The stator winding tails shall be of sufficient cross-sectional area and adequately braced to withstand the nominal three-phase symmetrical short circuit specified and the current density under these conditions shall not exceed 400 A/mm². The power frequency voltage withstand level of the interturn insulation of the stator windings as well as the

impulse withstand level as a whole shall be stated by the Tenderer.

Provision shall be made, for the inclusion of the imbedded temperature detectors (thermocouple or platinum resistance or thermistor type) in the windings for motors.

All motors above 11kW rating shall have embedded in their stator windings, two PTC thermistors per phase, suitable for Class B temperature rise. All motors rated 110kW and larger, shall have embedded in their stator windings, two PTC thermistors and one platinum RTD of type PT100 per phase and one platinum RTD of type PT100 per bearing. The bearing detectors shall touch the outer bearing race, shall be spring-loaded and shall be of the screw type. The characteristics of these temperature detectors shall match the thermal limitations of the motor electrical installation.

Motors above 11kW shall be supplied and wired with 230 Volt anti-condensate heaters.

The leads from the temperature detectors and heaters shall be brought out to a separate approved terminal box fitted in an approved accessible position onto the motor. This terminal box shall be provided with labels indicating clearly to which detector each terminal is connected. Flexible connections shall be used to avoid damage to the leads by vibration.

During type testing the relationship between the temperature indicated by the detectors and the winding temperature as determined by resistance measurement shall be established for the purpose of alarm and trip settings. This information shall be recorded on the motor test certificate.

The stator windings shall be fully insulated such that the supply leads may be connected to either the "start" or "finish" ends of the winding.

PS WPE 10.7 STATOR FRAME AND CORE

The stator core stampings shall be built up in such a way that the spacing, keying and clamping of the stampings shall result in a uniformly tight core.

The design shall be such that the temperature of all parts of the winding and core is kept as uniform as possible throughout. The frame size shall be to IEC/EN 60072-1, 60034 and EN 50347 standards with the motor being minimum IP54 rated.

When pedestal type bearings are provided the motor shall be complete with base frame.

PS WPE 10.8 ROTOR AND SHAFT DETAIL

The rotor bars or windings shall be locked to avoid longitudinal movement in the slots under starting conditions and shall be designed to minimise the possibility of conductors breaking.

The minimum locked rotor thermal withstand time at rated voltage shall be minimum 10 seconds under cold conditions and minimum 8 seconds under hot conditions.

The rotors shall be properly balanced in accordance with the vibration limits specified in IEC/EN 60034-14. All rotor shaft extensions shall be provided with keys and shall receive an anti-corrosive protection coating despatch from the manufacturer's works.

The shaft shall be manufactured from chrome steel with 316 stainless steel shaft sleeve.

PS WPE 10.9 TERMINAL ARRANGEMENTS ON MOTORS

As required, three or six phase ends of the motor windings shall be brought out to terminal boxes.

All terminal boxes shall be to approval and of the totally enclosed type designed to prevent the ingress of dust and moisture and sealed for the internal air circuit of the motor. All joints shall be flanged and sealed with gaskets of neoprene or other approved material. Motors having fabricated frames shall have terminal boxes, including

removable covers fabricated from mild steel plate with fully insulated terminals or connectors. Where specified the terminal boxes shall be of the phase segregated type.

The terminal boxes of motors over 300 kW shall be fitted with an approved phase segregated cable sealing and dividing box and cable gland or adapter plate together with the necessary fittings, including crimping lugs, to suit the cable. Only one cable box shall be provided per motor and this shall be interchangeable between terminal boxes. Terminal box positions are to match the existing arrangement.

The cable box shall be suitable for the termination of three-core high voltage cross-linked polyethylene insulated cables with copper conductors of the specified cross-sectional area. Where star delta starting is used, facilities shall be made in the cable box for termination of two power cables to suit the sizes of cables to be used. Motor terminal box to match existing position to align with cable duct routing. Contractor to verify on site before ordering the motors.

Terminals shall be of substantial design and connections having pinch screws bearing directly on cable cores will not be accepted. The terminal arrangement shall be suitable for the reception of copper cables and permit the motor to be disconnected from its supply cable without disturbing any sealing compound or damaging of cable tails and shall allow separate testing of the supply cable and motor windings. The insulation of the terminals or connectors terminal leads and intermediate disconnecting leads shall be of approved moisture resistant homogeneous material and, in particular, where leads enter any sealing compound, this insulation shall be waterproof. Natural rubber insulation shall not be used.

The electrical clearance and creepage distances with the correct terminations in position shall comply with the requirements of the relevant IEC/EN standards.

Terminal marking shall be made in a clear and permanent manner and shall comply with the relevant IEC/EN standards, where for three-phase motors, irrespective of the rotation required on site, the connections shall be such that then the supply leads L1 - L2 - L3, are connected to motor terminals U1 - V1 - W1 respectively the motor shall rotate in a clockwise direction when looking at the driving end. A permanently attached diagram or instruction sheet shall be provided giving the connections for the required case of motors suitable for both directions of rotation. Motors suitable for one direction of rotation only shall be clearly marked to indicate this.

High voltage line terminal boxes shall be suitable for connection to an electrical system with a nominal three-phase symmetrical short circuit capacity as stated in the Project Specification for a minimum fault clearance type of 0,25s. Unless satisfactory documentary evidence is provided, a prototype of each line terminal box design complete with cable sealing chamber shall be tested under internal short circuit conditions to demonstrate that the terminal box does not suffer damage (other than rupturing of the pressure release diaphragm or jeopardise the safety of personnel). In addition, through fault current tests shall be made to demonstrate that the box is suitable for the short circuit MVA specified.

Cable terminations or connection boxes shall be IP55 rated.

PS WPE 10.10 BEARINGS

Motors shall generally be fitted with heavy duty ball or roller bearings. Re-greaseable bearings are accepted.

The grease lubrication of ball or roller bearings shall be to approval. Grease lubricated bearings shall have relief holes to ensure that the bearings have been correctly packed and these holes shall be positioned so that excess grease can easily be removed.

The manufacturer or supplier of the motors shall recommend if bearing vibration or temperature sensors or RTDs are required for the bearings if failure of the bearings will be at risk. Suitable sensors shall be fitted should they be required. Similarly, requirements for bearing cooling be provided should the bearings require forced cooling or other cooling mediums.

PS WPE 10.11 PUMP MOTOR RATINGS

All fixed speed pump motors shall be continuously rated at a power output equal to at least 110% (with Zero Tolerance) of that required by the pump or other mechanical load when operating at the highest power consumption conditions.

Motors which will be driven from variable frequency inverters shall be rated at a power output of 110% - 115% of that required by the pump when operating at the highest power consumption conditions.

The motor and the load shall be correctly matched. The speed of the motor shall suit the pump load or other load as determined by the pump supplier or other load supplier.

The motor shall be rated for the following operating conditions:

DESIGN OPERATING CONDITIONS	REQUIRED
Altitude	22 msl
Ambient Temperature (min)	-5°C
Ambient Temperature (max)	40°C
Humidity	40-90%

PS WPE 10.12 SURGE PROTECTION AND EARTHING

Earthing of motors shall comply to SANS10142 and SANS60034-1 latest amendments.

Where required, surge suppression devices of the zorc type, shall be fitted into a compartment forming part of the cable terminal box and shall be connected to the motor terminals.

PS WPE 10.13 SERVICE FACTOR

Motors shall be supplied with a minimum service factor of 1.00.

PS WPE 10.14 GUARANTEES AND GENERAL PARTICULARS**PS WPE 10.14.1 Guarantees**

The Contractor shall guarantee certain specified aspects of the performance of the plant, and compliance with these tendered guarantees will be judged on the results of the witnessed factory tests specified for the motors.

Should the witnessed tests for any motor be unsatisfactory, the Purchaser shall have the right to refuse acceptance of such motor. For a period which will still enable the motor in question to be delivered to site in accordance with the requirements of the Contract allowing for normal transportation times, the Contractor shall then be allowed to effect refinements or adjustments in order to overcome the deficiencies of the motor.

If the motor still does not give satisfactory witnessed test results, the Contractor shall be required to replace such motor with a new one which will be subject to the same conditions regarding tests and guarantees as specified herein. Whilst awaiting a replacement motor the Client shall have the right to demand the delivery to site (and erection if required in terms of the Specification) and the use of such unsatisfactory motor.

PS WPE 10.14.2 Samples, Operating and Maintenance Instructions & Installation

PS WPE 10.14.2.1 Operating Instructions

Not less than two weeks before the specified Completion Date of the first motor, the Contractor shall supply Operating and Maintenance Instructions covering all aspects of the motors for discussion with the Engineer and shall submit a further five copies in a form approved by the Engineer.

PS WPE 10.15 TESTS

The manufacturer shall have the type of tests and certification reports for all relevant motors required for Low Voltage Motors and this Specification readily available for the Engineer for inspection.

Not less than fourteen day's notice of all tests shall be given to the Engineer in order that he may be present if he so desires. As many tests as possible shall be arranged together in accordance with a programme to be agreed with the Engineer. Five copies of the Contractor's records of all tests shall be furnished to the Engineer.

All material which is specified for tests at the Manufacturer's Works shall satisfactorily pass such tests before being painted.

All instruments shall be approved and if required shall be calibrated at the expense of the Contractor by the South African Bureau of Standards or such other body as may be approved.

The following tests shall be carried out in order to determine whether the materials and apparatus comply for Low Voltage Motors and this Specification.

PS WPE 10.15.1 Type Tests

No.	DESCRIPTION	ACCORDING TO STANDARD
1	Temperature rise test	IEC 60034-1
2	Load test	IEC 60034-2-1
3	Breakdown torque test	IEC 60034-1
4	Speed – Torque curve	-
5	Measurement of efficiency and power factor at 100%, 75%, 50% and 30% load	-

PS WPE 10.15.2 Batch Tests

All batch tests carried out by manufacturer shall be under his care and his expense. Upon request from the Engineer, the supplier shall supply the batch test reports. Batch tests shall be carried out by the manufacturer as part of their quality control procedure as per table below.

No.	DESCRIPTION	ACCORDING TO STANDARD
1	Winding resistance – cold	IEC 60034-1
2	Tests with locked rotor	IEC 60034-1

No.	DESCRIPTION	ACCORDING TO STANDARD
3	No-load tests	IEC 60034-2
4	Withstand Voltage test / Dielectric test	IEC 60034-3
5	Insulation resistance test (before and after dielectric test)	-
6	General visual checks, nameplate details, mounting, terminal box location and gland sizes	-
7	Measurement of shaft centre height dimensions	-
8	Measurement of clearances in terminal box	-
9	Verification of direction of rotation	-
10	Verification of type of terminals	-

PS WPE 10.15.3 Basic Tests

The motor shall be subjected to Basic Tests, Type Tests and Batch Tests in accordance with IEC 60034-1-2. and other relevant tests. Noise level tests to prove compliance shall be in accordance with IEC/EN 60034-9.

In addition to the above, the guarantee of slip at 80 percent normal voltage shall be proved.

These tests may also be carried out on randomly selected additional motors where such selection and additional number of motors shall be determined by the Engineer. The tenderer shall therefore quote a unit price per such additional test.

Apart from the basic tests, test measurements and/or calculation to obtain values for the following parameters, shall be carried out.

Inertia of rotor (I_m) in kg m², i.e. mass in kg x (radius of gyration in m²) Winding ratio (q).

- Stator resistance per phase at 75°C (r_1) in ohm.
- Stator reactance per phase (x_1) in ohm.
- Rotor resistance per phase at 75°C (r_2) in ohms.
- Full load speed (n_n) in radians per second.
- Break-away torque in Newton meter.
- Pull-out torque in Newton meter.

PS WPE 10.15.4 Duplicate Tests

Each motor shall be subjected to duplicate Tests in accordance with the relevant IEC/EN standards with the following additional tests:

- 1) Measurement of winding resistance (cold).
- 2) On over-voltage test at 1,5 times rated voltage applied with the machine running at no load for a period of 3 minutes to test inter-turn insulation.
- 3) Insulation tests and measurements as described in the relevant IEC/EN or other standards) shall be carried out on each motor. The Test results shall be recorded in the form as given by Table 2 of the abovementioned report.
- 4) Vibration measurements shall include measurements taken on each bearing housing and shall consist of at least three readings as follows:-
 - a. Vibration in the horizontal plane perpendicular to the shaft axis.
 - b. Vibration in the horizontal plane parallel to the shaft axis.
 - c. Vibration in the vertical plane perpendicular to the shaft axis.

- 5) Measurement of the air gap between rotor and stator shall be taken and recorded for each motor before and after the heat run.

PS WPE 10.15.5 Material tests on component parts

Test specimens shall be taken from the main forgings and castings; drawings giving the positions of all test pieces are to be submitted to the Engineer for approval. Before removing test pieces, these together with the forgings and castings which they represent, shall be hard branded in the presence of the Engineer. Forgings and castings shall be in the final heat treated condition before detaching test specimen.

All test specimens shall be tested in the presence of the Engineer. All mechanical test certificates shall include full details of chemical analysis and heat treatment. The materials used shall include chemical analysis and mechanical properties tests as appropriate.

PS WPE 10.15.6 Non-Destructive Testing

PS WPE 10.15.6.1 General

The Contractor shall submit for approval, well in advance of the commencement of forging, casting, rolling or fabrication, details of the techniques and procedures of examination to be employed on the principal and other times which shall include the following:

PS WPE 10.15.6.2 Rotor

- Examination prior to brazing of end rings.
- Witness brazing of first rotor end rings.
- Witness ultrasonic test of brazing first rotor end rings.
- Examine reports of ultrasonic tests on subsequent rotors and carry out spot checks if necessary.

PS WPE 10.15.6.3 Stator

Investigate quality of welding and proposed procedures. Examine assemblies before welding and after completion and check stress relieving evidence. Check loading dimensions and concentricity of bearing locations in relation to stator bore.

PS WPE 10.15.6.4 Bearings

Examine bearing housings after machining and check dimensions. Check bond of white metal to shells (ultrasonic test certificate acceptable).

PS WPE 10.15.6.5 Windings

Examine stator and rotor windings before assembly of motor.

PS WPE 10.15.6.6 Bearing Housings

Bearing housings shall be subjected to leak testing using oil or paraffin.

PS WPE 10.15.7 Routine Tests on Site

The following tests shall be carried out on Site on each motor and in the following order:

PS WPE 10.15.7.1 Drying out

The motors shall be dried out by the Contractor before any voltage is applied to them. The dry out shall be achieved by any approved method but the only evidence of dry

conditions which the Engineer will accept is an insulation resistance curve against time together with a polarisation index curve against time obtained during the drying out.

PS WPE 10.15.7.2 High Voltage Tests

The high voltage tests shall be carried out at voltages to be approved by the Engineer.

PS WPE 10.15.7.3 Direction of Rotation and No-Load Tests

Test to ascertain correct sense of shaft rotation followed by a 24-hour continuous no-load run during which the following will be monitored:

- 1) Winding temperature as registered by the embedded detectors.
- 2) Bearing temperatures (where applicable).
- 3) Vibration on each bearing.

PS WPE 10.16 INSTALLATION AND TERMINAL BOXES

The motor shall be foot mounted and shall be on a common base plate with the pump or other load or shall be on a separate base plate. Other mounting arrangements shall suit the pump or other load requirements and shall be confirmed with the Employer.

The motor and pump or other load shall be laser aligned by the pump/motor supplier to prevent vibration, bearing damage or shaft damage. Approved type couplings and guards shall be fitted between the motor and pump or other mechanical load.

The positions of the terminal boxes shall be confirmed with the Employer. The position shall suit the incoming cable supply or cable duct layouts.

PS WPE 10.17 SPECIAL REQUIREMENTS

- 1) The motor shall be supplied with new coupling and coupling guard to align and fit with the existing pump shaft alignment and size.
- 2) The motor is to suit the speed of the pump.
- 3) Motor is to match existing frame size.

PS WPE 11 MATERIAL, TRANSPORT, OFF-LOADING AND STORAGE

The Contractor must take due allowance in their tenders for the transport, off-loading of materials and the storage and safe custody thereof according to manufacturers' specifications on or off site until such can be accommodated or is required on site.

The motors shall be wired into temporary power supply and switched on during storage to prevent condensation forming in the motor windings.

PS WPE 11.1 INSPECTION OF LOCALLY MANUFACTURED SUPPLIES

Where locally manufactured plant or materials are offered, the Employer reserves the right to inspect such plant or goods during manufacture and to reject items that do not conform to the owner's requirements. Where a number of units are ordered by the owner the contractor shall notify the representative of the Employer when one unit has been completed so that the representative of the Employer may inspect and approve it.

PS WPE 11.2 ORDERING MATERIALS

The Contractor shall order the applicable mechanical equipment within 2 weeks of commencement of works and is warned to place all orders for materials or special materials as early as possible as he will be held solely responsible for any delay in the delivery of such goods.

PS WPE 11.3 PACKING

The contractor will be held responsible for packing all plant and other goods in such a manner as to ensure any loss or damage in transit. Unless otherwise specifically agreed upon, receptacles will not be returned or paid for and no additional charges will be

allowed for packing or packing materials.

PS WPE 12 PUMP AND MOTOR INFORMATION PLATES

Each pump shall be provided with a substantial information plate, preferably chromed or stainless steel, securely fastened to the pump casing in a readily visible position, and clearly and indelibly marked with the following details:

- Maker's name, pump type, serial number,
- Year of manufacture
- Rated duty of pump in litres per second,
- Head in metres at rated duty,
- Pump speed in rpm,
- Mass of upper casing in kg, (for horizontal split casing pumps,)
- Mass of lower casing in kg, (for horizontal split casing pumps,)
- Mass of complete rotating element in kg,
- Mass of completely assembled pump in kg.

Letters and figures shall be engraved, or embossed, NOT STAMPED.

Number plate: in addition, each pumping unit shall be provided with a chromium plated or stainless steel number designation plate not less than 100 mm square indicating "1", "2", etc., mounted in a position readily visible from the control console area. Pumps are normally numbered from the loading bay of the pump station (No 1 closest to the loading bay) but number order shall be confirmed by the Engineer.

PS WPE 13 ALIGNMENT

The pump and motor shall be laser aligned. Before turning on the pump and motor on site, the laser alignment shall be re-checked to ensure it has not shifted during delivery and installation of the pump set.

The pump unit shall be accurately aligned and levelled on Site by the Contractor, should the Contractor dismantle the pump set at the factory for transport, using which ever means necessary. The anchor nuts shall then be drawn tight against the base. The pump and motor shall then be checked for alignment. If alignment needs improvement, metal shims or wedges shall be added at the appropriate places under the base. The Contractor shall align the units using laser alignment and shall ensure that the measured deviations nowhere exceed those recommended by the manufacturers of the motors, pumps and flexible couplings respectively. The readings shall be made available to the Engineer upon request.

Where required, the Contractor shall then grout up the units solidly, filling the voids inside and under the baseplate with an approved non-shrink grout.

After the pumps have been in operation at least one day, the foundation bolts shall be finally tested for tightness, the alignment checked and dowel pins fitted in the pump and motor feet in the approved manner.

When the grout has thoroughly dried (about 14 days after grouting), the exposed edges shall be painted using an approved oil paint of the same colour as the pump baseplate.

Both the suction and discharge piping shall be supported over the pumps with rigid supports and/or anchors to prevent strain from the pipework acting directly on the pump.

The suction pipework shall be completely airtight and installed in a manner to ensure that no air can be trapped in the suction pipe (and manifold).

PS WPE 14 PERFORMANCE GUARANTEE

The Contractor shall guarantee that each pump unit shall achieve the duty specified to within a tolerance of -0% and +3 % on flow and 5 % on power absorbed when operating

under the specified head and pumping water of the specified quality. The Engineer will require that the contractor perform site tests to demonstrate the pump compliance.

The contractor shall take whatever steps are necessary to achieve the specified pump performance in accordance with the Engineer's instructions. The Engineer will not accept the pump units unless the specified performance is adequately and reliably demonstrated.

Pumps may be required to be witnessed tested for performance at the factory or assembly plant and test results submitted to the engineer prior to delivery to site.

The Engineer is to witness the FAT of the pumps at the manufacturer's premises. All costs associated with these tests are to be borne by the contractor.

PS WPE 15 TESTING AND COMMISSIONING

The entire installation shall be tested and commissioned in a well-documented procedure to be submitted by the contractor for approval by the Engineer. All test and commissioning data shall be recorded for inclusion in the O & Manuals. The Engineer shall be invited to witness and participate in all tests. One day notice shall be given for these tests.

This testing shall include inter alia the following:

- 1) The pumps shall be factory assembled and performance tested along with the supplied motor as per ISO 9906 2012.
- 2) Hydrostatic test should be at least 1.5 times of the rated pressure
- 3) Pump performance test report in accordance to ISO9906 shall be furnished by the manufacturer along with the supply of the pump. The pump performance shall be tested at no less than 3 points.
- 4) The pump test report shall bear the stamp of the factory and shall be signed by the testing engineer. The test report shall also bear the complete pump model description and part number/identification number of the supplied pump.
- 5) Witness performance testing of the pumps shall be arranged.
 - a. Commissioning activities as per particular specifications.

PS WPE 16 REFERENCE STANDARDS

The following standards are referred to:

- 1) ISO 9906:2012 – International Standards Organizations hydraulic performance tests for customers' acceptance of rotodynamic pumps.
- 2) EN-JL1040 / DIN W.-Nr. 2.1050.01 / DIN W.-Nr 0.6025 - European Standard for materials:
- 3) WRAS- conformance mark with the requirements of the drinking Water Supply (Water Fittings) Regulations 1999 and amendments of UK.
- 4) NEMA- American standard for Electrical equipment's
- 5) IEC - International Electrotechnical Commission

Compliance:

- 1) Pump shall be energy efficient and comply with the EuP Directive (Commission Regulation (EC) No 547/2012) for the minimum efficiency requirement

PS WPE 17 RESTRICTED WORKING CONDITIONS

The Contractor is to take note of the restricted working space to manoeuvre mechanical equipment within the pump station based on the positions of the existing pump-sets, pipework and motor control panels.

A temporary trolley will be required to manoeuvre the existing and new mechanical equipment during dismantling and installation. This will be supplied by the Contractor and removed thereafter. The Contractor is to also ensure applicable lifting equipment is provided for the removal of all mechanical and electrical equipment.

Contractor is to allow for safe temporary access into the pump station and around the

site.

PS WPE 18 DAMAGE OF PIPE SUPPORT BRACKETS, PIPEWORK, FITTINGS & VALVES.

The Contractor is to take cognisance of the close proximity to pipework, valves, fittings and support brackets and will be liable to any damages incurred to existing infrastructure within the pump station.

PS WPE 19 SENSORS

Pump casing temperature sensors are to be fitted to all pumps above 11kW ratings. These are to be supplied as per the pump OEM requirements and shall match existing systems where they are installed.

Pump bearing temperature and vibration sensors are required for pumps above 30kW, however facilities shall be provided in all other pumps for installing these in future. The sensors supplied are to be as per the pump OEM requirements and shall match existing systems where they are installed.

Motor winding temperature sensors are required only as specified. Motor bearing temperature sensors are not required.

PS WPE 20 DATA SHEETS

The Tenderer shall complete in full the information on the following data sheets in respect of the following"

- Equipment offered for each motor.
- Pump testing data subsequent to repairs and refurbishment.
- Applicable coupling data.

PS WPE 20.1 PUMP DATA SHEET

Note : Complete one for each equipment supplied

Contractual Duty Point specified (PS WPE 1 & 2)		
Number of pumps required	No	
Type of pump		
Manufacturer of Pump		
Country of Manufacture		
Make and Model of Pump		
SANS, BS , ISO or IEC Standards the pump is manufacture to		
Type of impeller (state whether open, single-port, two-port or shrouded)		
Number of impellers/ stages	No	
Size of solids which can pass through the pump in normal operation	mm	
Mass of fully assembled pump	kg	
Maximum allowable operating speed of pump	RPM	
Speed of pump at the specified duty point above	RPM	
Diameter of impeller offered	mm	
Will the impeller offered enable the pump to meet a duty point ranging from: ___ m³/hr x ___ m to ___ m³/hr x ___ m	State YES or NO	
Factory test pressure applicable to pump with suction and delivery flanges blanked off	kPa	
Pump efficiency at Duty Point	%	
Head developed by pump at zero discharge	m head of water	
Closed valve head of pump	m	
Moment of inertia of rotation assembly	kgm ²	
Power Absorbed		
Power absorbed by pump at specified Duty Point	kW	
Power absorbed by pump at a run point of 810 m ³ /hr	kW	
Power absorbed at best efficiency point:	kW	
Maximum power absorbed by pump at run out point of coupling	kW	
Voltage (525V for all pumps)	Volts	
NPSH		
NPSH requirement at specified Duty Point	m head of water	
NPSH requirement at a run point of 810 m ³ /hr	m head of water	
NPSH requirement at a run out point	m head of water	

Diameter of Pump Components:		
Suction inlet waterway and flange size	mm	
Delivery outlet waterway and flange size	mm	
Shaft (state minimum and maximum diameter if applicable)	mm	
Full size impeller diameter	mm	
Impeller diameter offered for duty specified	mm	
Minimum size impeller	mm	
Type and Material of Pump Components:		
Outboard bearing		
Inboard bearing		
Impeller		
% Chrome in impeller		
Shaft		
Shaft sleeves		
Volute Casing		
Diffusers		
Wear Ring		
Mechanical Seals:		
Manufacturer		
Type/model		
Seal materials		
Packed Glands:		
Type		
Packing materials		
PT100 pump casing temperature sensors for all pumps		

PS WPE 20.2 COUPLING DATA SHEET

Note : Complete one for each equipment supplied

Type of coupling and fixing method		
Mass of coupling	kg	
Type of coupling guard		
Approximate mass of coupling guard	kg	
Type of coupling bushing (where applicable)		
Type of coupling pins (where applicable)		

PS WPE 20.3 MOTOR DATA SHEET

Note : Complete one for each equipment supplied

Manufacturer		
Place of Manufacture		
SANS, BS, ISO or IEC Standards the motors are manufactured to		
Type Insulation (Class) and temperature Rise Class		
Rated output power (indicate rating such as 37 kW but a different rating may be offered provided there is always the specified minimum margin at the run out point)	kW	
Frame size and reference specifications		
Mass of fully assembled motor	kg	
Confirm integrally cooled	YES or NO	
Maximum allowable ambient temperature to prevent overheating	°C	
Weatherproof rating (IP)		
Motor efficiency class		
Rated maximum speed	RPM	
Initial starting current	Amps	
Full load current	Amps	
Starting current	Amps	
Minimum starting voltage	Volts	
Mounting type, enclosure and cooling method		
Stator winding material, insulation class and temperature rise		
Slip at full load % of synchronous speed.	%	
Starting torque in star as a % full load torque.	%	
Starting current in star as a % of full load current.	%	
Power drawn from electricity supply at pump duty point	kW	
Power drawn from electricity supply at pump run out point	kW	
Type of DE and NDE bearings and sizes		
Bearing lubrication type and grade		
Efficiency by summation of losses in accordance with BS 269:		
At full load	% / %	
At 3/4 load	% / %	
At 1/2 load	% / %	

Power factor:		
At full load	$\cos \phi$	
At 3/4 load	$\cos \phi$	
At 1/2 load	$\cos \phi$	

Anti-Condensation Heater and Thermistors:		
Heater Voltage	V	
Heater Power	kW	
Type of thermistors and number per phase		
Thermistor Voltage	V	
Operation of Thermistors		
Drawing Nos of the drawings supplied by Tenderer with the tender:		
Pump-motor assembly		
Pump characteristics H, Q, Efficiency, NPSH and Power drawn versus Q) for various speeds and impeller sizes		
Drawing Nos of the drawings supplied by Tenderer with the tender:		

DGI Consulting

NAIDU
CONSULTING



**PROJECT PARTICULAR SPECIFICATION:
ELECTRICAL, CONTROL & INSTRUMENTATION**

PS ECI

**TONGAAT WATER TREATMENT WORKS – WORK
PACKAGE 1**

Contract No. WS7382

Rev 0



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PREAMBLE

This Project Specification forms an integral part of the contract and supplements the Standard eThekwini Electrical and Instrumentation Specifications where relevant.

In the event of any discrepancy between a part or parts of the Standard or Particular Specifications and the Project Specification, the Project Specification shall take precedence. In the event of a discrepancy between the Specifications, (including the Project Specifications) and the drawings and / or the Bill of Quantities, the discrepancy shall be resolved by the Engineer before the execution of the work under the relevant item.

PS ECI 1 GENERAL

This electrical and instrumentation requirement for the Tongaat Water Treatment Works is for the new inlet head of works and improvements to the existing clarifiers, filters and chemical dosing systems

PS ECI 2 PROJECT DESCRIPTION AND SCOPE OF CONTRACT**PS ECI 2.1 BACKGROUND AND SITE**

The site of the works is the existing Tongaat WTW. The site is in Tongaat at WeWe.

The water treatment site comprises of the following existing and proposed new infrastructure:

- New inlet works, new screening structure, new flocculation channel, clarifiers, filters, chemical dosing building, chlorine dosing building, clear water reservoir, high lift pump station and site works.

PS ECI 2.2 SCOPE OF CONTRACT

This electrical and ancillary work contract comprises the complete design, supply, manufacture, delivery, testing and commissioning, maintenance and guarantee of the following:

PS ECI 2.2.1 Tongaat Water Treatment Scope Of Works**PS ECI 2.2.1.1 Disconnection And Removal Of Existing Equipment**

- a) Disconnection and removal of the existing inlet works actuated valve and cabling
- b) Disconnection and removal of the existing inlet works flow meter and cabling
- c) Disconnection and removal of the existing electrics and cabling to the existing guard house
- d) Disconnection and removal of the existing pole lights and cabling that is in the way of the new structures or buildings
- e) Disconnection and removal of the existing inlet works level sensor, transmitter and control panel
- f) Disconnection and removal of the existing filter control panels and cabling for Filters 1 – 6
- g) Disconnection and removal of the existing starters and associated equipment in the existing MCC 01 for the one existing backwash recycle pump
- h) Disconnection and removal of the MCC and cabling etc for the two existing sludge pumps
- i) Disconnection and removal of the existing 100kVA 525/400Volt transformer. To be replaced with new upgraded one.
- j) Disconnection and removal of the existing DB and electrical installation in the existing Admin Building/Ablutions

PS ECI 2.2.1.2 New Inlet Works, Screening & Flocculation

- a) Power supply from new 200kVA 400Volt transformer to the new Mixer MCC02
- b) New Mixer MCC02 (with PLC & HMI)
- c) Cabling and cable trays from the Mixer MCC02 to the mixers
- d) Weatherproof lockable isolators adjacent the flocculation mixers and mechanical screens and conveyor
- e) Continuity of power supply from the existing and new 400Volt transformer to the existing 400V DB in the high lift pump station
- f) Take free issue the MCC03 for the Screens and Conveyor supplied by others and install in position and connect up
- g) Power supply and cabling to MCC03 - Screens & Conveyor Control Panel (Control Panel supplied by Screens Supplier)
- h) Cabling from the Screens Control Panel to the mechanical screens and conveyor
- i) Lighting protection and earthing installation for the inlet works, screening and flocculation structures

- j) New site lighting around the inlet works and flocculation structure
- k) Preparing and submission of the instrument list and loop diagrams and final cable list with schedules, destinations, sizes etc.
- l) Design and submission of the MCC and other control panel drawings prior to any panel construction work commencing
- m) New batteries for the UPS section incorporated into the MCC
- n) PLC and HMI as per EWS specifications. Refer PLC_Specification_Rev06
- o) Integration of the MCC 03 to the PLC in MCC 02
- p) Earthing of the complete electrical installation and the MCC and associated electrical installation and pumps. Pumps, stirrers, and other motors to be effectively earthed and VSDs earthed where installed.
- q) Submit a preliminary schedule showing all tasks leading up to final commissioning within the stipulated timelines
- r) Supply 5 hard copies and 5 soft copies of the O & M manuals consisting of datasheets of all equipment, drawings and PLC & HMI with program including pages/trends/alarms etc (electronic and printed copies). The PLC programs shall be the property of EWS.
- s) Issuing of the Electrical Certificate of Compliance (COC).
- t) Issuing of the earth test certificates
- u) Testing and commission of the entire electrical installation

PS ECI 2.2.1.3 Clarifiers, Filters & Chemical Dosing System

1. CLARIFIERS & FILTERS

- a) New MCC05 and control for power and controls for the clarifier electric actuated de-sludge valves. (for Clarifiers 1 - 6)
The MCC05 shall also supply the power and control systems for the filter backwashing and air blower electric actuated valves (for Filters 1 - 6)
The clarifier scour valves will not be actuated.
- b) Power and signal cabling to all electric actuators
- c) Weatherproof lockable isolators adjacent all the electric actuators
- d) New control panels for the filters 1- 6 (FCP1-6) for automatic backwash and air blower sequencing and operation
- e) Power and signal cabling for the filter control panels and controls of the backwash pumps and air blowers
- f) Integration and modifications of the filter control system for the existing filter backwash pumps and air blowers in the existing MCC01 (the existing backwash pumps and air blowers are supplied from the existing MCC01)
- g) Preparing and submission of the instrument list and loop diagrams and final cable list with schedules, destinations, sizes etc.
- h) Design and submission of the MCC and other control panel drawings prior to any panel construction work commencing
- i) New batteries for the UPS section incorporated into the MCC
- j) Design and submission of the MCC and other control panels drawings prior to any panel construction work commencing
- k) PLC and HMI in MCC05 as per EWS specifications. Refer to PLC_Specification_Rev06
- l) Earthing of the complete electrical installation and the MCC and associated electrical installation and pumps. Pumps and motors to be effectively earthed from the MCC to the pumps and motors and to VSDs where installed.
- m) Submit a preliminary schedule showing all tasks leading up to final commissioning within the stipulated timelines
- n) Supply 5 hard copies and 5 soft copies of the O & M manuals consisting of datasheets of all equipment, drawings and PLC & HMI with program including pages/trends/alarms etc (electronic and printed copies). The PLC programs shall be the property of EWS.
- o) Issuing of the Electrical Certificate of Compliance (COC).
- p) Earthing of the complete electrical installation and all pumps and motors etc
- q) Issuing of the earth test certificates
- r) Testing and commission of the entire electrical installation

2. CHEMICAL DOSING SYSTEM

- a) Automation of the existing chemical dosing and chlorine dosing systems. The dosing systems are to be automated with dosing rates proportional to the flow rate into the works.
- b) Integration of the existing chemical dosing and chlorine dosing systems to the PLC in the MCC02 and to the new on-site SCADA system. The existing chlorine dosing and chemical dosing control panels are two separate panels

The automation and control of the dosing systems are to be in accordance with the FDS and P & ID diagrams included with this specification.

PS ECI 2.2.1.4 Backwash Pumps, Backwash Recycle Pumps & Sludge Pumps

- a) Disconnection and removal of the existing DOL starter and associated equipment for the existing backwash recycle pump (1 off) in the existing high lift pumps MCC01
- b) Supply and installation of starters and controls in the existing high lift pumps MCC01 with VSDs for the new recycle pumps (to replace the one existing pump and for the one new pump - 2 pumps in total)
- c) Emergency stop stations for the new recycle pumps
- d) No flow switch on the delivery pipe of each recycle pump for no flow protection
- e) Low level electrodes in the backwash channel for the low level protection of the recycle pumps.
- f) Cabling for the recycle pump motors, emergency stop, motor heater, motor thermistors etc
- g) Cabling for the recycle pumps low level electrodes and level sensors
- h) Disconnect and remove the existing MCC or control panel for the existing sludge pumps
- i) Disconnect and remove the cabling and other equipment for the existing sludge pumps
- j) New MCC05 with VSDs for the new sludge pumps and integration to the PLC & HMI in MCC02
- k) New motor termination box for the submersible sludge pump motors
- l) No flow switch on the delivery line of the sludge pumps
- m) Low level electrodes in the sludge tank/sump for the low level protection of the sludge pumps.
- n) Cabling to the sludge pump motors, emergency stops, level electrodes, level sensors, pump moisture & oil contamination sensors etc
- o) Cabling from the new MCC02 to the MCC05 (new sludge pumps)
- p) Design and submission of the MCC and other control panels drawings prior to any panel construction work commencing
- q) Replacing the existing star-delta starters in the existing MCC01 with VSDs for the control of the existing backwash pumps. Disconnection and removal of the existing starters and associated equipment
- r) Upgrading of the PLC & HMI in the existing MCC01
- s) Earthing of the complete electrical installation and the MCC and associated electrical installation and pumps. Pumps and motors to be effectively earthed from the MCC to the pumps and motors and to VSDs where installed.
- t) Submit a preliminary schedule showing all tasks leading up to final commissioning within the stipulated timelines
- u) Supply 4 hard copies and 4 soft copies of the O & M manuals consisting of datasheets of all equipment, drawings and PLC & HMI with program including pages/trends/alarms etc (electronic and printed copies). The PLC programs shall be the property of EWS.
- v) Issuing of the Electrical Certificate of Compliance (COC).
- w) Earthing of the complete electrical installation and all pumps and motors etc
- x) Issuing of the earth test certificates
- y) Testing and commission of the entire electrical installation

PS ECI 2.2.1.5 Admin Building & Guard House

- a) Disconnect and remove the existing DB, plugs, lighting, conduits and wiring from the existing Admin Building and Ablutions/Toilets

- b) Relocate the existing HMI panel, UPS and telemetry system from the existing control room to the new Control Room of the new Admin Building
- c) New DB-A1 for the Admin Building and Guard House DB-G1
- d) New lighting, socket outlets, aircon power points, conduit and wiring for the new Admin Building and Guard House
- e) New electric geyser in Admin Building Ablutions
- f) Lightning protection and earthing for the New Admin Building and Guard House
- g) Fire detection and alarm system for the New Admin Building
- h) Issuing of the Electrical Certificate of Compliance (COC).
- i) Earthing of the complete electrical installation
- j) Issuing of the earth test certificates
- k) Testing and commission of the entire electrical installation

PS ECI 2.2.1.6 Mechanical Installations

- a) Supply and installation of midwall split aircooled airconditioning units for the New Admin & Office Block including all refrigerant pipework, trunking etc. Units to have anti-corrosion treatment.
- b) Supply and installation of midwall split aircooled airconditioning units for the New Guard House including all refrigerant pipework, trunking etc. Units to have anti-corrosion treatment.
- c) Extract fans in the MCC Room and Chemical Rooms
- d) Connection of the aircon units and fan systems to their respective power points with testing and commissioning of the units
- e) Fire extinguishers and relevant signage

PS ECI 2.2.1.7 Instrumentation And Control Systems

- a) New electrical actuators for inlet flow control knife gate valve (DN400 inlet pipe and valve) specified elsewhere.
- b) New ultrasonic flow meter on the inlet to the works (DN400)
- c) Ultrasonic differential level sensors in the screen structure for control of the inlet screens and mechanical conveyor
- d) Ultrasonic level sensor in the flocculation channel (for level measurement) Siemens 24V DC Dual Point Multiranger or similar approved
- e) New electric actuators for the clarifier de-sludge valves
- f) New electric actuators for the filter back-wash and air blower valves
- g) New ultrasonic flow meter on the DN100 rising main from the backwash recycle pumps (for flow measurement)
- h) Relocation of the existing telemetry system from the old control room to the new Admin Building Control Room
- i) Relocation of the existing PLC/HMI Panel from the old control room to the new Admin Building Control Room
- j) Relocation of the existing UPS from the old control room to the new Admin Building Control Room
- k) Relocation of the existing SCD to the new inlet works before the flocculation mixing
- l) New PLC and HMI in the Stirrer MCC02
- m) New PLC and HMI in the De-sludge Valve MCC04
- n) Integrate the MCC03 (Screens / Conveyor) to the PLC/HMI in MCC02
- o) Integrate the MCC04 (Sludge Pumps) to the PLC/HMI in MCC02
- p) Modification of the PLC and HMI in the existing MCC01 for the high lift pumps for integration of the new recycle and sludge pumps
- q) Automation of the existing chemical and chlorine dosing systems and integration to the PLC in Stirrer MCC02 and to the new on site SCADA system
- r) New on site SCADA system with all hardware and software including UPS, monitor, printer etc complete
- s) Integration of all existing and new PLC /HMI to the new on-site SCADA system. This will include the existing PLC and HMIs in the existing high lift pumps MCC and existing Remote Control Panel in the High Lift Pump Station
- t) New telemetry systems at the following reservoirs for automatic control of the following existing high lift pumps at the WTW :
 - Mamba Ridge (Including Jan Roz & Burbreeze)
 - Tongaat South
 - Hambanathi

- Emona/Belvedere
- Metcalfe
- u) Modification to the existing telemetry system at the WTW to receive signals back from the remote reservoirs.
- v) Modification to the existing telemetry system at the WTW to transmit the new signals for all new pumps and new inlet works equipment for transmission to the EWS Control Room in Pinetown
- w) Earthing of all instruments
- x) Testing and commissioning of the entire instrumentation and control systems
- y) Exclusions or items to be provided by others under the process equipment supply:
 - Ph meters
 - Conductivity meters
 - Limit and proximity switches forming part of the screen and conveyor supply
 - SCD (streaming current detector)
 - SCD sampling pumps
 - Actuator for inlet control valve
 - Flow meter on inlet to works
 - Chemical dosing or chlorine dosing equipment and instruments

PS ECI 2.2.1.8 Site & General

- a) Make safe and disconnect and remove the existing 100kVA 525/400Volt transformer on site
- b) The supply and installation of a new 200KVA 525/400V lighting transformer on a concrete plinth at ground level as shown on the site plan (for all 400Volt equipment and 400Volt pumps on site)
- c) New site lighting poles and floodlights including site lighting around the inlet works, screens and flocculation structures
- d) All sleeves
- e) Manholes (by civil contractor)

PS ECI 3 DRAWINGS AND SUB-CONTRACTED OR SPECIALIST WORKS

The following work is considered specialist work and specialist contractors are to be engaged and appointed to carry out the design and installations, unless these services as available in-house :

The following has been included as specialist works:

- a) Supply and installation of the new MCCs and Control Panels
- b) Supply and installation of 200KVA 525/400V lighting transformer
- c) Modifications of the existing MCC01 for the new Backwash Recycle Pumps Control Panel
- d) Supply and installation of new Sludge Pumps Control Panel
- e) Supply and installation of new Filter Backwash & Blower Control Panels (6 off)
- f) Relocation, integration and re-commissioning of the of the existing SCD (streaming current detector)
- g) Lightning protection and earthing to all buildings and structures
- h) Electric valve actuators for Clarifiers and Filters and inlet works
- i) Supply and installation of the PLCs and HMIs including programming of the PLC and HMI
- j) Telemetry systems and new signal cabling from the existing telemetry panel to the PLC in the new MCCs
- k) New telemetry systems for the remote reservoir sites
- l) Re-programming and integration of the telemetry to MCC, instrumentation and PLC systems etc
- m) SCADA system and integration to PLC/HMIs etc
- n) Airconditioning and ventilation installations
- o) Compiling and providing the final cable schedules, cable block diagrams and instrument loop diagrams.
- p) Compiling and providing the P & ID diagrams, I/O Lists, network diagrams and FDS (functional design specification) for the entire plant on site including all treatment and pumping systems, chemical dosing processes. (to include pumps, pumping plant and valves, blowers, instruments, chemical dosing systems and pumps, chlorine dosing systems and pumps, PLC etc complete)

The above items listed in (n) and (o) above shall be submitted in both PDF and electronic CAD files.

Drawings :

The following drawings are issued with and form an integral part of the specifications and tender and shall be read with this document at all times:

DWG NO.	DRAWING NAME
D791-51-1500	Filter & Chemical Building Electrical Layout
D791-51-1501	Site Plan - Electrical and Instrumentation Layout
D791-51-1502	New Inlet Works Flocculation & Screening Structure - Electrical Layout
D791-51-1503	New Admin and Office Building - Airconditioning Layout
D791-51-1504	Proposed Extension to Admin Building - Electrical Layout
D791-51-1505	Supply and Cable Reticulation To Clarifier Actuators
D791-51-1506	Supply and Cable Reticulation To Filter Actuators
D791-51-1500 Sht 1 of 2	Schematic Single Line Diagram of 400V MCC and DBs
D791-51-1500 Sht 1 of 2	New Admin & Office Block - Schematic Single Line Diagram of DB-A1

PS ECI 4 TECHNICAL DATA

PS ECI 4.1 Screens, Conveyors & Stirrers

The following equipment and pumps are to be installed as part of the new scope of works for the Water Treatment Works

Inlet Works , Screens and Flocculation Basin:

- Inlet works electrical actuator 1 : 2,2kW (1 duty)
- Mechanical Screen 1 - 2 : 2,2kW (2 duty)
- Mechanical Conveyor 1 : 2,2kW (1 duty)
- Flocculation stirrers with gearbox 1 - 8 : 2,2 kW (8 duty)

Clarifier & Filters

- Clarifier 1 - 6 de-sludge valves 1 - 6 : 2,2kW (2 duty and 4 stand-by)
- Filters 1 – 6 de-sludge valves 1 - 6 : 2,2kW (2 duty and 4 stand-by)

The rated motor capacities for the above equipment is provisional only. The final power requirements are to suit the actual power required for all the stirrers, screens, conveyors, electric valve actuators, pumps etc.

The cables to all the equipment and motors must be terminated in a suitable sized cable termination box for the power cables, and to motor heater cables and motor & pump temperature sensors where provided.

PS ECI 4.2 Recycle And Sludge Pumps

a) Backwash Recycle Pumps :

The one existing recycle pump that is not coping is to be replaced with 2 self priming pumps, 1 duty and 1 stand-by pump.

The new backwash recycle pumps are rated at a duty of 55m³/hr with a head of 5,8m and will require motors of approximately 5,5kW. The pump selected is the Gorman Rupp self priming pump type T3C60SC-B/FM or similar and equal approved. The final motor sizes are to be determined by the contractor to suit the actual pump motor sizes required. Refer to the pump specifications included elsewhere.

The existing pump is fed from the existing high lift pumps 525Volt MCC. The existing starter panel is to be retrofitted with new VSD starters and controls for one 5,5kW for Pump No 1. The existing spare panel is to be fitted with a VSD and controls for the second 5,5kW pump for Pump No 2. The operating and control philosophy for the pumps are to match the existing systems.

The new pump motors are to be rated for 525Volts.

The motors are to be fitted with built-in PT100 temperature thermistors, which must be catered for by the contractor in the control circuitry. Anti-condensate heaters are to be fitted to all motors.

Backwash Recycle Pumps Required :

- Self priming pumps 1 - 2 : 5,5kW (1 duty , 1 stand-by)

b) Sludge Pumps :

The one existing sludge pump is to be replaced with 2 submersible pumps, 1 duty and 1 stand-by.

The new sludge pumps are rated at a duty of 33,8m³/hr with a head 6,5m and will require motors of approximately 5,5kW. The pump selected is the KSB single stage submersible pump type Amarex NF80-220 or similar and equal approved. The final motor sizes are to be determined by the contractor to suit the actual pump motor sizes required. Refer to the pump specifications included elsewhere.

The cables to the motors must be terminated in a suitable sized cable termination box for the power cables, and to pump PT100 thermistors, moisture and oil contamination sensors where provided.

Sludge Pumps Required :

- Sludge Submersible Pumps 1 - 2 : 5,5kW (1 duty , 1 stand-by)

PS ECI 5 MCC & CONTROL PANELS

The specifications and requirements for the motor control panels, PLC/HMI and SCADA systems are to be read in conjunction with the FDS (Function Design Specification) and the P & ID diagrams that are included with these documents. The control panels are to comply with the EWS standard specifications.

PS ECI 5.1 400 Volt MCC02 - For New Stirrers

PS ECI 5.1.1 General

The MCC design shall be undertaken by personnel who are able to demonstrate experience in the field of water treatment and pumping plant including PLC control and telemetry systems. The motor control panel components and installation methods and associated electrics shall comply strictly to the eThekweni Water standards and requirements all as specified in the detailed specification or elsewhere in the general specification. All equipment shall comply with the requirements of the EWS Standard Specifications included with this tender enquiry.

The MCC shall be floor mounted type with steel pedestals and fitted within the existing Chemical Building and generally in accordance with the Standard Specification. The panel shall be manufactured from min 1,6mm 3CR12 material and epoxy powder coated. The supply voltage available on site will be 400 Volts fed from the 525V/400V transformer. The panel shall be designed for type 2 co-ordination.

The panel shall comprise the following:

PS ECI 5.1.1.1 Panel No. 1 – Incomer

This panel shall contain:

- One set of suitable sized three phase and neutral copper bus bars complete with support insulators in accordance with the Standard eThekweni Specification. One substantial copper earthing bar complete with sufficient number of studs or bolts, nuts, and washers for the incoming and outgoing earth conductors.
- One 250Amp 400 Volts suitably rated triple pole switch lockable in the "off" position and shall be compliant with type 2 co-ordination. All live parts of the switch shall be shrouded to prevent inadvertent contact by maintenance personnel.
- 3 No. HRC Voltmeter fuses.
- 3 No. Current transformers.
- 1 No. Power meter Allen Bradley PM500 with facilities for phase / phase / neutral voltages and current on all 3 phases.
- 1 No. Set fuses with mains and phase failure relays incorporating phase loss, phase reversal, under voltage, over voltage and phase imbalance.
- 1 No. Power on indication light.
- 1 No. 4 Pole Surge arresters as specified in the Standard Specification.

PS ECI 5.1.1.2 Panel No. 3 (Stirrer 1)

400 Volt VSD Starter for 0,75 – 2.2 kW Duty Pump No. 1 (kW to be confirmed)

The panel shall be generally as described in the Standard Specification and shall have be pad lockable and contain:

- 1 No. Suitably rated triple pole fused switch mechanically interlocked with the panel door. All live parts shall be fully shrouded.
- 1 No. HRC control fuse
- 1 No. Control link
- 1 No. 400V Motor Protection Breaker or similar approved to eThekweni standards, incorporating motor protection, overload, under-current and anti-single phasing protection
- 1 No Elsec or similar earth leakage relay for outdoor motor protection
- 1 No VSD starter (to suit above motor kW)
- No Suitably rated control voltage circuit
- 1 No Manual/Auto/Off selector switch
- 2 No Manual stop/start buttons
- 1 No Re-set push button
- 1 Set Power on / run / trip indicator lights (3 off)
- 1 No. Misc. ammeter with 96 mm dial
- 1 No. Suitably rated ammeter and current transformer
- 1 No Run hour meter and start counter
- 1 Set Control equipment, relays, contacts, timers, etc. to automatically start, stop and trip the stirrers. The stirrers are to be operated by adjustable timers programmed in the PLC
The stirrers shall also be stopped when there is no flow into the works.
- 1 Set Circuitry for emergency stop locks

This panel shall be labelled " Stirrer No. 1 "

PS ECI 5.1.1.3 Panel No. 4 (Stirrer 2)

VSD Starter for 0,75kW 400 Volt Stirrer. 2

This panel shall be identical to the panel No. 3 for Stirrer No. 1

This panel shall be labelled " Stirrer 2 "

PS ECI 5.1.1.4 Panel No 5 (Stirrer 3)

VSD Starter for 0,75kW 400 Volt Stirrer 3

This panel shall be identical to the panel No. 3 for Stirrer No. 1

This panel shall be labelled " Stirrer 3 "

PS ECI 5.1.1.5 Panel No. 6 (Stirrer 4)

VSD Starter for 0,75kW 400 Volt Stirrer 4

This panel shall be identical to the panel No. 3 for Stirrer No. 1

This panel shall be labelled " Stirrer 4 "

PS ECI 5.1.1.6 Panel No. 7 (Stirrer 5)

VSD Starter for 0,75kW 400 Volt Stirrer 5

This panel shall be identical to the panel No. 3 for Stirrer No. 1

This panel shall be labelled " Stirrer 5 "

PS ECI 5.1.1.7 Panel No. 8 (Stirrer 6)

VSD Starter for 0,75kW 400 Volt Stirrer 6

This panel shall be identical to the panel No. 3 for Stirrer No. 1

This panel shall be labelled " Stirrer 6 "

PS ECI 5.1.1.8 Panel No. 9 (Stirrer 7)

VSD Starter for 0,75kW 400 Volt Stirrer 7

This panel shall be identical to the panel No. 3 for Stirrer No. 1

This panel shall be labelled " Stirrer 7 "

PS ECI 5.1.1.9 Panel No. 10 (Stirrer 8)

VSD Starter for 0,75kW 400 Volt Stirrer 8

This panel shall be identical to the panel No. 3 for Stirrer No. 1

This panel shall be labelled " Stirrer 8 "

PS ECI 5.1.1.10 Panel No. 11 (Spare)

Spare For Future 2,2 KW VSD starter

This panel shall be labelled " Spare "

PS ECI 5.1.1.11 Panel No. 12 (Spare)

Spare For Future 2,2 KW VSD starter

This panel shall be labelled " Spare "

PS ECI 5.1.1.12 Panel No 13 (PLC, Auto Control & HMI)

The panel shall be equipped as follows with EWS specified equipment, refer EWS PLC Specification _Rev06 :

- 1 No. Control circuit HRC fuse
- 1 No. Neutral link
- 1 No. PLC & 15" HMI as specified

- PLC controller & CPU
- Digital Input and Output Cards
- Analogue Input Card
- Expansion Modules & Spare Cards
- Ethernet Switch
- Wireless Router
- Modbus Serial Module and Power Monitor as required
- Surge arrestors as required. (all field devices should be surge protected)
- Any other equipment as required
- Laptop flip table

Note : The PLC in this panel shall be integrated and receive all signals from the Screens MCC03 and all the status of the motors for the screens, conveyors etc.

The PLC in MCCC02 shall be integrated to the new on-site SCADA system.

The MCC03 for the screens/conveyors and the chlorine dosing and chemical dosing control panels are to be integrated to the PLC & HMI in MCC02.

PS ECI 5.1.1.13 Panel No. 14 (UPS and backup batteries)

The UPS, battery charger and batteries as specified under the standard specification shall be installed in this cubicle. The battery shall be installed in a separate cubicle within the MCC or in a separate cabinet all to eThekwin standard specifications. The battery shall be 2 x 90 Amp Hour 12V DC Deltec deep cycle battery as per the standard specification.

The contractor shall provide the cabling between the MCC and the battery cabinet. A limit switch shall be provided in the battery box and UPS compartment for intruder alarm and wired to the PLC for remote monitoring via the telemetry system. The limit switch shall form part of the supply of the UPS and batteries.

PS ECI 5.1.1.14 Panel No. 15 (Local Distribution)

- 1 No 100 Amp TP Main Circuit Breaker and 3 phase busbars and earth bar from main busbars
- 1 No 80Amp TP CB (feed to Screens MCC/Control Panel)
- 1 No 80Amp TP CB (feed to DB/MCC for Clarifier and Filter actuated valves)
- 1 No 50Amp TP CB (feed to MCC for Sludge pumps)
- 2 No 20 Amp DP CB (spares)
- 2 No 30 Amp TP CB (spares)
- Future Domestic DB
- 6 No. 10Amp SP MCB for power supply to flow meter and spares etc
- Set Surge arrestors for power supply to telemetry cubicle and flow meter as specified
- Make allowance and space for future spare ways. A typed legend card must be installed in the DB compartment.

PS ECI 5.1.1.15 Panel No. 16 - Marshalling Panel

Adequate marshalling terminals, relays, bases etc shall be installed in this panel. Refer clause PS ECI 6.7 for all requirements.

PS ECI 5.1.1.16 Panel No. 17 - Level Transmitters

Allow for installation of three (3 off) Siemens Multiranger level transmitters in this panel for the sensors that are to be installed in the Screens and Flocculation basins.

Allow for suitable power supplies, protection breakers and surge arrestors for the level transmitters and other instruments.

PS ECI 5.2 400 Volt MCC03 - For Screens & Conveyor

The MCC and controls systems for the screens and conveyor shall be provided as a design and construct basis by the specialist screen and conveyor supplier. The electrical contractor will be responsible to take fee issue the MCC provided by others, install in position and connect up the panel.

The MCC design shall be undertaken by personnel who are able to demonstrate experience in the field of water treatment and pumping plant including PLC control and telemetry systems. The motor control panel components and installation methods and associated electrics shall comply strictly to the eThekweni Water standards and requirements all as specified in the detailed specification or elsewhere in the general specification. All equipment shall comply with the requirements of the EWS Standard Specifications included with this tender enquiry.

The MCC shall be floor mounted type with steel pedestals and fitted within the existing Chemical Building and generally in accordance with the Standard Specification. The panel shall be manufactured from min 1,6mm 3CR12 material. The supply voltage available on site is will be 400 Volts. The panel shall be designed for type 2 co-ordination.

All outdoor motors are to have earth leakage protection.

The starters for the screens and conveyors are to be VSDs.

Facilities shall be provided for separate compartments for each starter.

The screens and conveyors are to be manually and automatically controlled. In auto-mode the screens and conveyors are to be controlled by the differential level sensors installed in the screens structure. The speed will also automatically vary or be controlled by the differential levels.

All the signals from this Screens MCC03 shall be wired and integrated to the PLC & HMI in the Stirrer MCC02 which will be installed next to this MCC.

PS ECI 5.3 MCC/Controls For Backwash Recycle Pumps - Ex MCC01

The one existing recycle pump is to be replaced with two new upgraded pumps, 1 duty and 1 stand-by.

The recycle pumps are to be supplied from the existing 525V MCC which also supplies the existing high lift pumps.

The existing DOL starter for the existing 7,5kW recycle pump is to be removed and fitted with a new VSDs as described hereunder for Pump 1.

The spare cubicle in the existing MCC is to be fitted with a new VSD starter and controls as described hereunder for Pump 2.

PS ECI 5.3.1.1 Panel No. 1 (Backwash Recycle Pump 1)

525 Volt VSD Starter for 5,5 kW Recycle No. 1

The panel shall be generally as described in the Standard Specification and shall have be pad lockable and contain:

- 1 No. Suitably rated triple pole fused switch mechanically interlocked with the panel door. All live parts shall be fully shrouded.
- 1 No. HRC control fuse
- 1 No. Control link
- 1 No. 525V Motor Protection Breaker or similar approved to eThekweni standards, incorporating motor protection, overload, under-current and anti-single phasing protection
- 1 No VSD rated for the 525V 5,5kW Pump (TBC to suit final motor selected)
- 1 No Suitably rated control voltage circuit (fed from existing local smoothing transformer)
- 1 No Manual/Auto/Off selector switch
- 2 No Manual stop/start buttons

- 1 No Re-set push buttons
- 1 Set Power on / run / trip indicator lights (3 off)
- 1 No. Misc. ammeter with 96 mm dial
- 1 No. Suitably rated ammeter and current transformer
- 1 No Run hour meter and start counter
- 1 Set Control equipment, telemetry/PLC relays, contacts, timers etc. to automatically start, stop, trip and protect the pump from no-flow protection, suction sump low level protection as described in the control section. The pump shall be automatically (started and stopped) operated via levels in the sump. An ultrasonic level sensor shall be installed in the sump for this.
- 1 Set Circuitry for emergency stop locks

This panel shall be labelled “ Recycle Pump No. 1”

PS ECI 5.3.1.2 Panel No. 2 (Backwash Recycle Pump 2)

525 Volt VSD Starter for 5,5 kW Recycle No. 2

The panel shall be generally as described in the Standard Specification and shall have be pad lockable and contain:

- 1 No. Suitably rated triple pole fused switch mechanically interlocked with the panel door. All live parts shall be fully shrouded.
- 1 No. HRC control fuse
- 1 No. Control link
- 1 No. 525V Motor Protection Breaker or similar approved to eThekweni standards, incorporating motor protection, overload, under-current and anti-single phasing protection
- 1 No VSD rated for the 525V 5,5kW Pump (TBC to suit final motor selected)
- 1 No Suitably rated control voltage circuit (fed from local smoothing transformer)
- 1 No Manual/Auto/Off selector switch
- 2 No Manual stop/start buttons
- 1 No Re-set push buttons
- 1 Set Power on / run / trip indicator lights (3 off)
- 1 No. Misc. ammeter with 96 mm dial
- 1 No. Suitably rated ammeter and current transformer
- 1 No Run hour meter and start counter
- 1 Set Control equipment, telemetry/PLC relays, contacts, timers etc. to automatically start, stop, trip and protect the pump from no-flow protection, suction sump low level protection as described in the control section. The pump shall be automatically (started and stopped) operated via levels in the sump. An ultrasonic level sensor shall be installed in the sump for this.
- 1 Set Circuitry for emergency stop locks

This panel shall be labelled “ Recycle Pump No. 2”

All the pump status shall be wired back and integrated to the existing PLC and HMI in MCC01. The PLC and HMI shall be re-programmed or upgraded to suit.

PS ECI 5.4 400 Volt MCC04 - Sludge Pumps

PS ECI 5.4.1 General

The MCC design shall be undertaken by personnel who are able to demonstrate experience in the field of water treatment and pumping plant including PLC control and telemetry systems. The motor control panel components and installation methods and associated electrics shall comply strictly to the eThekweni Water standards and requirements all as specified in the detailed specification or elsewhere in the general specification. All equipment shall comply with the requirements of the EWS Standard Specifications included with this tender enquiry.

The MCC shall be wall mounted type outdoor weatherproof type and fitted within the existing Chemical Building and be generally in accordance with the Standard

Specification. The panel shall be manufactured from min 1,6mm 3CR12 material. The supply voltage available on site will be 400 Volts. The panel shall be designed for type 2 co-ordination.

The panel shall comprise the following:

PS ECI 5.4.1.1 Panel No. 1 – Incomer

This panel shall contain:

- One set of suitable sized three phase and neutral copper bus bars complete with support insulators in accordance with the Standard eThekwinini Specification. One substantial copper earthing bar complete with sufficient number of studs or bolts, nuts, and washers for the incoming and outgoing earth conductors.
- One 100Amp 400 Volts suitably rated triple pole switch lockable in the "off" position and shall be compliant with type 2 co-ordination. All live parts of the switch shall be shrouded to prevent inadvertent contact by maintenance personnel.
- 3 No. HRC Voltmeter fuses.
- 3 No. Current transformers.
- 1 No. Power meter Allen Bradley PM500 with facilities for phase / phase / neutral voltages and current on all 3 phases.
- 1 No. Set fuses with mains and phase failure relays incorporating phase loss, phase reversal, under voltage, over voltage and phase imbalance.
- 1 No. Power on indication light.
- 1 No. 4 Pole Surge arresters as specified in the Standard Specification.

PS ECI 5.4.1.2 Panel No. 2 - Distribution and Domestic

This panel shall be equipped with suitably rated 60 Amp 3 phase fused switch to feed the following station lighting, plugs and distribution:

- 6 No. 10Amp SP MCB for power supply to flow meter and spare
- Set Surge arrestors for power supply to telemetry cubicle and flow meter as specified
- 2 No 60A/30mA Earth leakage unit
- 2 No 20Amp SP CB - plug circuits
- 2 No 15Amp SP CB - light circuits
- 1 No 5Amp SP CB - spare
- 2 No 10Amp SP CB - spare
- Make allowance and space for future spare ways. A typed legend card must be installed in the DB compartment.

PS ECI 5.4.1.3 Panel No. 3 (Sludge Pump 1)

400 Volt VSD Starter for 5,5 kW Submersible Duty Pump No. 1 (kW to be confirmed)

The panel shall be generally as described in the Standard Specification and shall have be pad lockable and contain:

- 1 No. Suitably rated triple pole fused switch mechanically interlocked with the panel door. All live parts shall be fully shrouded.
- 1 No. HRC control fuse
- 1 No. Control link
- 1 No. 400V Motor Protection Breaker or similar approved to eThekwinini standards, incorporating motor protection, overload, under-current and anti-single phasing protection
- 1 No Elsec or similar earth leakage relay for submersible pump protection
- 1 No VSD starter 5,5kW (TBC to suit final motor selected)
- 1 No Transition timer
- 1 No Suitably rated control voltage circuit (fed from local smoothing transformer)
- 1 No Manual/Auto/Off selector switch
- 2 No Manual stop/start buttons
- 1 No Re-set push button

- 1 Set Power on / run / trip indicator lights (3 off)
- 1 No. Misc. ammeter with 96 mm dial
- 1 No. Suitably rated ammeter and current transformer
- 1 No Run hour meter and start counter
- 1 Set Control equipment, relays, contacts, timers, etc. to automatically start, stop and trip the sludge pumps. The pumps are to be operated by levels in the sump and adjustable timers programmed in the PLC
The pumps shall also be stopped when there is no flow in the pump discharge pipework and if the sump levels are low below the set point. No flow switches are to be fitted to the pipework and low level electrodes installed in the pump sump.
- 1 Set Circuitry for emergency stop locks

This panel shall be labelled " Sludge Pump No. 1 "

PS ECI 5.4.1.4 Panel No. 4 (Sludge Pump 2)

VSD Starter for 5,5kW 400 Volt Submersible Sludge Pump 2 (TBC)

This panel shall be identical to the panel No. 3 for Sludge Pump No. 1

This panel shall be labelled " Sludge Pump 2 "

PS ECI 5.4.1.5 Panel No 5 (Future PLC & HMI)

Panel 5 shall be for future PLC & HMI to be equipped as per the EWS standard specifications.

Note : All the pump and motors status and other signals from this panel in to integrate to the PLC & HMI in MCC02.

PS ECI 5.4.1.6 Panel No 6 (Auto Control)

This panel shall be equipped as follows :

1 No. Control circuit HR fuse
1 No. Neutral link
Set surge arrestors as required
Fuses and CBs as required
Control circuits, timers etc
Re-sets and trip re-sets etc as required
24V DC power supply for instruments

Adequate marshalling and control terminals, relays, bases etc shall be installed in this panel.

PS ECI 5.4.1.7 Panel No. 7 (Future UPS and backup batteries)

The panel shall be a panel for future PLC & HMI to be equipped as per the EWS standard specifications.

PS ECI 5.4.1.8 Panel No. 8 (Local Distribution)

- 1 No 100 Amp TP Main Circuit Breaker and 3 phase busbars and earth bar from main busbars
- 1 No 80Amp TP CB (feed to Screens MMC/Control Panel)
- 2 No 20 Amp DP CB (spares)
- 2 No 20 Amp TP CB (spares)

PS ECI 5.4.1.9 Panel No. 9 - Marshalling Panel

Adequate Marshalling terminals. Refer clause PS ECI 6.7 for all requirements.

PS ECI 5.4.1.10 Panel No. 10 - Level Transmitters

Allow for installation of two (2 off) Siemens Multiranger level transmitters in this panel

Allow for suitable power supplies and protection breakers for the level transmitters

PS ECI 5.5 MCC05 - Clarifiers & Filters Electric Actuated Valves**PS ECI 5.5.1 General**

The MCC design shall be undertaken by personnel who are able to demonstrate experience in the field of water treatment and pumping plant including PLC control and telemetry systems. The motor control panel components and installation methods and associated electrics shall comply strictly to the eThekweni Water standards and requirements all as specified in the detailed specification or elsewhere in the general specification. All equipment shall comply with the requirements of the EWS Standard Specifications included with this tender enquiry.

The MCC shall be floor mounted outdoor weatherproof type with steel pedestals and fitted within the existing Chemical Building and generally in accordance with the Standard Specification. The panel shall be manufactured from min 1,6mm 3CR12 material. The supply voltage available on site will be 400 Volts fed from the 525V/400V transformer. The panel shall be designed for type 2 co-ordination.

The panel shall comprise the following:

PS ECI 5.5.1.1 Panel No. 1 – Incomer

This panel shall contain:

- One set of suitable sized three phase and neutral copper bus bars complete with support insulators in accordance with the Standard eThekweni Specification. One substantial copper earthing bar complete with sufficient number of studs or bolts, nuts, and washers for the incoming and outgoing earth conductors.
- One 100Amp 400 Volts suitably rated triple pole switch lockable in the "off" position and shall be compliant with type 2 co-ordination. All live parts of the switch shall be shrouded to prevent inadvertent contact by maintenance personnel.
- 3 No. HRC Voltmeter fuses.
- 3 No. Current transformers.
- 1 No. Power meter Allen Bradley PM500 with facilities for phase / phase / neutral voltages and current on all 3 phases.
- 1 No. Set fuses with mains and phase failure relays incorporating phase loss, phase reversal, under voltage, over voltage and phase imbalance.
- 1 No. Power on indication light.
- 1 No. 4 Pole Surge arresters as specified in the Standard Specification.

PS ECI 5.5.1.2 Panel No. 2 - Distribution and Domestic

This panel shall be equipped with suitably rated 100 Amp 3 phase fused switch to feed the following equipment , station lighting, plugs and distribution:

- Suitably rated main switch
- Set three phase surge arrestors
- 16 No. 10Amp MCB for power supply to electric actuators for clarifier de-sludge valves and scour for the clarifiers 1 - 6
- 16 No. 10Amp MCB for power supply to electric actuators for filter backwash and air blower valves for the filters 1 - 6 clarifiers
- Make allowance and space for future spare ways. A typed legend card must be installed in the DB compartment.

PS ECI 5.5.1.3 Panel No 3 (PLC & HMI)

The panel shall be equipped as follows with EWS specified equipment :

- 1 No. Control circuit HRC fuse
- 1 No. Neutral link
- 1 No. PLC & 15" HMI as specified
- PLC controller & CPU
- Digital Input and Output Cards
- Analogue Input Card
- Expansion Modules & Spare Cards
- Ethernet Switch
- Wireless Router
- Modbus Serial Module and Power Monitor as required
- Surge arrestors as required. (all field devices should be surge protected)
- Any other equipment as required
- Laptop flip table

Note : The PLC & HMI in this panel shall integrate and send all signals and inputs to the PLC in the Screens MCC02 and the on site SCADA.

The control of the electric actuators shall be in accordance with the FDS document and per the Hazop report.

PS ECI 5.5.1.4 Panel No. 4 (UPS and backup batteries)

The UPS, battery charger and batteries as specified under the standard specification shall be installed in this cubicle. The battery shall be installed in a separate cubicle within the MCC or in a separate cabinet all to eThekweni standard specifications. The battery shall be 2 x 90 Amp Hour 12V DC Deltec deep cycle battery as per the standard specification.

The contractor shall provide the cabling between the MCC and the battery cabinet. A limit switch shall be provided in the battery box and UPS compartment for intruder alarm and wired to the PLC for remote monitoring via the telemetry system. The limit switch shall form part of the supply of the UPS and batteries.

PS ECI 5.5.1.5 Panel No. 5 - Marshalling Panel

Adequate Marshalling terminals. Refer clause PS ECI 6.7 for requirements

PS ECI 5.5.1.6 Panel No. 6 - Auto Control

This panel shall be equipped as follows :

- 1 No. Control circuit HR fuse
- 1 No. Neutral link
- Set surge arrestors as required
- Fuses and CBs as required
- Control circuits, timers etc
- Re-sets and trip re-sets etc as required
- 24V DC power supply for instruments

Adequate marshalling and control terminals, relays, bases etc shall be installed in this panel.

PS ECI 5.6 Distribution Boards

PS ECI 5.6.1 Admin Building DB – A1 :

A flush mounted DB with lockable door is required to be installed in the new Admin Offices. The DB is to be manufactured from 3CR12 sheeting and epoxy powder coated white. The DB shall be fitted with a legend card and labelled appropriately.

The specification for the DB shall be as per the drawing No D791-51-1500 Sht 1/2

Note : Adequate surge protection shall be provided for all DBs and control panels.

PS ECI 5.6.2 Gatehouse DB – G1

A surface mounted DB with lockable door is required to be installed in the new Guard House . The DB is to be manufactured from 3CR12 sheeting and epoxy powder coated white. The DB shall be fitted with a legend card and labelled appropriately.

The DB shall be equipped as follows :

- 40Amp DP Main Switch
- 2 x Surge arrestors
- 1 x 60Amp/30mA earth leakage relay
- 2 x 10Amp SP CB (Lights)
- 2 x 20Amp SP CB (plugs)
- 1 x 10Amp SP CB (photocell)
- 1 x 5Amp SP CB (photocell by-pass circuit)
- Make allowance for 40% spare ways

PS ECI 5.6.3 525/400volt Lighting Transformer

A 200kVA 525/400V Dyn 11 small power and lighting transformer is required for the additional equipment, lighting and small power on site. The transformer shall be an outdoor type.

The transformer is to replace the existing 100kVA transformer which is too small for all the additional loads.

The transformer shall be installed on a plinth in the existing position on site adjacent the new existing MCC Building.

Suitable cable boxes shall be provided on the primary and secondary side of the cable bushes for termination of the PVC ECC SWA PVC cables as per the cable schedule. The transformer shall be provided with a substantial earth bar.

Please refer to the Annexure B for other details required. The tenderer shall complete the compulsory returnable schedule and complete all other required relevant information and submit with the tender. Failure to do this may disqualify the tenderer.

Full details of the transformer unit together with a GA drawings, wiring diagrams and parts lists and equipment schedule shall be submitted at tender stage.

PS ECI 6 OPERATING AND CONTROL PHILOSOPHY OF THE PUMPS & SCREENS, MIXERS ETC

This specification covers the operating and control philosophy for the existing high lift pumps and other existing and new equipment at the existing Tongaat WTW.

Any deviations or changes from the operating and control features described here must be agreed upon between EWS and the Contractor in writing. The finally agreed upon operating and control philosophy must be included in the O&M manuals which will be submitted by the Electrical Contractor to EWS at the end of the contract.

PS ECI 6.1 Tongaat WTW High Lift Pumps

The existing high lift pumps MCC has starters and control systems for the following pumping systems:

- Mamba Ridge (Including Jan Roz & Burbreeze (2 Duty, 1 stand-by)
- Tongaat South (1 duty, 1 stand-by)
- Hambanathi (1 duty, 1 stand-by)
- Emona/Belvedere (1 duty, 1 stand-by)
- Metcalfe (1 duty, 1 stand-by)

Each set of pumps will have two or three pump starters (duty and stand-by) which will be controlled by the PLC. The pumps have existing star-delta or DOL starters which

will control the pumps that will pump water to the existing remote command reservoirs. The starters for the existing backwash pumps and the new backwash recycle pumps are to be replaced with VSD starters.

The Pumps shall operate in three distinct modes of control, namely Automatic, Manual and Tele-override. Currently some of the pumps are controlled manually and some controlled via pressure transmitters installed on the rising main pipelines.

EWS are currently installing telemetry systems at the remote command reservoirs for the automatic starting and stopping of the pumps from the pump station at the WTW.

The various duty and stand-by pump/s call shall be cycled after every start. Interlocking shall be provided that only one pump shall start at any time in both manual and tele-control modes. This shall be done by the function of the PLC.

The final control system shall be as detailed and specified in the FDS (Functional Design Specification) and Hazop Report.

PS ECI 6.2 Stirrers, Screens/Conveyors & Actuated Valves

In manual mode, the stirrers will be manually controlled by the stop and start buttons on the MCC. In auto-mode the stirrers will be controlled by adjustable timers built into the PLC.

In override mode, the stirrers will be controlled from the on-site SCADA.

In manual mode, the screens and conveyors will be manually controlled by the stop and start buttons on the MCC. In auto-mode the screens and conveyors will be controlled by differential level sensors installed across the screens in the screens basin. The speed of the screens and conveyors will be automatically adjustable via VSDs installed in the MCC by a function of the PLC

In override mode, the screens and conveyors will be controlled from the on-site SCADA.

The final control system shall be as detailed and specified in the FDS (Functional Design Specification) and Hazop Report

PS ECI 6.3 Clarifier And Filters

The Clarifier de-sludge valves will be controlled by adjustable timers built into the PLC. Alternatively they can be manually opened and closed at the local controls built into the actuators.

The automatic backwashing sequence of the filters shall be done by the PLC program on an adjustable timer based system for the opening and closing of the backwash and air blower valves. A local filter control panel will be installed for each filter where the backwashing sequence can be manually initiated from the control panel if required.

The automatic and manual operation of the filter backwashing and rinsing sequence will start and stop the backwash pumps and air blowers as required.

The final control system shall be as detailed and specified in the FDS (Functional Design Specification) and Hazop Report

PS ECI 6.4 Chemical & Chlorine Dosing Systems

The chemical and chlorine dosing systems are to be automated by the function of the PLC in MCC02. The dosing rates shall be proportional to the incoming flow into the works.

The existing control panels for the chemical dosing and chlorine dosing system shall be integrated to the PLC in MCC02 which will be in the same vicinity to each other.

The entire dosing system is to shut down should there be no flow into the works.

The final controls for the chemical and chlorine dosing systems shall be as detailed and specified in the FDS (Functional Design Specification) and Hazop Report.

PS ECI 6.5 Automatic Mode (For All Pumps)

The final controls for all the pumping systems shall be as detailed as specified in the FDS (Functional Design Specification) and the Hazop report.

a) EXISTING HIGH LIFT PUMPS

As an interim measure, the existing high lift pumps is operated via a pressure switch installed on the delivery main of the pumps. A control valve or shut-off valve is installed on the inlet of the reservoirs (for each pumping line) and create a back-pressure when the reservoir is full and cut-off the pumps when the pressure rises above the set-point. The pumps will re-start via built-in restart and run timers after a set pre-determined time. The above is a temporary measure until such time as the telemetry systems become fully functional.

Facilities are provided for the pump/s to operate automatically via telemetry start and stop signals from their respective remote command reservoirs. Radio telemetry systems are to be installed at the reservoirs installed under this contract. The pumps must operate on a duty- standby philosophy. In both manual and tele-control mode, only one pump must run at a time and there must be an interlock programmed into the PLC to prevent the standby pump/s from starting while the duty/s pumps are running. The interlock must only inhibit the pump when a start attempt is made. The duty pump must be automatically rotated by the PLC after every start.

A pressure sustaining control valve is installed on the delivery main of each pumping system and will be incorporated and have a circuit built into the control system for opening and closing of the valve in both auto and manual modes with built in timer and control circuits etc. The control valve will have limit switches and other controls which must be incorporated and built into the control system for soft stopping and starting of the pumps. The control valve must open before the pump starts up and must close before the pump shuts down to be set during commissioning.

b) BACKWASH RECYCLE PUMP AND SLUDGE PUMPS

The backwash recycle pumps and sludge pumps shall be automatically controlled by the levels in their respective sumps by set points built into the level sensors and the PLC.

The pumps must operate on a duty- standby philosophy. In both manual and SCADA control mode, only one pump must run at a time and there must be an interlock programmed into the PLC to prevent the standby pump from starting while the duty/s pumps are running. The interlock must only inhibit the pump when a start attempt is made. The duty pump must be automatically rotated by the PLC after every start.

c) GENERAL

In Manual Mode, all pumps shall operate when they are locally selected to do so, using the Auto/Manual/Off selector switch and the push buttons on the panel door.

Each pump must have, "Overload Trip" and "Under-Current Protection " or earth leakage trip for submersible pumps. All pump trip signals must be taken to the PLC to de-energize a "Pump Inhibit" relay which will trip the pump.

A no-flow switch shall be installed on the delivery side of each pump to trip the pump should a no flow condition arise. This is to protect the pump from dry running. Low level floats shall be installed in the clear water suction reservoirs or backwash and sludge channels or sumps to cut out the duty pumps should the levels are low. These levels shall be determined on site later. There should be no hard-wired trip signals (besides the inhibit, low level cut-out, etc) wired into the pump control circuit (unless agreed with EWS during review of the electrical drawings).

Where specified, thermistors installed in the pump and motor shall trip the pump in an over-temp situation. Pump temperature sensors installed in the pump shall trip the pump

in an excessive temperature situation.

Moisture or oil contamination sensors built into submersible pumps shall trip the pump should a problem occur.

When the pump inhibit relay is activated, the inhibit indication lamp on the pump panel must also be activated and the stand-by pump started, if ready and available. Pumps must automatically start up after a trip has been reset/cleared. Should any pump fail to start, after a period of 10 seconds, the next available pump should be requested to do so.

The duty pump/s must automatically start up after power is restored in the event of a power failure. All pumps must be limited to a maximum of ten starts per hour (to be set on the HMI). All other protection and other features, as mentioned in the contract document and standard specifications must be incorporated as required.

Note :

Interlocking of the pumps shall be implemented in the PLC and control system so that there are not more than one pump starting at any time. This shall be interlocked in both auto and manual modes.

All pumps shall be automatically rotated by the PLC program.

PS ECI 6.6 Telemetry (For All Pumps)

A "Telemetry or SCADA Control" feature must be incorporated into the design which will provide remote control (starting and stopping of pumps) from the Water Control Room or the local on-site SCADA system. This feature will only be applicable when the pumps are in Automatic mode. The Control Room shall be capable of remotely switching telemetry or SCADA control on/off, and capable of starting/stopping each pump individually when telemetry control is on. The pump interlocks must still be active in the tele-control mode.

Telemetry communications from the PLC to the Telemetry unit will be via serial cable. Remote control shall be via telemetry radio communication. Refer to the standard EWS PLC specification for the requirements and typical draft I/O list. The final I/O list shall be prepared and submitted by the contractor.

Provision should be made in the PLC program to ensure that when the "phase fail" signal is active it does not result in every other signal erroneously being sent through to Telemetry as well.

All high lift pumps shall be automatically controlled by levels in their respective remote command terminal reservoir/s via the telemetry system.

PS ECI 6.7 Marshalling

Signals shall include but are not limited to what is required below. Refer to the typical I/O lists under the PLC specifications for the full requirements. The final I/O lists shall be determined by the contractor and as determined from the FDS document and Hazop report.

The following minimum signals shall be provided as specified in the project and standard Specification and is applicable for all pumps, blowers, stirrers, screens & conveyors etc and other ancillary equipment :

PS ECI 6.7.1 Mains and Pump Signals:

- Power on/off
- Phase failure
- Auto / manual / off
- ELU trip/fault
- Mains fail, phase fail, over and under voltage

- Pumps run/stop
- Pumps trip
- Pumps run hours
- No flow trip
- Low level trip
- Pressure
- Actuated valve opened/closed/valve position
- E-Stop
- Temperature trip
- Thermistor (optional if installed)
- Over temperature
- Moisture or oil contamination
- Earth leakage fault

PS ECI 6.7.2 Instrumentation Signals:

- Pump/s call and stop signals
- Pumps no flow trip
- Reservoir and sump low level trip
- Local and Remote Reservoir levels
- Local and Remote Reservoir high level
- Local and Remote Reservoir low level
- Suction reservoir or sump low level trip
- Local reservoir and sump levels
- Flow meter signals (electronic meter)
- Flow meter signals (mechanical meter, where provided)
- MCC Room intruder alarm and battery box intruder alarm (wire into panel/plc)
- Fire alarm with local control panel (wire into panel/plc)
- 24V DC fuse fail
- Other signals as determined with EWS and the contractor

Note: Fire alarm detectors and PIR sensors shall be supplied by the electrical contractor.

PS ECI 6.7.3 Pumps & Blowers Remote Control Panel

All the high lift pumps, backwash pumps, backwash channel pump, sump pump, backwash recycle pumps etc as indicated or specified under the MCCs and control are shall be remotely controlled from the existing remote control panel installed in the lower level of the high lift pump room. The main controls are installed in their respective MCC/s.

Each pump or other equipment (refer to the MCC specifications for quantity) shall comprise a remote stop/start push button with run/stopped/tripped indication lights for both duty and stand-by pumps. The remote emergency stop locks (measured elsewhere) and wired to the main MCC shall stop the pump in an emergency. The panel shall be labelled to indicate which buttons or lights corresponds to which pump, blower or other equipment it operates.

The existing remote panel and controls is to be modified for remote operation of the new backwash recycle pumps and sludge pumps. A provisional sum is allowed for this work.

The contractor shall provide GA drawings, wiring diagrams and parts and equipment lists of the panel for comments and approval prior to manufacture.

PS ECI 7 PLC/HMI SPECIFICATION AND REQUIREMENTS

Refer to EWS latest PLC_Specification_Rev06 for the PLC and HMI requirements and details. HMI to be a minimum of 15 inch to EWS specifications.

PS ECI 7.1 PROGRAM / SCHEDULE/ MANAGEMENT

The electrical contractor must provide a program or project schedule clearly indicating the start date from award of contract and the estimated completion date. The program must address the following as a minimum:

- Logical flow of activities, milestones and deliverables
- The schedule must be realistic in relation to provided key resources and sub-contractors. (WBS)
- Include verifiable milestones, e.g. PLC development complete, equipment ordering complete, Factory Acceptance testing etc.
- Clearly indicate the critical path on the program (if applicable).
- The schedule must be resource loaded to show which resources (OEM, Tenderer, sub-contractor, EWS and others) will be completing each activity. (RACI Matrix)
- Make provisions for lead times (hardware ordering times, Client approval times, etc.) Include schedule assumptions to help the evaluation team understand how certain duration were estimated or arrived at and others.
- The contractor must provide a Project Communications Plan, implement a Change Management Request Process as well as a Lessons learnt Register on Handover.

PS ECI 7.2 INTELLECTUAL PROPERTY

All Intellectual Property developed in the course of a contractual relationship with the Municipality during this project shall remain in full control of the Municipality in terms of ownership and control rights. Intellectual Property rights assigned to the Municipality shall include but not be limited to the following:

PS ECI 7.3 WORKS RELATED DESIGN AND DOCUMENTATION

The Contractor grants the Municipality the right in accordance with the provisions of Section 22 of the Copyright Act 1978:

- The PLC Code will not be protected or locked in any way
- To copy any plan, diagram, drawing, document, specification, bill of quantities, design, calculations, works specific software developments and configurations, e.g. standard templates, mimics, reports, etc. or any other similar document made by the Contractor in connection with the works;
- To make free and unrestricted use thereof for its own purposes, modify same or have it modified by a third party for any reasons, without obtaining permission from the Contractor.
- To provide copies thereof to others (third party Contractors or Consultants of the Municipality) to be used by them for purposes of tendering, consultancy or service delivery.

PS ECI 7.4 TESTING/ COMMISSIONING

Refer to QualityControl_Rev03 Specification for the testing and commissioning procedures, specifications and details for the PLC and HMI.

It is a requirement that the designer and manufacturer of the MCC be present for the FAT and for the site testing and commissioning of the MCC and associated electrical installations. The PLC system integrator shall also be present for these activities.

PS ECI 7.5 Other

The PLC will be programmed by a specialist employed by the supplier of the motor control panel in consultation with EWS Mechanical and Electrical Branch and the Control and Instrumentation Branch. The specialist shall be a qualified and experienced system integrated using Siemens or equivalent software and hardware and programming tools. All testing and commissioning shall be undertaken by the system integrator.

The project will not be signed off for payment before all snags identified in the preliminary inspection are complete and a compliance certificate and test report is issued.

- a) The PLC system integrator must be a Recognized Siemens System Integrator or to suit any similar and equal approved PLC supplier. Proof of this must be submitted with the tender. The PLC shall be programmed by a specialist and a copy of the program shall be submitted and included in the hand-over documentation.
- b) The PLC systems proposed shall be provided to convert all the data from the instruments, motor control and control systems and to communicate to the SCADA system. The PLC system for the treatment process and pumping systems will be located in the existing and new MCCs. The PLC for MCC01 is existing. New PLCs are required in the following MCCs and buildings:
 - MCC02 - New Stirrers MCC (including inputs from the Screens MCC)
 - MCC05 - Actuated Valves MCC (for clarifiers and filters)

The MCC03 for the Screens and Conveyors and the MCC04 for the Sludge Pumps are to be connected and integrated to the PLC & HMI in MCC02.

The existing chemical dosing and chlorine dosing control panels (separate panels) are also to be integrated to the PLC & HMI in MCC02.

The new backwash recycle pumps are to be connected and integrated to the existing MCC01. The backwash pumps are supplied and controlled from MCC01. The PLC and HMI in this panel is to be upgraded and re-programmed.

The PLC will act as an interface between the process components (e.g. Motors, valves, measuring instruments, etc.) and the SCADA system, and as such, will perform the following main tasks and have the following features:

- Process signal acquisition, Process signal output, and Process automation task, transfer of collected data to the monitoring and supervisory system.
- The Process signal acquisition and output shall be by means of suitable signal formation modules for both digital and analogue values.

PS ECI 7.6

Construction

The PLC shall be of the Siemens S7 or equivalent and similar approved by the Employer's Representative or Engineer and be in accordance with the latest version of the EWS Standard Specifications for PLCs _ Rev06 . All equipment to be housed in IP65 Orange or Grey Enclosure with door mount HMI based on new ICASA specifications and where specified are required to be large enough to house a 3kVA single phase UPS. Where required there will be approximately 8 x VSD outputs, with I/O modules having fused terminal blocks. Communication shall be Ethernet. Latest versions of Siemens 15" HMI's compatible with the above PLC's and in accordance with EWS standard specification shall be installed in the door of the PLC panel for the above mentioned MCCs. Full details of the PLC operating and control philosophy shall be prepared and submitted with the necessary relevant FDS and P&ID's by the electrical contractor and control panel builder. The preliminary FDS and P&IDs are submitted with this tender and is to be updated as required by the contractor.

Full technical details and specification of the PLC and HMI proposed shall be supplied with the tender for evaluation and approval.

PS ECI 7.7

Water Treatment Process And Pump Station Instrumentation System

The required PLC & instrumentation equipment indicated on the P&IDs & FDS are to be prepared by the control panel builder will control the entire water treatment and pumping systems and linked to the SCADA to control and monitor the system. The final P &IDs and FDS is to be prepared and submitted by the control panel manufacturer. All new instruments are proposed to be tied into the SCADA system at the Tongaat Treatment Works Control Room and the remote EWS Control Room in Pinetown.

PS ECI 7.8

General

The SCADA AND PLC system shall include for all hardware, software engineering system design, programming, layouts, screen pages and wiring drawings etc complete in all respects. Full details of the system shall be provided with the tender offer. The programming shall be undertaken by a specialist system integrator who is qualified and experienced with the hardware and software for the equipment supplied.

The PLC will be programmed by a specialist employed by the supplier of the motor control panel in consultation with EWS Mechanical and Electrical Branch and the Control and Instrumentation Branch. The specialist shall be a qualified and experienced system integrated using EWS approved software and hardware and programming tools. All testing and commissioning shall be undertaken by the system integrator.

The project will not be signed off for payment before all snags identified in the preliminary inspection are complete and a compliance certificate and test report is issued.

A provisional sum has been allowed in the contract for the modifications and upgrading of PLC and HMI in the existing MCC01 and for re-programming by a specialist system integrator.

PS ECI 7.9 SCADA

The Tongaat WTW Control Room will consist of a new Control and Data Acquisition (SCADA) system which is used for the monitoring and partial control of the water treatment and pumping process. Currently the existing WTW does not have a SCADA and all monition etc is being done at the EWS Control Room in Pinetown.

A full new SCADA system per the Client standard instrumentation specifications is required to provide automatic control and monitoring information at the plant.

The proposed SCADA System is allowed for the new equipment and existing equipment and MCCs for the water treatment processes and pumping systems. The SCADA design and installation work shall be undertaken by an EWS approved specialist in this field and who is familiar and experienced with EWS projects.

The SCADA hardware shall be rack mounted and installed in a suitable position in the New Control Room. As a minimum the system to include the server and PC with 6 x HMI outputs, 1 x 55 inch monitor, and associated input equipment to be situated on the control desk. A 6KVA UPS will be required to power the SCADA.

The SCADA system proposed is the GeoSCADA (latest version) Agent Server Version with 8-75 Scanned Points , or similar and equal approved by the Employer's Representative or Engineer. The SCADA system will be provided to monitor and automatically control the entire treatment process, pumping and chemical dosing systems based on inputs received from the various water and process monitoring instruments. The full SCADA system integrates the total treatment, process, pumping and dosing systems and provides early warnings for critical elements to prevent damage to equipment and injury to personnel.

The SCADA system will be provided in the new Control Room and linked to the various components via data and instrumentation cabling. A computer system shall incorporate the SCADA software incorporating an overview of the entire water treatment process, pumping and dosing systems etc including screen pages and will provide interlocks, trends, alarms and historical data of the system. The SCADA system will be linked by hard wire ethernet or fibre cabling or telemetry to the proposed PLC systems in the following MCCs or buildings:

- MCC01 - Existing High Lift Pumps MCC
- MCC02 - New Stirrers MCC (including inputs from the Screens MCC)
- MCC05 - Actuated Valves MCC (for clarifiers and filters)

The communication between the PLC to Scada shall be via ethernet of fibre cabling. It shall be Ethernet enabled.

Remote communication shall be GSM telemetry systems.

The standard viewing and basic control operator screens include:

- Main Menu
- Single Line Diagrams
- Process P&ID's
- Instrument Data and Status
- Interlocks
- Trending
- Alarms
- Event Logs

The full requirements for the SCADA system shall be prepared and submitted in the FDS and P & IDs by the electrical and control panel builder contractor.

The SCADA, PLC & HMI systems shall include for all hardware, software engineering system design, programming, layouts, screen pages and wiring drawings etc complete in all respects. Full details of the system shall be provided with the tender offer. The programming shall be undertaken by a specialist system integrator who is qualified and experienced with the hardware and software for the equipment supplied.

Full technical details and specification of the SCADA system proposed shall be supplied with the tender for evaluation and approval.

PS ECI 7.10 Operating Philosophy Of The Pump Station

The control philosophy for the potable water and other pumping systems are fully described under the PLC auto control or manual control section for each MCC.

PS ECI 8 DOMESTIC ELECTRICAL, LIGHTING & POWER INSTALLATION

The electrical contractor shall be responsible for the supply, installation, testing and commissioning of the light points, switches, socket outlets, isolators, light fittings, conductors and wiring in the Pump Station buildings, MCC and telemetry rooms, Chemical Buildings, Admin Building, Gatehouse etc where applicable all as directed by the Engineer to the Contractor on site or as specified and quantified in the Schedule of Quantities.

PS ECI 8.1 Wiring:

Lighting - 1,5 mm² + earth
Sockets - 2,5 mm² + earth.

The entire electrical supply and installation work shall be in accordance with SANS 10142-1 latest amendment and the regulations of the OSH Act (Act 85 of 1993) and any contingent regulations. All work to be neat, parallel, level, uniform etc. Wiring shall be in galvanised bosal conduit.

PS ECI 8.2 Internal Lighting And Power Outlets:

Light fittings are to be installed in the concrete roof of the pump station/MCC rooms, telemetry room. Admin Building, Guard House etc or as shown on the drawings or as directed on site and wired back to the local DB in bosal or PVC conduit. A one or two lever one-way light switch is to be installed inside the for the lighting systems in pump stations or other rooms and buildings near the doors at a height of 1.4 meters above FFL. All lighting shall be LED or other type as specified.

Double or single socket outlets are to be installed within one meter of the MCC and telemetry room and in other building in positions as indicated on the drawings at a height of 1.2 or 0,3 meters above FFL. Socket outlets or other power piunts in other rooms and buildings are to be installed as shown on the drawings. All lights and plugs are to be wired using GP wire in 20mm bosal or PVC conduit in accordance SANS 10142-1.

All circuits must be clearly marked on the face of the DB panel.

PS ECI 9 OUTSIDE LIGHTING

External lighting shall consist of external bulkhead or floodlight light fittings with LED lamps as specified in the SOQ and shall be mounted on buildings or pole mounted around the site. The luminaires shall be operated by means of a photocell and a by-pass switch in the MCCs or DBs all in accordance with the standard specification.

PS ECI 10 LIGHT FITTINGS

The light luminaries as specified in the schedule of quantities shall be supplied and installed complete with lamps, etc. All luminaires shall be guaranteed for a period of 12 months from the date of the completion certificate. Alternatives shall be considered if similarly approved. Lamps and control gear shall bear the SABS mark of approval.

PS ECI 11 CABLES, CABLE TRAY, TRENCHING AND CABLE MARKERS

PS ECI 11.1 General

All power cabling shall be PVC/SWA/ECC/PVC, with copper conductors to SANS 1507. Cables shall be buried at a depth of min 500mm. Power cable glands and shrouds shall comply with SANS 1213 type Pratley or similar approved. Cables shall be full length point to point, no joints will be permitted.

All instrumentation cabling shall be multi strand copper braided cable or multi strand twisted pair cable. Installed in a sleeve or fixed to cable tray.

Instrumentation cable glands and shrouds shall be type Pratley, CCG or similar approved brass compression or as approved by the Client or Engineer. Each cable end shall be labelled with a Bowthorpe Hellerman or similar type PK tag showing the cable details as indicated in Appendix A in the standard specification.

Cable tray shall be of the Cabstrut or as approved pre-galvanised epoxy painted, medium duty tray supported on the wall by galvanised P2000 at intervals not exceeding one meter on the vertical or 750 mm on the horizontal, or P2000 cantilever arm if secured to the floor.

All trenches for low voltage and control cables are to be 600mm deep and 400mm wide.

Cable marking tape 150mm wide is to be installed at a depth of 300mm below ground line. All trenches must be inspected before they are backfilled. The trench must be back filled and compacted with a plate compactor in layers not exceeding 150mm. Ducts must be installed complete with 1.6mm galvanised draw wire. Two ducts may be laid in the same trench at a minimum distance of 150mm apart. All bends must be the long radius type. No more than 500 metres of excavation may be left open at a time. Excavations may not be left open especially over the December / January builders shut down period.

Cable markers shall be LG Green or similar and are to be installed at distances not exceeding 10 meters and at every change of direction. Markers are to consist of a concrete block 100mm c 100mm x 300mm and installed in the vertical position. An aluminium plate 75 x 75mm is to be embedded in the concrete or secured to the top of the block by means of two ram set screws 25mm long. The plate is to be punched with numbers and arrows on smaller than 10mm.

Installed cabling shall be made vandal proof which includes encasing the cables in concrete by the civil contractor. Cables shall be installed in sleeves and manholes. Where required, manholes shall be constructed by the civil contractor.

PS ECI 11.2 CABLES TO MCC, MOTORS AND OTHER EQUIPMENT

The electrical contractor shall supply, deliver to site, lay in cable ducts or sleeves and in ground or on surfaces the power and associated control cables for the various motors, between panels of the distribution board, the isolators, motor junction boxes, associated stop push buttons, motors, motor heaters, level electrodes, flow switches, etc.

He shall connect up the cables at all ends and then test and commission the various plant electrical installations.

Refer to Telemetry and Instrument Specification Revision 00, Section 17.

PS ECI 11.3 CABLE SCHEDULE

The contractor shall be responsible to provide the correct size and rated cabling for each application to be measured on site. Cables shall be full length and jointed cables will not be permitted. All lengths are re-measurable, and payment will be made for actual lengths installed.

Note each operating / safety device is to be supplied with a separate cable to a IP65 CCG box or weatherproof isolator at the device. Multi-core cables run to two or more devices will not be acceptable.

The following minimum cables are required and as itemised in the schedule of quantities:

WATER TREATMENT PLANT & PUMPING SYSTEMS AND SITE WIDE RETICULATION

NO	DESCRIPTION	FROM	TO	FUNCTION	LENGTH (m)
1	150 mm ² x 4c PVC ECC SWA PVC	New 200kVA 525/400Volt Transformer	New MCC02 Stirrers	Power	To measure on site
2	35 mm ² x 4c PVC ECC SWA PVC	MCC02	New Screens MCC03	Power	
3	35mm ² x 3c PVC ECC SWA PVC	MCC02	MCC05 - Clarifier & Filter Actuated Valves	Power	
4	35mm ² x 3c PVC ECC SWA PVC	MCC02	MCC04 Sludge Pumps	Power	
5	2,5mm ² x 3c PVC ECC SWA PVC	MCC02	All stirrer motors 1- 8	Power	
6	6mm ² x 3c PVC ECC SWA PVC	MCC03	Screens motor 1	Power	
7	6mm ² x 3c PVC ECC SWA PVC	MCC03	Conveyor motor 2	Power	
8	10mm ² x 3c PVC ECC SWA PVC	Ex MCC01	Recycle pump motors 1 - 2	Power	
9	10mm ² x 3c PVC ECC SWA PVC	MCCC04	Sludge pump motors 1 - 2	Power	
10	2,5mm ² x 14c PVC ECC SWA PVC	MCC05	Filter Control Panels 1 - 6 Filters	Power	
11	1,5mm ² x 14c PVC ECC SWA PVC	MCC05	Backwash Pumps Controls	Power & Controls	
12	1,5mm ² x 7c PVC ECC SWA PVC	MCC05	Air Blower Controls	Power & Controls	
13	1,5mm ² x 3c PVC ECC SWA PVC	MCC01	Recycle Pumps No-Flow Switch	Power & Controls	
14	1,5mm ² x 4c PVC ECC SWA PVC	MCC01	Recycle Pumps Low Level Floats	Power & Controls	
15	1,5mm ² x 4c PVC ECC SWA PVC	MCC01	Recycle Pumps E-Stop	Power & Controls	

NO	DESCRIPTION	FROM	TO	FUNCTION	LENGTH (m)
16	1,5mm ² x 3c PVC ECC SWA PVC	MCC01	Recycle Pumps motor heaters	Power	
17	1,5mm ² x 3c PVC ECC SWA PVC	MCC05	Electric valve actuators	Power	
18	1,5mm ² x 4c PVC ECC SWA PVC	MCC01	All motor thermistors (Backwash Pumps)	Control	
19	1,5mm ² x 3c PVC ECC SWA PVC	MCC - All	All E-Stops	Control	
20	1,5mm ² x 3c PVC ECC SWA PVC	MCC - All	Level Sensors	Control	
21	2.5mm ² x 4c PVC ECC SWA PVC	MCC - All	External pole and floodlights	Power	
22	25 mm ² x 4c PVC ECC SWA PVC	MCC02	Admin DB	Control	
23	16mm ² x 2c PVC ECC SWA PVC	MCC02	Guard House DB	Power	
24	1.5mm ² x 3c PVC ECC SWA PVC	MCC	All pumps temperature sensors - where required	Control	
25	1,5mm ² x 4c PVC ECC SWA PVC	MCC	All pressure transmitter on pump discharge or pipeline - where required	Control	
26	1,5mm ² x 4c PVC ECC SWA PVC	MCC	Submersible pump oil contamination and moisture sensors	Control	
27	1,5mm ² x 7c PVC ECC SWA PVC	MCC05 + Filter Control Panel	Backwash Pumps Control Panel	Control	
28	1,5mm ² x 7c PVC ECC SWA PVC	DB/MCC04 + Filter Control Panel	Air Blowers Control Panel	Control	
29	Twisted 4 or 6 pair instrument cable	MCC / PLC	All electric actuators, sensors, pump/motor sensors, instruments and to PLC etc	Control	
30	Decabond instrument cable	MCC / PLC	Instruments, - Sensors etc (All)		
31	1.5 mm ² 2 pair PVC overall screened Dekoron cable	MCC / PLC	Telemetry Cubicle, ultrasonic level sensors etc	Control/ signal	
32	1.0mm ² 4C individual screened & overall screened SWA instrument cable	Telemetry panel	Open channel ultrasonic flow meter	Control/ signal	
33	1,5mm ² x 7c PVC ECC SWA PVC	MCC05 + Filter Control Panel	Backwash Pumps Control Panel	Control	

Note:

- All the cables may not be in the cable schedule above, but sufficient cables are measured in the bill to cover all cable requirements.
- The contractor will be responsible to provide the final cable requirements and provide the final cable schedules, block diagrams etc for the power and instrument or signal cables
- All cables that are to be disconnected and removed shall be assessed on site by the relevant contractors and priced accordingly.
A final schedule of all cables shall be submitted with sizes, destinations etc to the Engineer and a method statement shall be provided of how this work is to be carried out.

PS ECI 12 TELEMETRY AND INSTRUMENTATION**PS ECI 12.1 Introduction**

The Telemetry System project outlines the background information required for the project. The project charter includes the scope, roles and responsibilities, resource commitment, and an overview of the various phases of the project. The intended audience of the Telemetry System project charter is the project sponsor and project management.

PS ECI 12.2 Project Overview

This project involves the upgrade and additions to the existing telemetry and instrumentation equipment at Tongaat water supply network, for the upgrades and improvements to the works and for the telemetry systems to the remote command reservoirs.

The project also involves, inter alia, the supply, installation, configuration, testing and commissioning of the new telemetry and instrumentation equipment. It also involves the integration to the new MCCs, OPC and new SCADA configuration. The telemetry panel at the WTW is to be installed and in the new control room and operators building. Telemetry systems are to be at the remote reservoir sites for reservoir level and auto control of the various high lift pumps. These signals are transmitted to the EWS Control Room.

Under this phase of the work the telemetry signals are to be transmitted to the Water Treatment Works and onto the new SCADA system and to the EWS Control Room.

The scope of telemetry and instrumentation work for each site is detailed below.

PS ECI 12.3 Tongaat Water Treatment Works Telemetry Scope Of Work

- Tree (3 off) 24V DC Dual point Multirangers (type Siemens 7ML50331AB102A) installed in the inlet into the works in the screens basin. Integrate / incorporate to the telemetry and MCC
- The new flow meter for the inlet works to integrate / incorporate to the telemetry and MCC
- Incorporate and integrate to new XPX10 level transducers (7ML11153CA30)
- Supply and installation of new Webb radio antenna, cables with associated mountings and accessories in the WTW Control Room
- Supply and wire optical isolation between serial devices (Moxa TCC120I) (4 sets)
- Supply and wire DC supply and serial surge protection devices
- Supply and install new cables from the telemetry panel to the new MCC PLCs and the new SCADA system
- Supply and install new cables and any additional installation accessories
- Remove old telemetry instruments and equipment and delivery to EWS stores
- SCADA configuration
- Provide project management

- Integration of the new and existing MCCs and the new telemetry system and all instruments.

PS ECI 12.4 Remote reservoir sites

New telemetry systems are to be installed at the following remote reservoir sites for the automatic control of the high lift pumps at the WTW. The telemetry systems will also transmit the reservoir levels to and integrate to the WTW SCADA and to the EWS Control Room. Telemetry systems are required at the following reservoir sites.

- Mamba Ridge (Including Jan Roz & Burbreeze (3 Pumps : 2 Duty, 1 stand-by)
- Tongaat South (2 Pumps : 1 duty, 1 stand-by)
- Hambanathi (2 Pumps : 1 duty, 1 stand-by)
- Emona/Belvedere (2 Pumps : 1 duty, 1 stand-by)
- Metcalfe (2 pumps : 1 duty, 1 stand-by)

Each reservoir site will entail the following:

- Each reservoir telemetry will automatically control their respective pumps (start and stop) based on levels in the reservoir. The reservoir levels will also be transmitted to the SCADA at the WTW and to the EWS Control Room
- Supply, install and commission a new telemetry panel as per specification. Power supply to the telemetry panel will be provided by the electrical contractor
- The panel must include the RTU and digital radio amongst other equipment with 100 amp hour batteries complete, things in accordance with the EWS specifications and standards
- Supply and incorporate Dual point Multirangers (type Siemens 7ML50331AB102A)
- Supply and install the XPX10 two-level transducers (7ML11153CA30) with stainless steel mounting brackets as per agreed positions.
- Supply and installation of new omni directional Webb radio antenna, cables and coaxial cables, with associated mountings and accessories.
- Supply and wire optical isolation between serial devices (Moxa TCC120I) (4 sets)
- Supply and wire serial surge protection and DC surge protection devices for all telemetry equipment
- Supply and install new level instrument cables and any additional installation accessories
- SCADA configuration and integration
- Provide project management
- Provide 230Volt power supply to each site for the telemetry systems. New applications for the power supplies may be required.

Deliverables

- A fully functional and integrated telemetry system, enabling monitoring of all alarms and events of the reservoirs and pump controls (start/stop) to the new SCADA system at the WTW and the existing SCADA at the EWS Control Room.
- Enabling monitoring of the intruder alarm, fire alarm and battery box alarm for the Telemetry Rooms at the reservoir sites
- Re-established communication between sites and front end
- Detailed Project Documentation and Safety File (Hard Disk)
- Documentation pack with all drawings, wiring diagrams, loop diagrams , I/O lists , as-builts , O & M manuals etc complete
- Integrated MCC/PLC, enabling the monitoring of all alarms and events, on the existing GeoSCADA.
- Booked training on SCADA, Instrumentation and Telemetry Systems provided by specialist equipment supplier

PS ECI 12.5 DELIVERABLES

- A fully functional and integrated telemetry system, enabling monitoring of all alarms and events of the Water Works and all the pump sets, stirrers, screens ,conveyors etc . (1 or 2 duty and 1 stand-by as indicated in the MCC

specifications)

- The high lift pumps shall be integrated to start and stop automatically from the remote reservoir telemetry systems and will automatically control the pumps (start and stop). Currently the pumps are manually operated.
- The level monitoring of all remote reservoir sites and all pumps call / stop status at the new local SCADA at the WTW and at the EWS Control Room
- Enabling monitoring of the ultrasonic flow meter installed on the inlet channel of the works
- Re-established communication between remote sites and front end where existing systems are operational
- Detailed Project Documentation and Safety File (Hard Disk)
- Documentation pack with all drawings, wiring diagrams, loop diagrams, I/Os etc complete
- Integrated MCC/PLC, enabling the monitoring of all alarms and events, on the new on-site GeoSCADA
- Booked training on SCADA, Instrumentation and Telemetry Systems provided by specialist equipment supplier

PS ECI 12.6 DEPENDENCIES

- Access – eThekwini Water or their appointed civil contractor to provide site access when required
- Transducer Coring – Civil contractor to ensure that the transducer cores and associated galvanized enclosures are provided in advance of installation.
- Civil Structures – Civil contractor to ensure that the civil structures such as all Structures, Buildings , Telemetry Room, Pump Rooms etc are ready for installation of equipment.
- Civil Contractor to ensure that trenching for transducer cabling is carried out and that cables are concreted in as per requirements.
- Routing –Agreement on the positions for equipment mounting and the routing of cabling.
- Power – Power should be installed and made available in the Telemetry room before Telemetry work can proceed.
- Commissioning – An authorized person from the telemetry contractor must be available to sign off all testing, delivery, site installation and handover/commissioning and documentation for the project.
- Communication Process
 - Communication process for the project to follow EWS guidelines as per the table below:-

Communication	Medium	Delivery Date	Frequency	Description/Notes	Audience	Owner
Project Team Communication	Meeting	Ongoing	Weekly	Weekly status meeting to discuss schedule, communications, actions, risks & issues	Project Team	PM
EWS Communication	Email	Ongoing	Weekly	Weekly status report for overview of the project progress	EWS	PM
	Meeting	Ongoing	Monthly	Monthly executive overview of the project progress	EWS	PM
	Email/Phone	Ongoing	As required	Queries	EWS	PM
Main Contractor Communication	Meeting	Ongoing	As required	Safety File	EWS	Safety Officer
	Email	Ongoing	Bi-monthly	Bi-monthly status report for overview of the project progress	Main Contractor	PM
	Email/Phone	Ongoing	As required	Queries	Main Contractor	PM
	Meeting	Ongoing	Monthly	Monthly overview of the project progress	Main Contractor	PM

A 1mm² 2/4 pair PVC overall screened cable such as a DEKORON cable is to be installed within a telemetry encasement and cable tray from the main panel or MCC to the telemetry panel.

Refer to Ethekewini Telemetry and Instrument Install Specification Latest Revision 00 & 01. This specification shall be read with and used in conjunction with the above Ethekewini standard specifications.

PS ECI 13 EARTHING

The entire installation must be properly and effectively earthed as prescribed in the Standard Regulations of the Wiring Premises SANS 10142-1 and to the requirements of the relevant supply authority.

Earthing of the buildings and electrical installations shall meet the requirements of SANS 10313 as amended and SABS/IEC 61024 as amended. The main earth from the Supply Authority must not be relied upon as an effective ground earth.

The MCC/s , control panels , DBs etc shall be earthed as per the SANS codes. All metal platforms, staircases, handrailing, cable trays and racks etc shall be effectively earthed.

All motors, pumps and pump base plates shall be effectively earthed using min 16mm² PVC insulated earth wires and terminations.

The testing of the earthing system must be witnessed by the EWS representatives and the Engineer.

PS ECI 14 METERING & ON-SITE POWER SUPPLY

PS ECI 14.1 Metering

No metering facilities are required except for the power meter and kWH meter installed in the MCCs.

The metering is currently carried out on the MV network at the Tongaat Hulett infrastructure at the Mill.

The contractor will be required to liaise closely with the Supply Authority to ensure a timely mains connection to the meter cubicle or MCC and to co-ordinate and shut downs and start ups required..

Completion certificates, COC's and meter cards shall be submitted to the Supply Authority to enable the Supply Authority to energise the mains where required.

PS ECI 15 EXISTING MV TONGAAT HULETT SUPPLY

The existing power supply to the site is provided by the Tongaat Hulett Mill distribution supply network and is to remain as is.

PS ECI 16 MCC & DISTRIBUTION BOARDS

The electrical installation for all buildings, structures and processes at the WTW shall comply with the latest requirements of SANS 10142-1 and a compliance certificate with test report shall be issued at the completion of the project. The local distribution board may form part of the main MCC in new installations where specified.

DB circuit breakers shall be clearly marked with the item they are feeding e.g. lights, plugs, external lights. A typed legend card shall be installed in the domestic cubicle indicating all equipment, circuit breakers etc.

If there is more than one lighting circuit, each circuit shall be marked lights 1, light 2, etc. the light fittings that are fed by light circuit 1 shall be clearly marked LC1... to identify where they are feed from. Plug and all other circuits must be marked in the same manner.

The DBs shall be clearly labelled with name, source of supply, cable sizes and kA rating and co-ordination type.

PS ECI 17 INSTRUMENTATION

Refer to Telemetry and Instrumentation Specification Revision 00 & 01

PS ECI 17.1 Pressure Transducer

Where required, the pressure transducers are to be mounted on the delivery main in the pump station/s of any pump system and shall be the type WIKA S-10, 0-25 bar 4-

20mA loop powered (2 wire) unit supplied complete with a PTFE pressure washer or similar and equal approved. The max operating pressure setting will be given. The contractor is to obtain prior approval if he intends using a transducer from another supplier.

Where specified, the pressure switch shall be used to automatically control the pumps via the PLC depending on the set point pressure settings in the pumping system. The delivery pressure transmitter shall be wired to the PLC which shall relay the signal to the SCADA system.

PS ECI 17.2 Temperature Transducer (Supplied With Pump And Motor)

Where required, approved motor thermistors and controllers shall be supplied with the pumps and motors. The installation of the controllers and wiring in the MCC shall be undertaken by the electrical contractor.

PS ECI 17.3 Pump Casing Transducer & No Flow Switch

An IFM or similar approved electronic no flow switch or similar and equal approved shall also be installed on the delivery line on the discharge of the pumps. An ½ inch BSP socket shall be welded on the pipework for this. The controller shall be installed and wired in the MCC.

PT100 temperature sensors shall be installed for the pump casings or motor and pump bearing NDE or DE as specified or as required.

PS ECI 17.4 Flow Meters, Level Sensors

a) Ultrasonic Flow Meter

The ultrasonic flow meters shall match the existing meters as far as possible and be in accordance with the EWS standard specification and the Preferred Equipment List. The Contractor to ascertain the meter details. The meter shall be an ultrasonic type 24V DC with sensor, transducer etc or similar and equal approved. The meter shall be supplied with 10m of factory installed cabling for termination on a junction box for wiring to the MCC / PLC.

The meter sensor shall be installed on a hot stainless steel bracket and fixed to the screens and flocculation basin at the inlet to the works.

The main inlet meter is to measure the inflow into the works and to be integrated into the control systems to control the dosing and dosing rate of the chemicals and chlorine. This flow measurement shall be wired into the PLC and telemetry system. The other two meters shall be used to measure the differential levels across the inlet screens and control the speed of the front raked mechanical screen and mechanical conveyors. VSDs will be installed in the MCC for the speed control initiated by the PLC program.

The unit shall be supplied by 24V DC power supply with RS485 modbus communication capability with 10m factory supplied instrument cable and all other accessories complete. A weatherproof cable junction box with adequate terminals is to be installed at each instrument for the easy termination of the cables.

A 2 pair screened signal instrument cabling will be required from the flow meter to the PLC and telemetry panel.

b) Ultrasonic Flow Meters – General

Ultrasonic Flow measurement shall be by means of a sensor (transducer) and separate transmitter, with the sensor powered via the transmitter. The sensors shall be mounted on suitably-sized brackets of glass-fibre reinforced construction, stainless steel or similar non-corroding material directly over the medium being monitored.

The sensor shall furthermore be equipped with an integral cable long enough to reach the transmitter, with the complete unit IP68 rated.

The transmitter shall be of minimum IP65 rating and housed in a 316L protective

enclosure providing the same rating. The transmitter shall have a local LCD display, which shall be visible with the protective housing closed. The enclosures shall be installed against a building wall or a separate 316L stand specifically provided for this purpose.

The unit shall conform to the standard specification with the following qualifications:

a) Transducers

This section covers ultrasonic transducers located above the surface of the water, at the measuring point.

Suitable stainless steel support brackets shall be supplied for the ultrasonic transducers.

Design:

Enclosure	:	IP65
Membrane	:	Stainless Steel
Electrical Connection	:	20mm ISO conduit
Max Operating Temperature	:	60°C

b) Transmitter

Preference shall be given to a unit that is "smart" in that calibration and diagnostic checking shall be by hand-held calibrator.

The ability of the system to be configured to ignore unwanted signals from obstructions is essential.

Design -

Enclosure	:	To suit application
Output	:	4-20mA into 250 Ω load, pulse, 1x digital
Power Supply	:	24V DC
Calibration Adjustments	:	Independent for Zero & span

Performance -

Accuracy	:	1% of span or better
Repeatability	:	0,2% of span
Dead Band	:	<0,2% of span
Ambient Temperature Effect	:	<0,5% of maximum span per 10°C change
Preferred	:	Siemens or as per EWS preferred

Equipment List

The Transmitters and Transducers shall be installed as indicated on the general arrangement or site plan drawings included and shall be cabled to the PLC control panel via separate shielded twisted pair instrumentation cables. Power supply and Totalizing Signals shall be connected via separate multi-core power and control cables.

Note : Mechanical flow meters are existing and not required.

PS ECI 17.4.1 Level Sensors

The level sensors shall be in accordance with the EWS standard specification and the Preferred Equipment List. Where possible sensors shall match existing systems used on site.

a) Ultrasonic level measurement shall be by means of sensors (transducer) and separate transmitter, with the sensors powered via the transmitter. The sensors shall be mounted on suitably-sized brackets of glass-fibre reinforced construction, stainless steel or similar non-corroding material directly over the medium being monitored.

The sensor shall furthermore be equipped with an integral cable long enough to reach the transmitter, with the complete unit IP68 rated.

The transmitter shall be of minimum IP65 rating and housed in a 316L protective enclosure providing the same rating. The transmitters shall have a local LCD display, which shall be visible with the protective housing closed. The enclosures shall be installed against a building wall or a separate 316L stand specifically provided for this purpose.

The units shall conform to the specification listed in the Standard Specifications or Preferred Equipment List for "Ultrasonic Flow Meters", and with the following qualifications:

Power supply	:	24V DC
Output	:	4-20mA analog signals (x2), 2x digital

b) Differential Level measurement over screens basin

Two ultrasonic sensors with a common transmitter shall be mounted over the inlet

channel for control of the screen.

The sensors shall be mounted one upstream and one downstream of the screen on suitable brackets manufactured from either 304 Stainless Steel or glass reinforced polyester.

Medium : Raw & Clear Water
Measuring Range : 0 - 5m
Outputs : 4-20mA (x2); 2x digital

Sensors shall be used for level measurement and for control as required.

PS ECI 18 SIGNAGE

Signage inside and on the outside of the door to the pump station shall be provided in compliance with OHS Act (85 of 1995) and SANS 10142-1. In addition, a sign with the designation of the relevant pump station shall be fixed above the pump station door and a sign on the outside of the door shall read "UNAUTHORISED ENTRY NOT PERMITTED" It shall be on black PVC board with yellow lettering.

A label no smaller than 80mm high shall be mounted adjacent to each pump to identify it as a "PUMP 1 or "PUMP 2".

PS ECI 19 SECURITY

PS ECI 19.1 Fire Detection:

A detector type photoelectrical smoke detector of type Regal Altro Type (photoelectric smoke detector model No. JIC-636AR) must be installed on the ceiling or roof slab near the MCC panel only or in other control rooms or offices in accordance with the suppliers specification and in a position where the smoke will accumulate if there is a fire in the pump station. The detector must be wired back to the main panel in 4 core 0.25mm² telephone cable and must be wired directly to the isolation relay and PLC. The unit may not be installed near ventilation fans, florescent lights or in the A frame roof space.

A fire detection and alarm system is required for the Admin Building and Ablutions in accordance with SANS10139. A Ziton ZP2 addressable alarm panel or similar and equal approved system is to be installed in the Control Room. The fire alarm panel shall have battery back up for 72 hours back-up time.

The following ancillary equipment shall form part of the fire alarm system:

- Ziton or similar addressable optical smoke detectors installed in all rooms , offices, toilets, ablutions etc
- Ziton or similar manual break glass units at exist doors. Outdoor units are to be weatherproof.
- Ziton or similar sirens with flashing bean lights inside the Control Room and outside the building.

The fire alarm wiring is to be 0,8mm² red PH fire retardant cabling wired in 20mm diameter bosal galvanised conduit. All the devices are to be addressed.

The alarm signal shall be wired to and integrated to the PLC/HMI and SCADA system and for final transmission and integration to the remote SCADA system at the EWS Control Room.

A comprehensive block plan and operating instructions shall be installed at the fire alarm panel.

Training is to be provided to EWS staff on the operation and maintenance of the system.

Five sets of the O & M manuals are to be provided for the entire fire detection and alarm system

PS ECI 19.2 Intruder Alarm:

An intruder alarm system shall be provided inside the pump station MCC room and the telemetry room and other rooms (where applicable) consisting of a single passive infra-red and microwave detector (IR AND MW) in each room, directly wired to the isolation relay and PLC for remote monitoring through the telemetry system. Cabling shall be a 0.25mm² 4 core telephone type cable. The detector shall be wall mounted at a height of 2.6 meter from floor level opposite the door and shall be a Regal Altro Type (Rokonet digital Zodiac PIR/QUAD RK-410QD0000A).

PS ECI 20 OPERATING PHILOSOPHY OF THE PUMP STATIONS

- a) The control philosophy for the potable water, recycle water or sludge pumping systems are fully described under the PLC auto control section for each system.
- b) The pump system for each pipeline system consists of two or three (duty and standby) drawing from the clear water reservoir or sumps at the Tongaat WTW and pumping to the existing remote command reservoirs or inlet to the works
- c) A new MCC container room building is to be constructed on the site to house the MCC and telemetry equipment.
- d) The new pumps (duty and standby) will be fully automated, operating on the level sensor and telemetry level system and monitored by the telemetry system. The PLC will be programmed to carry out this function. Currently the pumps will be run manually and in auto mode using a pressure switch system until such time as the telemetry system becomes fully functional.
- e) Currently the high lift pumps are be manually controlled and pressure controlled, in future the system shall be remotely controlled vial radio telemetry systems

PS ECI 21 OTHER REQUIRMENTS

- a) The PLC will be programmed by a specialist employed by the supplier of the motor control panel in consultation with EWS Mechanical and Electrical Branch and the Control and Instrumentation Branch.
- b) The PLC system integrator must be a Recognized Certified Allen Bradley or Siemens System Integrator. Proof of this must be submitted with the tender.
- c) The project will not be signed off for payment before all snags identified in the preliminary inspection are complete and a compliance certificate and test report is issued.
- d) All cables are to be numbered according to the standard specification. Wiring colour codes must be adhered to in accordance with the standard specification. All light and plug circuits are to be labelled in accordance with the standard specification.
- e) Signage of the pump station/s or other buildings must be done in accordance with the standard specification.
- f) All equipment supplied and installed shall be in accordance with the project specifications and as laid out under the standard specification.
- g) All documentation such as insurances, compliance with Dept of Labour and OHS Act requirements, construction programme, cash flow schedule and approved MCC shop drawings must be completed before work on site may begin.
- h) The complete O & M manuals as detailed in the enclosed documents must be submitted for comments and approval prior to the commissioning. The final documents shall be submitted on approval.

PS ECI 22 LIGHTNING PROTECTION AND EARTHING SYSTEMS TO PUMP ADMIN BUILDING , GATEHOUSE etc

- a) The Admin Building, gatehouse and other structures (or Pump Stations , Telemetry and MCC Rooms where applicable) will require lightning protection and earthing systems as shown on the drawings. The buildings are constructed of brickwork with a concrete roof.
- b) A lightning protection and earthing system required for the above buildings and for the new lighting transformer and shall be installed in accordance with IEC62305, SANS1013 and SANS 10199 standards.
- c) The earth resistivity survey shall determine the final number and spacing of the earth electrodes.
- d) An earth mat consisting of 70mm² bare copper earth conductor shall be installed

around the buildings or transformer with earth electrodes installed in positions shown on the drawings or as directed by the Engineer on site. A 10dia solid aluminium roof terminal conductor shall be installed around the roof of the building or other structures and connected to the earth mat. This conductor shall be connected to the earth mat using 70 mm² PVC insulated earth conductors in PVC conduit. Test points shall be installed on all down conductors to the earth mat.

- e) The roof over the buildings shall be connected to the earthing ring main using 70mm² PVC insulated earth conductors. installed in positions shown on the drawings or as directed by the Engineer on site. A 10dia solid aluminium roof terminal conductor shall be installed around the roof of the buildings connected to the reinforcing in the roofs. This conductor shall be connected to the earth mat.
- f) The steel columns of any buildings or structures shall be bonded to the earthing system. 70mm² insulated earth wires installed in PVC conduit shall connect the steel bases and connected to the earth mat
- g) All underground connections to the earth electrodes or other earth conductors shall be exothermic welds and denso wrapped.
- h) All exposed earth wires shall be installed in conduit.
- i) The final resistance required shall be 7 ohm or less. (preferably 1 ohm or less)
- j) A 300mm x 6mm earth bar shall be installed adjacent the MCC and connected via 70mm² insulated earth wire to the earth mat.
- k) All steel handrailing, staircases, cat ladders or other metal structures shall be bonded to the earthing system.
- l) The integrity of the any existing earth mat is to be checked and tested and report submitted to the Engineer
- m) The installation shall be undertaken as shown on the drawings or as directed by the Engineer on site. The installation and testing shall be witnessed by the Engineer and a full test and compliance certificate shall be submitted by the contractor.
- n) An as built layout shall be provided to the Engineer and Employer on completion of the work.
- o) The final earth test results and compliance certificates shall be submitted with the hand-over data pack for the installation.

PS ECI 23

DRAWINGS AND MCC REQUIREMENTS

- a) The contractor will be required to provide schematic and wiring and layout drawings with parts list of the MCC for approval prior to manufacture. The I/O list and diagrams, terminations, cable block diagrams, cable schedule and instrument loop diagrams shall be included and supplied with the wiring diagrams. These shall be updated to as built and included in the O & M manuals.
- b) The FDS (functional design specification) and P&ID diagrams are to be updated as required to suit the final control and instrumentation systems
- c) The contractor shall provide 5 sets of final as-built record drawings in both hard and soft copies. Five sets of manuals with technical leaflets of only the equipment supplied shall be bound into a hard-covered hinged binder together with contact details of the contractor and MCC manufacturer. The manuals shall also be provided in electronic format to the Client and Engineer.
- d) It is the contractor's responsibility to design the motor control centre power and control circuitry installation in accordance with the specification and good engineering practice. This shall include the PLC, HMI and SCADA systems.
- e) The design shall be undertaken by personnel who are able to demonstrate experience in the field of water pumping plant including control systems, PLC and telemetry systems.
- f) The testing and commissioning of the MCC and control systems shall be undertaken by the MCC designer and manufacturer in conjunction with the electrical contractor. The designer and manufacturer shall be present for both the FAT and on-site SAT testing and commissioning.

PS ECI 24

WATER TREATMENT PLANT

PS ECI 24.1

Requirements From The Contractor

The following is required from the Electrical Contractor :

- a) Company profile
- b) Experience report with list of at least five completed projects for water and waste water treatment and pumping plants with values of similar nature and scope of work
- c) Qualifications and CV of key personnel. Minimum NFQ5 qualifications required for site agent, supervisor and foreman. Qualifications to be submitted with tender.
- d) References (minimum three)
- e) Compulsory CIDB registration of minimum CIDB grading of 5EB, (electrical)
- f) Documentation of the MCC equipment and electrics
- g) Meeting with EWS Mechanical and Electrical Branch and the Employer's Representative (Consulting Engineer) to discuss the dynamics of the project
- h) The complete installation must be guaranteed for 12 months from the date of the completion certificate.
- i) The contractor shall insure the entire works for the duration of the contract.

PS ECI 25 PAYMENT & RETENTION

Payment will be in accordance with the items included in the Schedule of Quantities and will be on successful completion of each activity.

The tendered rate is to include for all mobilisation costs, company overheads, insurances, guarantees, overtime (where applicable), transport, profit, site supervision for the duration of the works, reporting and printing requirements, computer and associated data costs.

PS ECI 26 STANDARD ETHEKWINI SPECIFICATIONS APPLICABLE TO THIS PROJECT

The following eThekwini standard specifications enclosed with this document shall apply and be read with this specification at all times;

- eThekwini Municipality PLC_Specification_Rev06 – 4052023
- eThekwini Municipality Telemetry and Instrument Install Specification_ Rev01 - 17082023
- eThekwini Municipality Quality Control Specification_Rev02
- EWS Standard Specifications, GS1 - Standard Specifications for DB's and Motor Control Centres 202000519
- EWS Commissioning _ Fat Forms 19112020 with Test Reports & FAT Combined
- EWS Quality Control Rev_03 - 0304200
- EWS List of Preferred Instrumentation Equipment 7

PS ECI 27 TYPICAL FACTORY ACCEPTANCE AND SITE ACCEPTANCE TESTING (FAT AND SAT) PROCEDURES

Refer to Latest Working Revision of the Quality Control Specification

PS ECI 27.1 Procedures

PS ECI 27.1.1 Project Flow (PF)

- a) Receive control philosophy from EWS (included in specifications)
- b) Review above philosophy
- c) Raise queries to EWS
- d) Receive final control philosophy from EWS (Signed)
- e) PLC Quality Control FDS, Processes and Procedures
- f) Program PLC
- g) Create HMI Screens
- h) Send HMI screens for approval
- i) Review and finalise screens with EWS
- j) Factory acceptance test
- k) Site acceptance test

PS ECI 27.1.2 Factory Acceptance Test (FAT)

- a) Visual inspection to confirm that the drawing matches the physical panel.

- b) Input & output testing (Confirm correct wiring to and from PLC) - Refer to Annexure 1
- c) Verify HMI signals correspond to item 1 - Refer to Annexure 2
- d) Verify telemetry signals
- e) Operating and control philosophy - Refer to Annexure 3
- f) All external signals to be simulated

PS ECI 27.1.3 Site Acceptance Test (SAT)

- a) Input & output testing of field wiring and marshalling
- b) Test all signals as per FAT including no flow and overload test

Note: The designer and manufacturer of the motor control panel together with the electrical contractor shall be present on site to carry out the site testing and commissioning of the complete MCC, PLC/HMI & SCADA , electrical and associated systems.

PS ECI 27.1.3.1 PLC Hardware and FAT Check List

The electrical contractor and panel builder shall confirm the equipment for the PLC and HMI for the equipment and parts as outlined below and confirm with EWS before submitting the tender and ordering the equipment.

PLC Hardware

The below list of minimum hardware to be installed within the PLC cubicle of the MCC;

Item	Description	Tag Name (Ref. to DWG)	Supplier	Part Number	Quantities
1	PLC Controller	CPU	Siemens	6ES7214-1AG40-0XB0	1
2	Digital Input Module	Digital Input Card	Siemens	6ES7221-1BH32-0XB0	2
3	Digital Output Card	Digital Output Card	Siemens	6ES7222-1HH32-0XB0	2
4	Analog Input Card	Analog Input Card	Siemens	6ES7231-4HF32-0XB0	2
5	HMI	HMI TP1500	Siemens	6AV2124-0QC02-0AX0	1
6	Ethernet Switch	8 PORT ETHERNET SWITCH	DELTA	DVS-008I00	1
8	Wireless Router	WIFI	D-Link	N150	1

Note : The Ethernet Switch, Modbus Serial Module, Power Monitor , Wireless Router and ancillary equipment etc as required shall be determined by the contractor and approved obtained from EWS C & I Department prior to procurement.

ANNEXURE A**COMPULSORY RETURNABLE DATA SHEETS****TECHNICAL DATA SHEET: MCC PANELS (Complete one for each MCC & Control Panel)****NAME OF SITE:** _____**RATING OF MCC PANEL:** _____

No	ITEM	SPECIFIED	OFFER
1	Manufacturer	Unspecified	
2	Floor/Wall Mounted	Yes (floor)	
3	Front & Side Access	Yes	
4	Form Type & kA rating	2b/4b (manufacturer to confirm)	
5	Material	2mm 3CR12 SS	
6	Finish	Painted Electric Orange (epoxy coated)	
7	Cable Entry	Bottom	
8	Base	Hot dipped galvanised	
9	Doors	Lockable	
10	IP Rating	IP 44	
11	Electrical Details	400V, 50Hz, Full Neutral	
12	Earthing Details	Full Length	
12A	Instrument Earth	Full Length	
13	Busbar Chamber	Top	
14	Grouping of Equipment	Individual	
15	Door Interlocks	Isolator Interlocks	
16	Panel tiers	Bolted together transportable sections -no more than 1.5m in length. Extensible and modular	
17	Dielectric Barriers	Yes	
18	Busbar Supports	Epoxy Insulators on Steel	
19	Compliance with detailed technical specification	Yes/No	
20	SANS Approved	Yes/No	
21	Busbar Material	Copper	
22	Mouldered Case Circuit Breakers	Schneider, ABB or similar	
	Manufacturer	Yes/No	
	In Accordance with Spec	Yes/No	
23	Main Circuit Breakers	Schneider, ABB or similar	
	Manufacturer	Yes/No	
	In Accordance with Spec	Yes/No	
24	Selector Switches	Unspecified	
	Manufacturer	Yes/No	
	Type	Rotary	
	In Accordance with Spec	Yes/No	

NAME COMPANY: _____ **SIGNATURE OF REP:** _____**DATE** _____

COMPULSORY RETURNABLE DATA SHEETS..... Continued**TECHNICAL DATA SHEET: HIGH LIFT PUMPS MCC PANEL****NAME OF SITE:** _____**RATING OF MCC PANEL:** _____

No	ITEM		SPECIFIED	OFFER
25	HRC /Semi Conductor Fuses Fuses			
	Manufacturer	Unspecified		
	Type	Visible Link		
	In Accordance with Spec	Yes/No		
26	Contactors			
	Manufacturer	Unspecified		
	Type	AC3		
	In Accordance with Spec	Yes/No		
27	Variable Speed Drives-Low Harmonics	Yes/No		
	Manufacturer	Unspecified		
	Type	AC3		
	In Accordance with Spec	Yes/No		
	Soft Starters	Yes/No		
	Manufacturer	Unspecified		
	Type	AC3		
	In Accordance with Spec	Yes/No		
28	Ancillary Relays			
	Manufacturer	Unspecified		
	Type	Plug-In		
	Field convertible contact configuration	Yes/No		
	In Accordance with Spec	Yes/No		
29	Push Buttons			
	Manufacturer	Unspecified		
	Type	As per spec		
	In Accordance with Spec	Yes/No		
30	Indicator Lamps			
	Manufacturer	Unspecified		
	Type	As per specs		
	In Accordance with Spec	Yes/No		
31	Emergency Stop Button			
	Manufacturer	Unspecified		
	Type	As per specs		
	In Accordance with Spec	Yes/No		
32	Automatic Change over Equipment			
	Manufacturer	Unspecified		
	Type	As per specs		
	In Accordance with Spec	Yes/No		
	Power Safe as per specs	Indicator Lamps		
		Manufacturer	Unspecified	
		Type	As per specs	
		In Accordance with Spec	Yes/No	
33	Other Equipment			

NAME COMPANY: _____ **SIGNATURE OF REP :** _____
DATE _____

ANNEXURE B**LIGHTING TRANSFORMER (OUTDOOR TYPE)****REQUIREMENTS OF 200 KVA, SINGLE RATIO, 3 PHASE, 525/400 V TRANSFORMER**

1) This Schedule shall be completed, signed and returned with tender documents of which it forms part:

Ref No.	Technical details	EWS Requirement	Contractor's offer
1	Name of Manufacturer		
2	Place of Manufacture		
3	Manufacture's reference number		
4	Rated Power	200 kVA	kVA
5	Rated primary no load voltage	0,525 kV (525 V)	kV
6	Rated secondary no load voltage	400 V/230 V	V/ V
7	Insulation level	(TBA) kV	kV
8	Vector group	Dyn11	
9	Overall dimensions: (i) Length (ii) Depth (iii) Height	By Manufacturer	mm mm mm
10	Primary voltage tapplings	±2,5% and ± 5%	
11	Tap change switch	n/a	
12	Material of windings: (i) Primary (ii) Secondary	Copper/Aluminium Copper/Aluminium	
13	Mass of core and windings		kg
14	Mass of complete transformer		kg
15	Oil capacity		litre
16	Guaranteed impedance voltage	4,5 to 5,5 %	%

***Delete that which is not applicable.**

Name: _____ Date: _____ Company: _____

Sign: _____

Ref No.	Technical details	EWS Requirement	Contractor's offer
17	Guaranteed upper limit of no-load losses at rated voltage and frequency:		W
18	Guaranteed upper limit of load losses at rated voltage and frequency:		W
19	Temperature rise at rated voltage and power of: (i) Windings (ii) Top oil	65 °C 60 °C	°C °C
20	Method used to ensure that terminals suitable for both copper and aluminium conductors	Tinning or silver plating of terminals	
21	Bushings: MV or LV	Type C-Epoxy Resin Porcelain	
22	Creepage distance of MV bushings	31 mm/kV	
23	Cable boxes (Type and sizes)	Cable boxes (Primary and Secondary) Sizes by manufacturer	
24	Colour	No. G 35 of SANS 1091	
25	Corrosion protection: In accordance with in Eskom Standard: 240-56030674 for new units for protection in C5-M (Very High Marine) environments	Yes	*Yes/No
26	Warranty period	36 months	

***Delete that which is not applicable.**

Name: _____

Date:_____

Company:_____

ANNEXURE C**SCHEDULE OF RECOMMENDED ELECTRICAL & ANCILLIARY EQUIPMENT**

THE TENDER MAY HOWEVER OFFER ALTERNATIVES (TO BE APPROVED BY CLIENT & ENGINEER PRIOR TO TENDER SUBMISSION)

Note : Refer to the EWS standard specification for instrumentation and control equipment.

Soft starters	Schneider, ABB,WEG,
Variable speed drives	Schneider, ABB,WEG,
Circuit Breakers	Schneider, ABB,
Contactors, indication lamps	Schneider, ABB,
Relays, fuses, motor protection relay	Schneider, ABB ,Omron,
Control switches, selector switches	Krause and Naimer, ABB, Telemecanique, Moeller
Electronic Motor Controller	ABB UMC22-FBP,Omron SEK
Ammeter, voltmeter, current transformer, operations counter, hour meter.	Hartmann and Braun
Cables, Wire	Aberdare
HRC fuses and holders	G.E.C.
DC Power Supplies	Siemens SITOP series, ABB
Electrically operated solenoids	Festo, Asco, Burkert
Level Control	Siemens Milltronics Multiranger MR200 DP 6R, Siemens stainless steel echo max transducer brackets SMS310.
Surge Arrestors	Dehnguard 275 and 1 No. DehnGap
Power supplies	Siemens / SITOP series
Relays	Omron, ABB
Terminal relays	Weidmuller, Klippon, Phoenix Contact
Electrical motors	WEG, ABB
Emergency stop stations	Cutler Hammer, ABB
Circuit breakers	ABB, Schneider, M&G
Fuse switches	ABB Stromberg
Terminals	Klippon, Phoenix Contact
Cable glands	Pratley or CCG Envirogland
Junction boxes	York enclosures
Power Monitor Meter	Schneider PM820, ABB (or as specified)
Electronic motor controller	ABB UMC 100 with MTQ22
Open channel measurement flow meter	Siemens Milltronics Multiranger MR-200 DP 6R
Radar level meter	Krohne, VEGA, Siemens
Magnetic flow meter	Safmag, Siemens, Krohne, Endress & Hauser
Other flow meters	Siemens, Fuji, Krohne, Endress & Hauser
Flow switches	EGE, IFM
Pressure transmitter	Siemens, Fuji, Rosemount, Endress & Hauser

Differential pressure transmitter		Siemens, Fuji, Rosemount, Endress & Hauser
Chlorine gas leak detectors		Siemens, Grundfos
Residual chlorine meter		Siemens, Grundfos
Dissolved oxygen meter		Hach LDO type
Turbidity meter		Hach, Endress & Hauser
Temperature measurement		Wika, Siemens
Pressure gauges		Wika
Air flow meters - Thermal resistance type		Endress & Hauser
Proximity switch		efector (Shorrock Automation)
Solenoid operated valves		Bürkert
Surge protection		Surgetek : BCT BE24 (signals)
		DEHNguard 275 (line)
		DEHNgap B (neutral)
		DehnVentil 255 - Mains
UPS		APC
SCADA		Wonderware,
PLC		Schneider Modicon / Quantum range / M580 or the latest available, Siemens S7-1200
HMI		Schneider Magelis XBG15" or Siemens (touch screen) with Modbus TCP/IP
Industrial Ethernet network switch		Unmanaged - Hirschmann
		Managed - Hirschmann
Pneumatic actuators		Festo, Biman
Electrical Valve actuators		Auma
Telemetry Unit		ISTAT M2X3 or per latest EWS specifications for Instrumentation

The tender may submit a total solution of any brand Schneider, ABB, or a combination thereof.



Project Particular Specification

Electric Actuators

PS ACT

NAIDU
CONSULTING
ENGINEERING DEVELOPMENT

Functional Upgrade of Tongaat Water
Treatment Works - Work Package 1

Revision 0

August 2024

DGI Consulting

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PREAMBLE

This Project Specification forms an integral part of the contract and supplements the Employer's Standard Specifications where relevant. This specification shall be read in conjunction with the following specifications:

- 1) Project Particular Specification: Mechanical, Electrical and Instrumentation Installation
- 2) Standard EWS Specifications for Instrumentation

All material, equipment, and fittings required shall be manufactured and supplied by an Employer preferred approved supplier. It is the Contractors's responsibility to confirm with their supplier that they are approved by the Employer.

PS ACT 1 Electric Actuators

The electric actuators shall match the existing actuators as far as possible and be in accordance with the EWS standard specification and the Preferred Equipment List. The following actuators are required.

- a) Inlet Works Control Valve 1 (to fit DN 400 knife gate valve) : No = 1

Type and Make - to EWS standards , supplier to provide details for approval
Speed and Torque Requirements - To suit valve offered , details to be provided
Controller type - Positioner version - modulating control
Gearbox - part turn gearbox type
Modulating - Yes
Power Supply Voltage - 400V AC 3phase 50 Hz
Controls - 24V DC
Facilities : Close, Open , Stop , Emergency
Control 4-20Ma ; feedback 4-20Ma with min. 6 programmable output contacts
With adaptor, matching of couplings , bolts and nuts & washers
Installation of gearbox and actuator to be included
Setting of torque limits to be included
Testing and commissioning to be included

- b) Clarifier De-sludge Valves 1 - 6 (to fit DN100 butterfly valve) : No = 6

Type and Make - to EWS standards , supplier to provide details for approval
Speed and Torque Requirements - To suit valve offered , details to be provided
Controller type – Basic Version - On/Off
Gearbox - part turn gearbox type
Power Supply Voltage - 400V AC 3phase 50 Hz
Controls - 24V DC
Facilities : Close, Open , Stop , Emergency
Control 4-20Ma ; feedback 4-20Ma with min. 6 programmable output contacts
With adaptor, matching of couplings , bolts and nuts & washers
Installation of gearbox and actuator to be included
Setting of torque limits to be included
Testing and commissioning to be included

- c) Clarifier Control Valves 1 (to fit DN350 butterfly valve) : No = 1

Type and Make - to EWS standards , supplier to provide details for approval
Speed and Torque Requirements - To suit valve offered , details to be provided
Controller type – Basic Version - On/Off
Gearbox - part turn gearbox type
Power Supply Voltage - 400V AC 3phase 50 Hz
Controls - 24V DC
Facilities : Close, Open , Stop , Emergency
Control 4-20Ma ; feedback 4-20Ma with min. 6 programmable output contacts
With adaptor, matching of couplings , bolts and nuts & washers
Installation of gearbox and actuator to be included
Setting of torque limits to be included

- d) Air Blower Control Valves 1 - 6 (to fit DN300 butterfly valve) : No = 6

Type and Make - to EWS standards , supplier to provide details for approval
Speed and Torque Requirements - To suit valve offered , details to be provided
Controller type – Basic Version - On/Off
Gearbox - part turn gearbox type
Power Supply Voltage - 400V AC 3phase 50 Hz
Controls - 24V DC

Facilities : Close, Open , Stop , Emergency
 Control 4-20Ma ; feedback 4-20Ma with min. 6 programmable output contacts
 With adaptor, matching of couplings , bolts and nuts & washers
 Installation of gearbox and actuator to be included
 Setting of torque limits to be included

e) Filter Control Valves 7 - 11 (to fit DN350 butterfly valve) : No = 5

Type and Make - to EWS standards , supplier to provide details for approval
 Speed and Torque Requirements - To suit valve offered , details to be provided
 Controller type – Basic Version - On/Off
 Gearbox - associated or part turn gearbox type
 Power Supply Voltage - 400V AC 3phase 50 Hz
 Controls - 24V DC
 Facilities : Close, Open , Stop , Emergency
 Control 4-20Ma ; feedback 4-20Ma with min. 6 programmable output contacts
 With adaptor, matching of couplings , bolts and nuts & washers
 Installation of gearbox and actuator to be included
 Setting of torque limits to be included

f) Filter Control Valves 12 - 17 (to fit DN200 butterfly valve) : No = 6

Type and Make - to EWS standards , supplier to provide details for approval
 Speed and Torque Requirements - To suit valve offered , details to be provided
 Controller type – Basic Version - On/Off
 Gearbox - part turn gearbox type (MULTI – TURN)
 Power Supply Voltage - 400V AC 3phase 50 Hz
 Controls - 24V DC
 Facilities : Close, Open , Stop , Emergency
 Control 4-20Ma ; feedback 4-20Ma with min. 6 programmable output contacts
 With adaptor, matching of couplings , bolts and nuts & washers
 Installation of gearbox and actuator to be included
 Setting of torque limits to be included

The length of instrument and power cables required are shown on the cable schedule. The actuators shall be fitted to the valves at the supplier's premises.

PS ACT 1.1 Electric Power Supply

The following rated values are applied:

Electric motors	400 V - A.C. 50 Hz 3 phase, 4 wire	± 5 % ± 2	± 10 %
Anti condensate heaters	110V – 250V – A.C. or D.C. or 12V – 48V – A.C. or D.C.	± 10	
Electronic equipment (position transmitters etc)	24V D.C	± 15	

PS ACT 1.2 Design and Construction Requirements

- Actuators shall be designed for valve operation to ensure proper function. Actuators shall be rated for the following duty classifications according to IEC 34 / VDE 0530:
 - a) short – time duty (S2-15min)
 - b) intermittent duty (S4-25% ED); up to 1200 starts per hour; no. of starts depending on actuator size and output speed
- All actuators must be suitable for operating in any mounting position.
- The design must provide simple setting, testing, maintenance and repair. Torque and limit switching shall be of the mechanical type to allow settings without special tools or instruments (e.g. battery backed setting tools).
- To guarantee proper function under high ambient temperatures, torque and limit sensing shall be of mechanical type. All materials used shall be suitable to withstand operation under specified environmental conditions. All necessary precautions shall be taken to avoid any type of corrosion and electrochemical effects, which may take place between different kinds of metals.
- For rising stem applications, the design must allow to remove the actuator from the output drive without disturbing the function of the valve.
- Electrical connection of actuators shall be made by plug / socket connector, to allow quick disconnection in case of maintenance or repair and use of portable test equipment for pre-commissioning testing.
- Torque-transmitting housings must be made of cast-iron, except motor housing.
- No plastic parts of any type shall be used, except for electric / electronic components, operating knobs / levers, mechanical position indicators and sealing elements.
- In order to minimise the amount of spare-parts required, parts like switches, covers, plug / sockets, limit- and torque-switching gears etc. must be interchangeable throughout the model sizes installed
- Actuators shall be designed in such a way, that exposure to environment will not interfere with the safe operation. All joints shall be sealed by radial seals or O-rings.
- In order to prevent loss of screws during commissioning or maintenance, all covers shall be fixed with captive screws.
- Depending on valve application, actuators shall be self-locking. Self-locking shall remain active even if the actuator is switched into hand-operation-mode.
- Valve mounting dimensions shall be according to ISO 5210.
- Where applicable , the actuators shall be mounted on suitable pedestals with spindles to suit the mounting arrangements.

PS ACT 1.3 Actuator Electric motors

- All motors shall be specifically designed for valve-actuator operation which is characterised by high starting torque, low stall torque and low inertia.
- Motors shall be of the non-ventilated totally enclosed type (TENV). Motor housings and covers can be made of sea water resistant aluminium.
- Motor-insulation must be in accordance with IEC 85 Class F (155° C).
- Motors must be protected by 3 thermal contacts, which are embedded in the motor windings. Motor connections shall be internal by the means of plug and socket (up to 5 Kw).
- Motors must be totally separated from the lubricant-filled gearing of the actuator, allowing to replace a motor without losing any lubricant regardless of mounting position.
- Actuator motors must develop full torque when power is turned on. Therefore, direct starting under full voltage is required. All motors shall be of the high starting torque type to facilitate 'unseating' of the valve.
- Each motor shall have a rating plate marked in accordance with IEC 34.1 as far as applicable.
- Preference will be for actuators driven by 400Volt motors.

PS ACT 1.4 Sizing Criteria

- One actuator size (same outside dimensions) shall be available to cover output speeds from 4 to 90 rpm for a given torque range, to avoid oversizing and unnecessary weight load on valve stem, flange and yoke. An increase of actuator size caused by higher actuator output speed is not acceptable to avoid weight oversizing of actuators.
- Actuators must be selected to provide sufficient amount of torque required for safe valve operation. The actuator output torque must be available at 90 % of the nominal voltage.
- In order to enable proper sizing of applicable electric equipment, the actuator supplier has to inform or advise about the current at maximum setting torque.
- The actuator shall be capable of opening and closing the valve against this differential pressure within the time specified on the valve data sheet.

PS ACT 1.5 Limit and Torque Switches

- Unless otherwise specified, electric valve actuators shall be equipped with two limit switches, one for the end position 'OPEN' and one for the end position 'CLOSED'.
- For torque seating and over torque protection, actuators must be equipped with two torque switches, one for opening and one for closing direction.
- All switches (limit and torque) shall be of the snap-action micro switch type, totally enclosed acc. IP66, each with one set of NO contacts and one set of NC contacts. The connecting wires shall be sealed in the switch-housing.
- Switch contacts shall be rated for:

Type of current	Switch rating I max		
	30 V	125 V	250 V
AC (inductive load, cos phi = 0,8)	5,0 A	5,0 A	5,0 A
DC (resistive load)	2,0 A	0,6 A	0,4 A

- Torque- and limit switch setting devices must be easily accessible for adjustment.
- Limit- and torque switches must be operated by counter gear-driven cams, which are mechanically linked to the driving devices, without slip-clutches. No battery backed limit sensing shall be used to avoid malfunction of the actuator in case of power failure or dead battery.
- Torque switch signalisation must be active in manual operation (by handwheel) as well.
- The torque switch sensing shall have calibrated dials, which directly indicate the set-torque, independently for 'OPEN' and 'CLOSE' direction. No electronic torque sensing shall be used.
- Actuators used for advanced control applications may incorporate an absolute encoder for limit switching and torque switching. Torque switching shall still be active during manual operation when using such a device. No battery back-up device will be permitted.

PS ACT 1.6 Position indication

- Actuator shall be equipped with a local indicator which continuously shows the valve travel from fully open to fully closed and vice versa. The indicator shall be based on a mechanical principle to show the valve position during electric or manual operation.
- If required, a 4 - 20 Ma transmitter shall be installed in the actuator. High quality potentiometers shall be used to sense the valve position.

- Each actuator shall provide an adequately sized internal and external connection for earthing.

PS ACT 1.9 Anti-condensation heater

- In order to prevent condensation, a heater must be installed inside of the actuator, suitable for continuous operation.

PS ACT 1.10 Enclosures

- Protection class of the actuator, including the motor, shall be IP 68 according to EN 60529.

PS ACT 1.11 Handwheel

- Actuators must be equipped with a handwheel for manual operation. Clockwise operation of the handwheel shall cause clockwise movement of the output drive. The face of the handwheel shall be clearly marked with an arrow and the word 'CLOSE'.
- The handwheel must be sized in such a way, to allow convenient operation. The torque switches shall be active in manual operation mode as well, thus allowing to provide a signal when the set-torque has been reached.
- Operation of the handwheel shall require manual declutching. Under manual operation, the handwheel shall drive the worm shaft. Self-locking shall be maintained in hand operation. The motor must be disengaged during manual operation. The handwheel shall automatically disengage when the electric motor is energised.

PS ACT 1.12 Bearings and gears

- Bearings shall be of the antifriction or self-lubricating type. Bearings shall not require any maintenance between general overhauls.
- Power gears shall be made from heat treated steel. Worm-wheels shall be made of bronze material.
- The actuator gear housing shall be filled with adequate quantity of lubricant. Re-lubrication between general overhauls shall not be required.
- In case quarter-turn-gearboxes are required in combination with multi-turn actuators to operate the valve, the gear housing shall be made out of cast iron (GG) or ductile iron (GGG). End stops in both directions, located at the input shaft (not the gear housing) shall be available by means of a travelling nut to protect the valve against excessive torque. The gearbox shall be designed as per valve and actuator requirements. The worm wheel shall be made out of bronze. Segment / quadrant type worm wheel, as well as spindle or scotch – yoke type of gearbox shall not be allowed. Enclosure for gearbox shall be IP 67.

PS ACT 1.13 Noise level

- Under all operating conditions the noise level of actuators shall not exceed 75 Db(A) at 1 m.

PS ACT 1.14 Name plates

- Two nameplates shall be attached to each actuator: one on the motor housing, showing all relevant motor data, one on the actuator housing showing all relevant actuator and mechanical data. Special information, like the valve tag no., shall be shown if required.
- The nameplates shall be securely fixed to the actuator and motor, so that they cannot be removed or scratched off during shipment, installation, operation or maintenance.

PS ACT 1.15 Painting and corrosion protection

- Corrosion protection shall fulfil the requirements of salt spray tests in accordance with DIN 50021.
- Actuator painting must be performed in such a way, that no corrosion takes place under the ambient conditions as specified. All outside screws or bolts shall be made out of stainless steel (A2)
- Surface preparation for cast iron parts shall be sand blasted, equivalent to Sa 2 ½ according to SIS 0559 000-1967 / DIN 55 928, part 4.
- Surface treatment for external parts which need to be removed during commissioning or maintenance shall be electro dip coated or metallic surface protected.
- Primer coating: 2-component primer based on epoxy resin with micaceous iron oxide
- Finish coating: Entire film thickness: at least 140 µm

PS ACT 1.16 Inspection and Testing at Manufacturer's Work

Each actuator shall be factory tested. Tests shall be performed in accordance with IEC standards as far as applicable. The Engineer shall witness all tests and the manufacturer's premises.

A final inspection and testing record shall be supplied with each actuator. This shall include the following information:

- General actuator data
- Nominal current
- No load current
- Starting current
- Power factor at rated torque
- Output speed
- Torque switch setting
- Limit switch setting (turns/stroke)
- High voltage test
- Functional test (including all options)
- Visual test

Preferred makes of the actuators shall be in accordance with the EWS Standard Specifications and Preferred Equipment List or similar and equal approved. The valve supplier shall be responsible for the design and provide detailed shop drawings of the actuator and mounting arrangements as required.

The valve shall be delivered to the actuator supplier's premises for them to fit the electric actuators to the valves and factory test the actuators before delivery to site for installation.

Full technical specifications and details shall be supplied for all the actuators and included with the tender submitted.



Project Particular Specification

Valves

PS VS

NAIDU
CONSULTING
ENGINEERING DEVELOPMENT

Functional Upgrade of Tongaat Water
Treatment Works - Work Package 1

Revision 0

August 2024

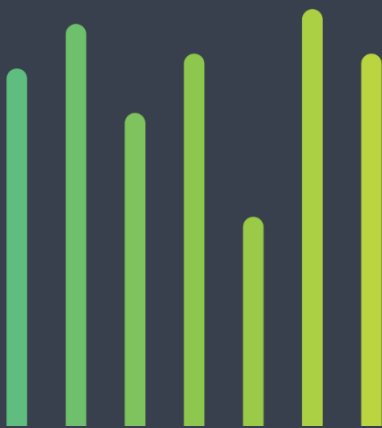


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PREAMBLE

This specification, titled "VS: VALVES", is based on the eThekweni Water and Sanitation (EWS) particular specifications titled "VSS: VALVE STANDARD SPECIFICATION". However, this specification supersedes the EWS particular specifications and shall serve as the definitive standard for the design, manufacture, supply, installation, and testing of all valves within its scope.

In the event of any discrepancy between this specification and the original EWS document, the provisions of this specification shall take precedence. All contractors, suppliers, and stakeholders are required to comply fully with the requirements outlined herein.

.

PS VS 1 PREAMBLE AND SCOPE

This particular specification covers materials, manufacturing and testing requirements for wedge gate, resilient seat gate valves, check, butterfly and air valves for use in water installations.

This specification must be read in conjunction with the project specification and drawings which provide specific detail related to the scope of work.

In the event of any discrepancy between a part or parts of the Standard Specifications and the Project Specification, the Project Specification shall take precedence. In the event of a discrepancy between the Specifications, (including the Project Specifications) and the drawings and / or the Bill of Quantities, the discrepancy shall be resolved by the Employer's Agent before the execution of the work under the relevant item.

PS VS 2 INTERPRETATIONS **PS VS 2.1 Supporting Specifications**

The following form part of this specification:

- a) SANS 664-1:2011 – Wedge Gate and Resilient Seal Valves for Waterworks: Part 1: General
- b) SANS 664-2:2011 – Wedge Gate and Resilient Seal Valves for Waterworks: Part 2: Wedge Gate
- c) Valves
- d) SANS 664-3:2011 – Wedge Gate and Resilient Seal Valves for Waterworks: Part 3: Resilient Seal
- e) Valves
- f) SANS 191:2015 – Cast Steel Gate Valves
- g) SANS 1849:2008 – Butterfly Valves for General Purposes
- h) SANS 1551-1: 2008 – Check Valves (flanged and wafer types): Part 1: PN Series (DN 40 to DN 600 with PN up to 2500 kPa)
- i) 600 with PN up to 2500 kPa)
- j) SANS 1551-2: 2007 – Check Valves (flanged and wafer types): Part 2: Class Series (DN 40 to DN 600 with PN up to 4200 kPa)

Where there is conflict, the requirements contained in this specification shall take precedence over the above-mentioned SANS specifications.

PS VS 2.2 Abbreviations

EPDM	Ethylene Propylene Diene Monomer (M-Class)
DN	Nominal Diameter
PN	Nominal Pressure
NBR	Nitrile Rubber
QCP	Quality Control Plan

PS VS 3 MATERIALS, WORKMANSHIP AND CONSTRUCTION **PS VS 3.1 General**

The types, sizes, end connections and pressure ratings of the valves required are as scheduled in the Bills of Quantities and specification and on the relevant drawings.

Unless specifically stated otherwise, all valves are to be suitable for use in terminal positions.

Technical Data Sheets are included in the Returnable Schedules section of the tender document to enable tenderers to provide specific details of the valves offered.

PS VS 3.2 Quality Verification

The valve manufacturer shall have in place, and shall fully comply with, a certified SANS 9001 integrated quality system that is applicable to the valve design, manufacturing, testing and coating and lining processes.

A QCP shall be prepared by the manufacturer well in advance of commencement of manufacture and submitted to the Employer's Agent for consideration and amendment as deemed necessary and shall thereafter be updated and adhered to be the manufacturer.

PS VS 3.3 Corrosion Protection

PS VS 3.3.1 General

All valves shall be coated externally and lined internally as specified hereunder.

Coating and lining materials shall be suitable for use on potable water systems. The cured materials shall be chemically unaffected by free chlorine or chloramine in water up to concentrations of 10mg/l and to ozone concentration up to 5mg/l in water and by fluids with a pH ranging from 4 to 10.

The coating and lining of valves shall be carried out at the factory prior to the dispatch of the valves. Nonferrous metals or stainless-steel surfaces must not be painted.

PS VS 3.3.2 Surface Preparation

All cast iron and steel surfaces of every valve shall be prepared for painting to a thoroughly clean condition, free of all grease and deleterious matter.

Surfaces shall be degreased using a water-free solvent degreaser such as that that complies with SANS 1344 or, for use in enclosed systems, with SANS 1365.

After complete removal of oil or grease contamination, the valve shall be thoroughly washed with clean potable water to remove all residues. The surface shall be water break free. The valve shall then be allowed to dry.

PS VS 3.3.3 Blast Cleaning

Abrasive materials used for blast cleaning shall be free from oil or grease, as shall be the compressed air used in air blast cleaning.

Surfaces shall be blast cleaned by air blast cleaning methods, then vacuum cleaned or blown off to achieve a standard equal to Sa3 of Swedish Standard SIS 05 5900 when tested in accordance with SANS 5767.

The profile produced by blast cleaning shall be angular and shall have an average peak to valley height of 60 to 100 microns, when tested in accordance with SANS 5772. Hackles shall be removed with coarse abrasive paper.

Residual dust and debris shall not exceed 0.2% when tested in accordance with SANS 5769.

Water soluble salts shall not exceed 100mg/m² at any point when tested with the Webber-Reilly Reagent.

Any laminations revealed by blast cleaning shall be ground out and re-blasted. If grinding penetrates the body to a depth greater than 8% of the nominal wall thickness the valve shall be rejected.

PS VS 3.3.4 Handling of Cleaned Valve

After cleaning, the surfaces shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces in contact with the valve shall be clean and free from oil, grease, grit, dirt and other contamination.

PS VS 3.3.5 Coating and Lining Materials

The materials shall comply with SANS 217: 2015 Type 1A for solvent borne chemically cured epoxies.

A total minimum dry film thickness of 250 µm that is to be pinhole free over the entire painted surface shall be achieved.

Coating and lining repairs shall be carried out using repair systems that comply with the specified performance requirements and shall be compatible with the coating and lining materials. The Contractor shall submit proof to the Employer's Agent from the suppliers of the lining and coating suppliers to this effect.

The mating faces of flanges shall be masked and left uncoated. All runs or drips of epoxy shall be removed from the mating faces of the flanges and the flange profiling shall be clearly visible over the entire flange face.

The mating face shall receive one coat of an approved polymer based, waterborne rust inhibitor.

Care shall be exercised to ensure that after application of all coatings there are no runs or drips and that the flange profiling is clearly visible over the entire flange face. Excessive coating build up in flange bolt holes that could snag bolts will not be permitted.

PS VS 3.3.6 Inspection

Low voltage, wet sponge detection of pinholes is to be conducted on all coated surfaces of the valves. There shall be no defects in the coatings and linings when tested in accordance with ASTM D5162. The finish coating is to be smooth and glossy, free from pinholes, excessive runs, sags, "orange peel" finish, occlusions and other visible defects.

PS VS 4 INTENTIONALLY LEFT BLANK

PS VS 5

WEDGE GATE VALVES (SANS 664 Part 1 & Part 2)

Where no materials are specified, the valve shall be constructed with materials as stated in Table 4 — General materials for valves as specified in SANS 664-1:2011. Generally, valves shall be providing with rising spindles, where space permits.

With reference to Annex A.1 to SANS 664-1:2011 Wedge Gate and Resilient Seal Valves for Waterworks: Part 1: General:

- a) The sizes, pressure ratings, end connections and other specific details of the valves required are as scheduled in the Bill of Quantities.
- b) The method(s) of operation of the valves shall be as stated in Table A below.
- c) The direction of turning the spindle to close the valve shall be as shown in Table A below.
- d) The valves shall be provided with a means for repacking the gland whilst the valve in under pressure.
- e) The flange details are given in Table A below.
- f) Flanges are to be either flat faced or raised face as shown in Table A below. The backs of each flange shall be spot faced over areas large enough to accommodate every washer and nut.
- g) All flanges are to be drilled with the holes off horizontal and vertical centrelines.
- h) Hexagon-head bolts shall comply with the requirements of SANS 1700-5-1.
- i) All valves shall be double flanged unless otherwise scheduled in the Bills of Quantities.
- j) Unless stated in Table A below, no position indicators are required.
- k) Unless stated in Table A below, no identification plates are required.
- l) Test certificates are required and shall be submitted to the Employer's Agent.
- m) The Employer reserves the right to arrange for inspections and/or witnessing of the manufacture and/or testing and/or coating and lining of the valves. Full details shall be prescribed in the QCP – refer to VS.3.2 above.
- n) The body ends of the valves need not be sealed.
- o) Unless otherwise stated in Table A below, the coating system specified in VS.3.3 above is applicable.

With reference to Annex A.2 to SANS 664-1: 2011 Wedge Gate and Resilient Seal Valves for Waterworks: Part 1: General:

The requirements shall be agreed and documented in a QCP – refer to VS.3.2 above.

With reference to Annex A to SANS 664-2: 2011 Wedge Gate and Resilient Seal Valves for Waterworks: Part 2: Wedge Gate Valves:

- a) The type of trim shall be “Type 3 – Standard” as shown in Table 1 – Trim Materials
- b) Trim rings shall be pinned to the body. Trim rings secured by pressing are not permitted. Bonding liquids are not acceptable as the primary means of securing trim rings.
- c) Working pressures of valves are not normally given as they may vary significantly.
- d) Shoes and channel guides of non-corrosive material, namely bronze, are required for valves:
 - i. DN150 or larger with differential pressures of 500 kPa or higher,
 - ii. Installed where the valve is at an angle to the vertical
 - iii. Wherever gearing or an actuator is installed
- e) Seat leakages in accordance with table 2 are permissible.

PS VS 5.1

Testing

Notwithstanding the requirements of SANS 664-1: 2011, the test pressure requirements are as follows: All wedge gate valves DN 300 and larger shall be subjected to:

- a) An open end gate strength test of 1.5 times the “Pressure Rating” of the valve on both sides of the gate. Drop tightness (gate leakage) in respect of this gate strength test is not required but shall comply with the requirements of SANS 664.
- b) A body test of 2.0 times the “Pressure Rating” of the valve.

TABLE A – WEDGE GATE VALVES

SANS 664-1		PN 10	PN 16	PN 25	PN 40
Annex A.1 (b)	Operation	Valve cap/ hand wheel	Hand wheel	Valve Cap	Hand wheel / actuator
Annex A.1 (c)	Direction of closing	Anti-clockwise	Anti-clockwise	Anti-clockwise	Anti-clockwise
Annex A.1 (e)	Flanges	SANS 1123: Table 1000	SANS 1123: Table 1600	SANS 1123: Table 2500	SANS 1123: Table 4000
Annex A.1 (f)	Flange faces	Flat face	Flat face	Flat face	Flat face
Annex A.1 (j)	Position indicator	N/A	Required	N/A	Required
Annex A.1 (k)	Identification plates	Required	Required	Required	Required
Annex A.1 (o)	Coating System	VS.3.3	VS.3.3	VS.3.3	VS.3.3

PS VS 6 RESILIENT SEAT VALVES (SANS 664 Part 3)

Where no materials are specified, the valve shall be constructed with materials as stated in Table 3—General materials for valves as specified in SANS 664-3:2011. Valves shall generally be provided with rising spindles unless otherwise specified in the Bills of Quantities.

With reference to Annex A.1 to SANS 664-3:2011 Resilient Seal Valves for Waterworks:

- a) The sizes, pressure ratings, end connections, and other specific details of the valves required are as scheduled in the Bill of Quantities.
- b) The method(s) of operation of the valves shall be as stated in Table A below.
- c) The direction of turning the spindle to close the valve shall be as shown in Table A below.
- d) The valve seat shall be resilient and bonded or mechanically secured to ensure a tight seal under all specified operating pressures.
- e) Flange details are given in Table A below. Flanges are to be either flat-faced or raised-faced as shown in Table A below. The backs of each flange shall be spot-faced over areas large enough to accommodate every washer and nut.
- f) All flanges are to be drilled with the holes off horizontal and vertical centrelines.
- g) Hexagon-head bolts shall comply with the requirements of SANS 1700-5-1.
- h) All valves shall be double-flanged unless otherwise scheduled in the Bills of Quantities.
- i) Unless stated in Table A below, no position indicators are required.
- j) Unless stated in Table A below, no identification plates are required.
- k) Test certificates are required and shall be submitted to the Employer's Agent.

With reference to Annex A.2 to SANS 664-3:2011 Resilient Seal Valves for Waterworks: The requirements shall be agreed and documented in a QCP – refer to VS.3.2 above.

PS VS 6.1**Testing**

Notwithstanding the requirements of SANS 664-3:2011, the test pressure requirements are as follows:

- a) All resilient seat valves DN 300 and larger shall be subjected to:
- b) A hydrostatic strength test of 1.5 times the pressure rating of the valve.
- c) A leakage test at the rated pressure of the valve to ensure drop-tight sealing.

Table AA – Resilient Seat Valves

SANS 664-3	PN 10	PN 16	PN 25	PN 40
Annex A.1 (b) Operation	Handwheel/Valve Cap	Handwheel	Handwheel	Actuator/Handwheel
Annex A.1 (c) Direction of closing	Anti-clockwise	Anti-clockwise	Anti-clockwise	Anti-clockwise
Annex A.1 (e) Flanges	SANS 1123: Table 1000	SANS 1123: Table 1600	SANS 1123: Table 2500	SANS 1123: Table 4000
Annex A.1 (f) Flange faces	Flat face	Flat face	Flat face	Flat face
Annex A.1 (j) Position indicator	Not required	Required	Not required	Required
Annex A.1 (k) Identification plates	Required	Required	Required	Required
Annex A.1 (o) Coating system	VS.3.3	VS.3.3	VS.3.3	VS.3.3

PS VS 7**CHECK VALVES (FLANGED AND WAFER TYPES) – PN SERIES (SANS 1551 Part 1)**

With reference to Annex. A.1 to SANS 1551-1:2008 – Check Valves (Flanged and Wafer Type):

- a) The rating of the valves shall be as scheduled in the Bills of Quantities.
- b) Door return springs are not permitted.
- c) Unless otherwise stated in Table B below, the coating system specified in VS.3.3 above is applicable.
- d) The sizes of the valves are as scheduled in the Bills of Quantities.
- e) Valves with a nominal bore greater than 600 mm must be of the double door or multi-door type and, if so shown in Table B below, shall be fitted with an integral valved bypass. In other respects they must be in accordance with the specifications for the single door type. A suitable arrow indicating the flow direction through the valve shall be cast onto the body of the valve.
- f) All valve flanges shall have bolt holes unless otherwise indicated in Table B below.
- g) All valves shall be double flanged. Flange details are given in Table B below. The backs of each flange shall be spot faced over areas large enough to accommodate every washer and nut. All flanges are to be drilled with the holes of horizontal and vertical centre lines.
- h) Unless stated in Table B below, no identification plates are required.

With reference to Annex. A.2 to SANS 1551-1:2008 – Check Valves (Flanged and Wafer Type):

- a) None of the valves will be used at temperatures that exceed 120 °C.
- b) The materials shall be suitable for purpose and shall be agreed and documented in a QCP which is to be approved by the Employer's Agent before manufacture commences.
- c) The Volvo trim materials shall be suitable for purpose and shall be agreed and documented in the QCP - refer to VS.3.2 above.
- d) Door seat rings shall be fixed with non-corrosive if fixing screws.

- e) The maximum permissible leakage rate shall be as stated in column 2 of Table 1 and Table 2 for metal seated and resilient seated valves respectively.
- f) No defects are acceptable unless accepted in writing by the Employer's Agent or his representative, who is duly authorised in writing to approve defects and the method of repair.
- g) Unless otherwise stated in Table B below, the coating system specified in VS.3.3 above is applicable.
- h) The face-to-face dimensions shall be suitable for the proposed installation and shall be agreed and documented in the QCP, which is to be approved by the Employer's Agent before manufacture commences – refer to VS.3.2 above.
- i) The dimensions "A" and "E" are to be agreed and recorded in a QCP prior to commencement of manufacture of the valves.
- j) Unless otherwise stated in Table B below, no additional features are required.
- k) All flanged check valves shall have an access cover.
- l) Unless otherwise stated in Table B below, bolt holes shall be drilled and not tapped.
- m) None of the valves will be used at temperatures exceeding 50 °C.
- n) Unless stated in Table B below, no identification plates are required.
- o) The symbols shown in 7.2.2 are to be used.

PS VS 7.1 Testing

Notwithstanding the requirements of SANS 1551-1:2008, the test pressure requirements are as follows:

All PN Series check valves DN 300 and larger shall be subjected to:

- a) An open end gate strength test of 1.5 times the "Pressure Rating" of the valve on both sides of the gate. Drop tightness (gate leakage) in respect of this gate strength test is not required but shall comply with the requirements of SANS 664.
- b) A body test of 2.0 times the "Pressure Rating" of the valve.

TABLE B - CHECK VALVES - PN SERIES

SANS 1551-1		PN 10	PN 16	PN 25	PN 40
Annex A.1 (c)	Coating system	VS.3.3	VS.3.3	VS.3.3	VS.3.3
Annex A.1 (e)	Bypass	Integral DN 25 valved bypass	Integral DN 25 valved bypass	Integral DN 25 valved bypass	Integral DN 25 valved bypass
Annex A.1 (e)	Additional features	Extension arm and counterweight	Extension arm and counterweight	Extension arm and counterweight	Extension arm and counterweight
Annex A.1 (f)	Bolt holes	No bolt holes	No bolt holes	No bolt holes	No bolt holes
Annex A.1 (g)	Flanges	SANS 1123: Table 1000	SANS 1123: Table 1600	SANS 1123: Table 2500	SANS 1123: Table 4000
Annex A.1 (g)	Flange faces	Flat face	Flat face	Flat face	Flat face
Annex A.1 (h)	Identification plates	Required	Required	Required	Required
Annex A.2 (g)	Coating system	VS.3.3	VS.3.3	VS.3.3	VS.3.3
Annex A.2 (j)	Additional features	Extension arm and counterweight – must state position ie. left or right side when viewed in direction of flow	Extension arm and counterweight – must state position ie. left or right side when viewed in direction of flow	Extension arm and counterweight – must state position ie. left or right side when viewed in direction of flow	Extension arm and counterweight – must state position ie. left or right side when viewed in direction of flow
Annex A.2 (l)	Bolt holes	Drilled & tapped	Drilled & tapped	Drilled & tapped	Drilled & tapped
Annex A.2 (n)	Identification plates	Required	Required	Required	Required

PS VS 8

BUTTERFLY VALVES

With reference to Annex A.1 to SANS 1849: 2008 – Butterfly Valves:

- a) The types of valves required are as scheduled in the Bills of Quantities
- b) The nominal sizes (DN) of the valves are as shown in the Bill of Quantities and on the Technical Data Sheet(s).
- c) The nominal pressures (PN) of the valves are as scheduled in the Bills of Quantities.
- d) None of the valves will operate at a temperature above 50 °C.
- e) Flange details are given in Table C below. The backs of each flange shall be spot faced over areas large enough to accommodate every washer and nut. All flanges are to be drilled with the holes off horizontal and vertical centrelines.
- f) The face-to-face dimension of the valves shall be in accordance with Table 5 unless as agreed and recorded in a QCP – refer to VS.3.2 above.
- g) The service application shall be “tight-shut-off” as per 4.6.1 a).
- h) Wafer lugged valves shall have drilled through holes unless otherwise stated in Table C below.
- i) Tapping connections shall be in the side of the valve opposite to the operator end of the shaft.
- j) Support feet shall be provided for valves greater than DN 400.
- k) The service differential pressure shall be “Nominal Pressure PN” of the valve.
- l) The operating devices shall be as stated in the Table C below.
- m) The direction of turning the spindle to close the valve shall be as shown in Table C below.
- n) Details of the actuators required, if any, are given in the tender document.
- o) The locking mechanism is not required to provide for an intermediate position.
- p) The valve body and disc material shall be ductile iron unless otherwise agreed and recorded in a QCP prior to commencement of manufacture of the valves.
- q) The leakage rate for low leakage valves shall be rate D.
- r) Valves will not be used for regulating purposes.
- s) A test certificate is required for every valve.
- t) Unless otherwise stated in Table C below, the coating system specified in VS.3.3 above is applicable.
- u) All valves shall have their jointing surfaces protected during transit and storage.
- v) All valves shall have their body ends sealed to exclude foreign matter during transit and storage.
- w) Each valve shall have a manufacturer’s certificate.

With reference to Annex A.2 to SANS 1849:2008 – Butterfly Valves:

- a) This specification does not deal with the “other types of valves, shouldered, socketed, etc.”
- b) The design and function of position indicators shall be as agreed and recorded in a QCP – refer to VS.3.2 above.
- c) The maximum allowable leakage rate shall be agreed and recorded in a QCP prior to commencement of manufacture of the valves.

In addition to the requirements of SANS 1849:2008, all valves shall comply with the following minimum requirements:

- a) Valves shall be double flanged and be suitable for installation in terminal positions unless otherwise stated.
- b) Valves shall be of the “tight shut off type” and water seals shall be the resilient seal type.
- c) All stainless-steel components shall be Grade 316 stainless steel unless the design of the valve warrants a higher strength, high chrome steel.
- d) Hubs for shaft bearing housings shall form an integral part of the valve body.
- e) Valve bodies shall have adjustable mechanical stops to prevent over travel of the valve disc in the open and closed position.
- f) Valves shall have the configurations shown in the table below:

(a) Nominal Pressure	PN 10 & PN 16	PN 25	PN 40	> PN 40
(b) Seal	EPDM or Nitrile – see g) below	EPDM or Nitrile – see h) below	EPDM or Nitrile – see h) below	Metal – see i) below
(c) Eccentricity	Nil	(d) Double eccentric	(e) Double eccentric	(f) Triple eccentric

- a) For PN 10 and PN 16 valves, the resilient, synthetic rubber EPDM or Nitrile seal shall preferably be easily replaceable (not bonded), and shall entirely cover the inside of the body overlapping over the sides to form the seal between the body and matching pipework. The liner shall be keyed to the body with the annular grooves in the bore of the valve to minimise distortion of the material. However, a fully bonded seal is acceptable, in which case, the seal should be bonded onto a phenolic backing ring, the valve manufacturer will be required to guarantee that they are able to reline their valves in RSA.
- b) For PN 25 and PN 40 valves, the resilient, synthetic rubber EPDM or Nitrile seal shall be fixed to the disc with Grade 316 stainless steel retaining rings protected against galvanic corrosion in accordance with VS 3.3 above. The recess for the retaining ring in the blade or body shall be coated as specified or the seal face shall be assembled with a coat of wet solvent free epoxy having been applied. Seal retaining screws shall not be recessed but have a hexagonal or Allen key bolt head and spring washer underneath to ensure that water seepage does not occur into the screw area. The seal assembly should be done with the use of “Anti-seize” to ensure ease of removal and further prevent water seepage and corrosion.
- c) For valves with a PN > 40, the disc seal shall be stainless steel and, as they need to be carefully matched the manufacturer shall supply a complete spare set including fixings and the costs shall be included in the tendered rate quoted for the valve. Furthermore, the valve manufacturer will be required to confirm that a facility to recondition the valve exists in RSA.
- d) The design shall be such as to allow the disc to seal drop-tight to the liner, so that there is no ingress of fluid to the shaft area.
- e) The seat shall be sufficiently wide to permit at least 10 mm “lead” distance on each side for the resilient seal.
- f) The resilient seal shall be “non-stick” and shall be stable and not deteriorate under conditions of continuous submersion in chlorinated potable water.
- g) The valve seal and seat shall be replaceable without dismantling the valve - not applicable to PN 10 and PN 16 valves that may have bonded seals.
- h) Discs shall be a single casting of a hydrofoil section with a smooth continuous surface. The maximum combined stresses in the disc shall not exceed 20% of the minimum yield stress of the material used when the specified unbalanced pressure is applied on either of the two sides.
- i) Shafts may either be continuous or of a stub-shaft configuration. In the case of stub shafts, they must extend into the disc hub for a distance of at least 1,5 times the diameter of the shaft and they shall not protrude from the hubs i.e. the shaft shall not be exposed.
- j) Shafts may be either round or hexagonal in cross section. The disc shall be attached to the shaft by means of a 'square drive' or spline or key. No allowance shall be made on dowel pins or taper pins to transmit torque. The connection of the disc to the shaft shall be capable of transmitting a shaft torque equivalent to at least 75% of the design torsional strength of the shaft. Dowel and taper pins that may be required to prevent lateral movement shall be mechanically secured.
- k) Shafts shall be fabricated from high strength, high grade, stainless steel and be located in self lubricating sleeve type bearings/bushes. Each valve shall be fitted with at least one adjustable thrust bearing set to hold the disc securely concentric with the body or seat.
- l) Shafts shall be located inside the disc and not be in contact with the water.
- m) Shaft sealing shall be achieved with two replaceable O-rings at each end of the shaft and, where applicable, the rubber lining is to be moulded along the stem.
- n) Each valve shall be equipped with an operating lever, or a gearbox with a handwheel, or an actuator as stated in Table C below.
- o) Each valve shall be so protected as to minimize the possibility of damage during transit and storage. All valves shall be individually crated.

- p) The valves will be installed with their shafts horizontal and the valve operating spindle, vertical. The direction of opening shall be such that the bottom of the disc moves in a downstream direction. The 'handing' of the valves shall be as shown in Table C below.

PS VS 8.1 Testing

Notwithstanding the requirements of SANS 1849:2008, the test pressure requirements are as follows:

- a) All valves shall be subjected to an open-end gate strength test of 1,5 times the 'Pressure Rating' of the valve on both sides of the gate. Drop tightness in respect of this gate strength test is not required but shall comply with the requirements of SANS 1849.
- b) All valves shall be subject to a body test of 2.0 times the 'Pressure Rating' of the valve.

PS VS 8.2 Gearboxes (for Butterfly Valves)

Where required and/or where specified, all gearboxes on butterfly valves shall comply with the following:

- a) Gearboxes shall be side mounted and of the spur/worm type capable of being manually operated, by one person under the maximum unbalanced working pressure whilst applying a torque of no more than 120 Nm.
- b) Shear pins shall be fitted to gearboxes in order to provide overload protection.
- c) Water must not be able to leak past the main shaft and enter the actuator.
- d) Disc position indicators shall be fitted to the gearbox and shall clearly indicate the fully open and closed positions.
- e) A suitable arrow indicating the preferred flow direction through the valve, where such preference is applicable, shall be cast onto the body of the valve and, where applicable, the inappropriate arrow ground off.
- f) The gearbox shall be fitted to the right-hand side or left-hand side of the valve when viewed from the upstream side as stated in Table C below.
- g) The handwheel shall be of appropriate size and the direction of rotation of the operating hand wheel to close the valve shall be as stated in Table C below.
- h) Gearboxes shall be coated in accordance with the coating specification for its associated valve.

TABLE C - BUTTERFLY VALVES

SANS 1849		PN10	PN16	PN25	PN40
Annex A.1 e)	Flanges	SANS 1123: Table 1000	SANS 1123: Table 1600	SANS 1123: Table 2500	SANS 1123: Table 4000
Annex A.1 e)	Flange faces	Flat face	Flat face	Flat face	Flat face
Annex A.1 h)	Holes in wafer valves	Drilled and tapped	Drilled and tapped	Drilled and tapped	Drilled and tapped
Annex A.1 l)	Operating device	Hand wheel	Hand wheel	Hand wheel	Actuator/ Handwheel
Annex A.1 t)	Coating System	VS.3.3	VS.3.3	VS.3.3	VS.3.3
VS.8.2 f)	Location of gearbox	Left / right hand side when viewed in the direction of flow	Left / right hand side when viewed in the direction of flow	Left / right hand side when viewed in the direction of flow	Left / right hand side when viewed in the direction of flow
VS.8.2 g)	Direction of closing	Anti-clockwise	Anti-clockwise	Anti-clockwise	Anti-clockwise

PS VS 9 AIR VALVES

PS VS 9.1 Design and Performance

The design and performance characteristics of the air valves must have been tested and approved by the Council for Scientific and Industrial Research (CSIR) or other similar testing authority.

Valves shall be capable of discharging high volumes of air through the large orifice under positive line pressure filling conditions and shall be capable of letting in high volumes of air under negative pressure conditions. In addition, the valve shall be capable of releasing small quantities of dis-entrained air at all line pressures up to the rated working pressure of the valve.

Air valves shall not exhibit the characteristics of dynamic closure in both the exhaust and vacuum mode. The valves shall be dual acting and suitably sized to enable the following without creating shock or pressure surges in the pipeline:

- Unrestricted intake of air under negative (sub atmospheric) pressure
- Unrestricted discharge of air under pressurised air pressure conditions and,
- Slow discharge of air that may come out of solution when the space beneath the air valve is full of water under pressure

The primary intake/discharge orifice shall be equivalent in cross-sectional area to the nominal diameter of the air valve. The discharge/intake port shall be protected by a non-corrosive screen or shield that shall not impair the discharge characteristics of the valve.

Discharge of pressurised air shall be controlled by the seating and unseating of a small orifice nozzle which shall only open in the presence of air and shall not leak under normal operating conditions.

The valve construction shall be proportioned with regard to the inherent material strengths such that excessive deformation or damage of any kind or leaks do not occur when the air valve is subjected to twice its rated pressure.

Valves shall react immediately to negative pipeline pressure in order to prevent the formation of unacceptably high negative pressure conditions.

During air discharge conditions, the large orifice shall close at a differential pressure across the large orifice of between 4 and 6 kPa in order to minimize transient pressure effects. The design shall enable air to continue to be released once the large orifice has closed under such conditions. This may be achieved by means of a secondary orifice or other approved manner. A slow closing characteristic is an important feature so as to sudden rate of change of velocity which will result in a pressure spine and concomitant surges in the pipeline.

The valve shall seal drop tight, without the use of a mechanical spring device, at all line pressures from 10 kPa up to 1,5 times the rated working pressure of the valve.

The valve floats and seals shall require minimal maintenance and it shall be possible to carry out such maintenance without removing the valve. Provision shall be made for the installation of a 6 mm stainless nipple and ball valve for the fitting of pressure gauges for testing purposes. The stainless-steel nipple shall extend through the body to cover all the threads.

Unless otherwise stated in Table D below, all ferrous components shall be treated as specified in VS.3.3 above.

All stainless-steel components shall be painted with "Everbond" or similar material applied in accordance with the manufacturer's instructions, the purpose of which is to disguise the stainless steel to minimise the risk of theft.

All air valves shall be supplied with a copy of the relevant factory test certificates that reflect the test pressure and valve serial number. Original factory test certificates together with a copy of the QCP referred to in VS.3.2 above, shall be issued for each valve.

Flange details are given in Table D below. The backs of each flange shall be spot faced over areas large enough to accommodate every washer and nut. All flanges are to be drilled with the holes off horizontal and vertical centrelines.

TABLE D – AIR VALVES

	PN10	PN16	PN25	PN40
Flanges	SANS 1123: Table 1000 *	SANS 1123: Table 1600 *	SANS 1123: Table 2500 *	SANS 1123: Table 4000 *
Flange Faces	Flat face **	Flat face **	Flat face **	Flat face **
Coating System	VS.3.3	VS.3.3	VS.3.3	VS.3.3

PS VS 10 VALVE ACTUATORS

Refer to Particular Specifications for Valve Actuators.

PS VS 11 DRAWINGS

The valve manufacturer shall provide fully dimensioned drawings for each type and size of valve and actuator. Drawings must be provided in .pdf and in an CAD format as required by the Employers Agent.

PS VS 12 INSPECTION

An inspector may be appointed by the Employer to witness the hydraulic and other testing of valves and/or to inspect valves prior to their release for delivery to site. Where an independent inspector is appointed, the test and/or inspection certificates must be signed by the supplier and the inspector.

The following procedure shall be employed for the inspection of all valves:

- All valves will be subject to inspection at their place of manufacture or assembly or, where not manufactured or assembled locally, at the valve supplier.
- Inspection may be carried out by the Engineer or a third party appointed by or on behalf of the Employer.
- Where valves are provided with corrosion protective coatings, provision must be made for the prepared surfaces to be inspected by the Engineer or his representative prior to the application of any coatings or linings.
- Provision must be made for all valves to be subjected to inspection and testing following application of corrosion protection coatings and prior to release from the factory for delivery to site.
- Tests on the coatings and linings may include visual inspection, dry film tests and wet sponge
- “holiday” detection tests at the Engineer’s discretion.



Project Particular Specification

Water Meters

PA WM

NAIDU
CONSULTING
ENGINEERING DEVELOPMENT

Functional Upgrade of Tongaat Water
Treatment Works - Work Package 1

Revision 0

August 2024

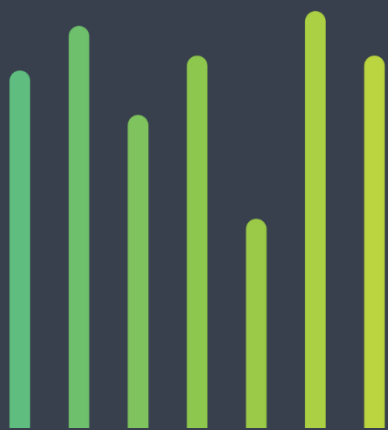


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PREAMBLE

This Project Specification forms an integral part of the contract and supplements the Employer's Standard Specifications where relevant. This specification shall be read in conjunction with the following specifications:

- 1) Project Particular Specification: Mechanical, Electrical and Instrumentation Installation (PA MEI)

All material, equipment, and fittings required shall be manufactured and supplied by an Employer preferred approved supplier. It is the Contractors's responsibility to confirm with their supplier that they are approved by the Employer.

PA WM Water Meters

PA WM 1 Ultrasonic Flow Meters

The ultrasonic flow measuring equipment for recording potable bulk water supply for the works shall be supplied and installed as indicated on the Drawings shall be installed in the meter chambers.

The Contractor will be required to supply, install, calibrate, and commission all metering equipment supplied.

The meters offered shall be of an approved standard design capable of operating under the specified working conditions.

Meter shall be installed strictly in accordance with manufacturer's instructions.

PA WM 1.1 Ultrasonic Flow Meters Specifications and Requirements

Ultrasonic flow meters shall comply with the following:

- 1) The flow meter shall be the in-line ultrasonic type and not strap on type comprising of a minimum of 2 pair of sensors and remote microprocessor based converter unit. The system shall be inherently bi-directional with separate isolated analogue (4-20mA) and pulse outputs (volt free) for forward and reverse flow.
- 2) The flowmeter shall be provided with facilities for a pulsed output to enable electronic data recording, display and/or logging equipment to be linked to the meter.
- 3) The flowmeter shall be equipped with both a local flow display on site and shall also interface with the PLC and to the SCADA system via telemetry to relay the water flow rate and totaliser to the control room.
- 4) The flow meter shall have no moving parts to ensure that there is no damage from particulate matter e.g. stones, etc.
- 5) The wetted materials shall be compatible with and suitable for use on potable water. The liner shall be certified by an internationally recognised body such as AWWA or equivalent.
- 6) The flow sensor and probes enclosure and fittings shall be of stainless steel or better and shall be rated to IP68 requirements to be suitable to indefinite submergence to a depth of up to 10m. A coupling medium is to be applied to ensure good acoustic contact between sensor and coupling.

PA WM 1.1.1 Ultrasonic Flow Meter Accuracy

The system accuracy shall be equal to or better than $\pm 0.5\%$ of measured value under reference conditions irrespective of flow direction with a flow range of 0.01 to 20 m/s full scale (i.e. 2000:1 turndown). Repeatability shall be equal to or better than $\pm 1.0\%$.

PA WM 1.1.2 Ultrasonic Flow Meter Coating and Lining

The flow meter shall be epoxy lined and coated to a minimum dry film thickness of 300 μ m.

PA WM 1.1.3 Ultrasonic Flow Meter Sensor Tube

The flow sensor measuring tube shall be made from AISI grade 316L stainless steel.

PA WM 1.2 Ultrasonic Flow Meter Transmitter

The flow meter, electronic equipment, and transmitter shall meet the minimum requirements and must include the following:

- 1) At least 2 digital outputs, potential free contacts programmable for counter outputs related to flow in both directions.
- 2) The instrument must be configurable via the integral display keypad and PC-based configuration via plug in port.
- 3) LCD with custom configurations for presenting different measured values and status variables with a minimum of three totalisers. There shall be independent totaliser displays to give forward total, reverse total, nett totals, time and date. The display shall be backlit.
- 4) Remote non-re-settable integrator with cyclometer display to give a running total of flow in selectable for kilolitres, megalitres etc.
- 5) Remote 'Rate of Flow' indicator (analogue display, selectable for litres/second, megalitres/day).
- 6) The device shall incorporate a menu selection allowing range, units, etc to be made. Data shall be stored in a non-volatile memory.
- 7) The signal converter shall be capable of non-full pipe detection.
- 8) The meter software shall incorporate multi password protection to prevent inadvertent or fraudulent programming or units of measurement changes.
- 9) The transmitter unit shall be protected to a minimum IP67 and must be of remote version type to be wall mounted which shall house the above.
- 10) Programming software and communication cables compatible with a USB interface on the programming station.
- 11) An isolated 4 to 20mA analogue output that is programmed for the flow rate.
- 12) Signal cable outputs with cable gland in wall-mounted panel to enable transmission of data by radio telemetry to the Employer's main board.
- 13) Instrument to give detailed status indication of all configuration settings i.e. hardware or software.
- 14) The signal transmitter must be fitted with built in communication interface with the integral MODBUS protocols. No converters will be accepted. Optional Profibus and Hart Ethernet configurable connections shall be available.
- 15) System to have immunity to radio frequency interference and not affect radio telemetry equipment installed on site.
- 16) The electronic display and recording equipment described above shall be installed before hydraulic pressure and it shall be calibrated and commissioned in-situ after hydraulic pressure testing completion and approvals.

PA WM 1.2.1 Ultrasonic Flow Meter Cabling and Sensor Probes

The cabling length to connect the signal transmitter and meter shall be determined by the Contractor.

The cable shall meet the following requirements:

- 1) The cable length between sensor and transmitter to meet the installed conditions.
- 2) Cabling between the signal transmitter and meter shall be single cable providing both power and measurement signal from the flowmeter sensor to the flow meter transmitter.
- 3) The sensor cable to be PVC or PTFE insulated.
- 4) All inputs and outputs to be galvanically isolated from the power supply. All pulse/status outputs and Analogue 4-20 mA output to be fully galvanically separated.
- 5) The flow sensor and probes enclosure and fittings shall be of stainless steel or better and shall be rated to IP68 requirements to be suitable to indefinite submergence to a depth of up to 10m. A coupling medium is to be applied to ensure good acoustic contact between sensor and coupling.

PA WM 1.3 Ultrasonic Flow Meter Power Supply

The meter and transmitter shall be suitable for 24V DC power supply without the need for link setting or voltage selection. A 24-hour battery backup with a 24V DC charger shall be incorporated into the system. Alarm contacts for loss of supply and voltage must be made available in the system. The battery must be of the lithium type.

The meter and transmitter shall have transient power protection.

The power for the charger equipment is to be provided under this Contract by means of a 230V, 15A supply from a dedicated rated circuit breaker in the distribution board.

Any electrical supplies which may be required for the charger are to be provided by the Contractor under this Contract and the cost thereof will be deemed to be included in the tendered rates.

PA WM 1.4 Ultrasonic Flow Meter Pressure Rating

Meters shall be suitable for a maximum working temperature of 0 to 70°C at pressures up to 1.5 x meter design pressure rating shown in Table 1 on the drawings. All meters shall be flanged to SANS 1123 or EN 1092-1.

PA WM 1.5 Ultrasonic Flow Meter Inlet and Outlet Pipe Runs

Tenderers must provide full details of the minimum lengths of straight pipe required upstream and downstream from each type of appurtenance, so that the accuracy of the meters remains within the specified accuracies.

The specification is based off minimum installation of straight pipe requirement of 5 x meter diameter upstream from the flow meter and 3 x meter diameter downstream from the flow meter.

Any additional straight pipe lengths required for the offered flow meter for the upstream and downstream spool pieces are deemed to be inclusive in the pricing of the flow meter.

PA WM 1.6 Ultrasonic Flow Meter Panel

The wall mounted meter panel shall be completely enclosed over the whole front face and at the sides. The panel is to be designed so that access to the equipment therein will be from the front. All cable entries shall be from the bottom.

The panel shall be finished in baked enamel with either a smooth or stippled surface.

All bolts, screws and handles for the operation of the front access door shall be polished metalwork free from scratches and of uniform appearance. All labels shall be made in

approved sandwich type board with not less than 10 mm lettering. All bolts, nuts, screws, and washers shall be 316 stainless steel.

PA WM 1.7 Ultrasonic Flow Meter Calibration and Other Certification

The meter performance shall have been verified using wetted calibration with potable water on a fully traceable test facility that is internationally accepted. Laboratory traceability packs shall be available on request. Meter calibration certificate to be provided and results to comply applicable to an accredited standard i.e. SANAS or better.

The meter shall also be provided with an ITS (inspection test plan), pressure certificate, material specification, and material certificate.

The meter shall be designed and manufactured under the ISO 9000 series of quality standards. It shall also have a meter body length to current ISO standard for in-line ultrasonic flow meters to facilitate interchangeability of product.

PA WM 1.8 Ultrasonic Flow Meter Direction of Flow

The forward flow direction indication shall be provided on of the meter housing in a position which can be seen from the top of the meter. This indication shall be in the form of an arrow forming part of the casting or in the form of an engraved brass plate with an arrow and fixed to the housing with drilled and tapped stainless steel machine screws.

PA WM 1.9 Ultrasonic Flow Meter Documentation

5 x copies, specific for the meter for the specified pipe size, covering installation, and operating and maintenance instructions, shall be provided prior to installation and commissioning.

General arrangement (GA) drawings shall be supplied with the meter and shall also be included in the O & M manuals.

Meter datasheet (both soft and hard copies) to be provided after commissioning

Full details of the meter offered and of its guaranteed performance capabilities and accuracies shall be furnished with the tender.

PA WM 1.10 Ultrasonic Flow Meter Measurement and Payment

An item has been scheduled in the Bill of Quantities for the supplying, installing, installation of transmitter, cabling, calibrating, testing, and commissioning of all the necessary flow measuring and recording/display equipment as specified. The rates tendered shall be deemed to include for all labour, plant, materials, and equipment necessary to complete the work.

Unit: No.

PA WM 2 Electromagnetic Flow Meters

The electromagnetic flow measuring equipment for recording potable bulk water supply for the works shall be supplied and installed as indicated on the Drawings and shall be installed in the meter chambers:

The Contractor will be required to supply, install, calibrate, and commission all metering equipment supplied.

The meters offered shall be of an approved standard design capable of operating under the specified working conditions.

Meters shall be installed strictly in accordance with manufacturer's instructions.

PA WM 2.1 Electromagnetic Flow Meter Specifications and Requirements

Electromagnetic flow meters shall comply with the following:

- 1) The flow meter shall be electromagnetic type with remote microprocessor based converter unit. The system shall be inherently bi-directional with separate isolated analogue (4-20mA) and pulse outputs (voltage free) for forward and reverse flow.
- 2) The flowmeter shall be provided with facilities for a pulsed output to enable electronic data recording, display, and/or logging equipment to be linked to the meter.
- 3) The flow meter shall have no moving parts to ensure that there is no damage from particulate matter e.g. stones, etc.
- 4) The wetted materials shall be compatible with, and suitable for, use on potable water. The liner shall be certified by an internationally recognised body such as AWWA or equivalent. Acceptable electrode material is stainless steel.
- 5) The performance of the flow meter must be immune to stray currents, cathodic currents, and electromagnetic interference.
- 6) The flow sensor and probes enclosure and fittings shall be of stainless steel or better and shall be rated to IP68 requirements to be suitable to indefinite submergence to a depth of up to 10m. A coupling medium is to be applied to ensure good acoustic contact between sensor and coupling.
- 7) The meter must be fitted with potential free relay contacts for power, instrument fault, etc.

PA WM 2.1.1 Electromagnetic Flow Meter Accuracy

The system accuracy shall be equal to or better than $\pm 0.5\%$ of measured value between flow velocities 0.5 and 10 m/s under reference conditions irrespective of flow direction with a flow range of 0.1 to 10 m/s full scale. Repeatability shall be equal to or better than $\pm 0.1\%$.

PA WM 2.1.2 Electromagnetic Flow Meter Lining and Coating

The flow meter shall be epoxy lined and coated to a minimum dry film thickness of 300 μ m.

PA WM 2.1.3 Electromagnetic Flow Meter Sensor Tube

The flow sensor measuring tube shall be made from AISI 316L grade stainless steel.

PA WM 2.1.4 Electromagnetic Flow Meter Sensor Tube Liner

The flow sensor tube shall be lined with a polyurethane lining and be capable of operating under the following conditions:

- 1) Temperature rating: 0 to 50°C
- 2) Pressure rating: 1 kPa to 4000 kPa (Absolute)

PA WM 2.2 Electromagnetic Flow Meter Transmitter

The flow meter, electronic equipment, and transmitter shall meet the minimum requirements and must include the following:

- 1) At least 2 digital outputs, potential free contacts programmable for counter outputs related to flow in both directions.

- 2) The instrument must be configurable via the integral display keypad and PC-based configuration via plug in port.
- 3) The signal converter display shall be a multi-line multi-character LCD display with dual alphanumeric custom configurations for presenting different measured values and shall have independent totaliser displays to give forward total, reverse total, nett totals, time and date. The display shall be backlit.
- 4) Remote non-re-settable integrator with cyclometer display to give a running total of flow in selectable for kilolitres, megalitres etc.
- 5) Remote 'Rate of Flow' indicator (analogue display, selectable for litres/second, megalitres/day).
- 6) The device shall incorporate a menu selection allowing range, unit's etc to be made. Data shall be stored in a non-volatile memory for a minimum retention of 10 years.
- 7) The signal converter shall be capable of non-full pipe detection.
- 8) The meter software shall incorporate multi password protection to prevent inadvertent or fraudulent programming or units of measurement changes.
- 9) The transmitter unit shall be protected to a minimum IP67 and must be of remote version type to be wall mounted which shall house the above.
- 10) Programming software and communication cables compatible with a USB interface on the programming station.
- 11) An isolated 4 to 20mA analogue output that is programmed for the flow rate.
- 12) Signal cable outputs with cable gland in wall-mounted panel to enable transmission of data by radio telemetry to the Employer's main board.
- 13) Instrument to give detailed status indication of all configuration settings i.e. hardware or software.
- 14) The meter system must through the software be capable of providing the historical information of the calibration setting, flow rates, peak, reverse average etc. These must be date stamped.
- 15) The signal transmitter must be fitted with built in communication interface with the integral MODBUS protocols. No converters will be accepted. Optional Profibus and Hart Ethernet configurable connections shall be available.
- 16) System to have immunity to radio frequency interference and not affect radio telemetry equipment installed on site.
- 17) The electronic display and recording equipment described above shall be installed before hydraulic pressure and it shall be calibrated and commissioned in-situ after hydraulic pressure testing completion and approvals.

PA WM 2.2.1 Electromagnetic Flow Meter Cabling and Sensor Tubes

The cabling length to connect the signal transmitter and meter shall be determined by the Contractor.

The cable shall meet the following requirements:

- 1) The cable length between sensor and transmitter to meet the installed conditions.
- 2) Cabling between the signal transmitter and meter shall be single cable providing both power and measurement signal from the flowmeter sensor to the flow meter transmitter thus reducing cabling costs and can be up to 250 meters in length.

- 3) The sensor cable to be PVC or PTFE insulated.
- 4) All inputs and outputs to be galvanically isolated from the power supply. All pulse/status outputs and Analogue 4-20 mA output to be fully galvanically separated.

PA WM 2.3 Electromagnetic Flow Meter Power Supply

The type of meter power supply shall be shown on the drawings and/or Bill of Quantities for the electromagnetic flow meter required.

Any electrical supplies which may be required for the charger are to be provided by the Contractor under this Contract and the cost thereof will be deemed to be included in the tendered rates.

PA WM 2.3.1 Electromagnetic Flow Meter Mains Powered Supply

The meter and transmitter shall be suitable for 24V DC without the need for link setting or voltage selection. A 24-hour battery back-up with a 24V DC charger shall be incorporated into the system. Alarm contacts for loss of supply and voltage must be made available in the system. The battery must be of the lead acid type.

The meter and transmitter shall have transient power protection.

The power for the charger equipment is to be provided under this Contract by means of a 230V, 15A supply from a dedicated rated circuit breaker in the distribution board.

PA WM 2.3.2 Electromagnetic Flow Meter Battery Powered Supply

The meter and transmitter shall be powered by battery power. The Transmitter shall be supplied with an internal replaceable battery pack for 3.6V DC (or other suitable standard voltage) with a minimum life span of 15 years. This shall include to power up the unit and for the data signal processing and communication to the remote signal receiving site/s.

The transmitter shall be programmed to have no loss of totaliser data during battery replacement. Alarm contacts shall be set for battery pre warning and battery final warning. The battery shall be of the lithium type.

The meter shall have on-board data logging capability and transmitting of data to the remote SCADA or base station via GPRS/GSM output transmission. The unit shall have an on-board GPRS/GSM modem with WiFi capability. The contractor shall include in the price of the meter to supply a sim card and data contract for a period of 24 months after practical completion for the two way data communication between sites.

Full details of the unit together with the battery specifications shall be provided with the tender.

PA WM 2.4 Electromagnetic Flow Meters Pressure Rating

The meters shall be suitable for a maximum working temperature of 0 to 70°C at pressures up to 1.5 x meter design pressure rating shown in Table 3 and on the drawings. All meters shall be flanged to SANS 1123 or EN 1092-1.

PA WM 2.5 Electromagnetic Flow Meter Inlet and Outlet Pipe Runs

Tenderers must provide full details of the minimum lengths of straight pipe required upstream and downstream from each type of appurtenance, so that the accuracy of the meters remains within the specified accuracies.

The specification is based off minimum installation of straight pipe requirement of 5 x meter diameter upstream from the flow meter and 3 x meter diameter downstream from the flow

meter.

Any additional straight pipe lengths required for the offered flow meter for the upstream and downstream spool pieces are deemed to be inclusive in the pricing of the flow meter by the Contractor.

PA WM 2.6 Electromagnetic Flow Meter Earthing Requirements

The flow meter unit shall be extremely robust and shall be supplied with built in earthing electrodes or supplied complete with earthing rings to upstream and downstream faces of flow meter tube.

Flow meter to supplied and installed with 1.2m earthing spike or earthing mat to the flow meter supplier's recommendations and sizing.

All gaskets between meter faces, earthing ring, and pipe special flange shall be electrically insulating as well as sealing. Bolts shall have insulating bushes as well as insulating washers, so they do not offer a conductive path between the pipe and the mag meter body.

PA WM 2.7 Electromagnetic Flow Meter Panel

The wall mounted meter panel shall be completely enclosed over the whole front face and at the sides. The panel is to be designed so that access to the equipment therein will be from the front. All cable entries shall be from the bottom.

The panel shall be finished in baked enamel with either a smooth or stippled surface.

All bolts, screws and handles for the operation of the front access door shall be polished metalwork free from scratches and of uniform appearance. All labels shall be made in approved sandwich type board with not less than 10 mm lettering. All bolts, nuts, screws, and washers shall be 316 stainless steel.

PA WM 2.8 Electromagnetic Flow Meter Calibration and Other Certificates

The meter performance shall have been verified on a fully traceable test facility that is internationally accepted. Laboratory traceability packs shall be available on request. Meter calibration certificate to be provided and results to comply applicable to an accredited standard i.e. SANAS or better.

The meter shall also be provided with an ITS (inspection test plan), pressure certificate, material specification and material certificate.

The meter shall be designed and manufactured under the ISO 9000 series of quality standards. It shall also have a meter body length to current ISO standard for magnetic meters to facilitate interchangeability of product.

Condition monitoring by use if an in-situ calibration verification device may be used to actively carry out corrective or preventive maintenance of the flow meter system.

PA WM 2.9 Electromagnetic Flow Meter Direction of Flow

The forward flow direction indication shall be provided on of the meter housing in a position which can be seen from the top of the meter. This indication shall be in the form of an arrow forming part of the casting or in the form of an engraved brass plate with an arrow and fixed to the housing with drilled and tapped stainless steel machine screws.

PA WM 2.10 Electromagnetic Flow Meter Documentation

5 x copies, specific for the meter for the specified pipe size, covering installation and operating and maintenance instructions, shall be provided prior to installation and commissioning.

General arrangement (GA) drawings shall be supplied with the meter and shall also be included in the O & M manuals.

Meter datasheet (both soft and hard copies) to be provided after commissioning

Full details of the meter offered and of its guaranteed performance capabilities and accuracies shall be furnished with the tender.

PA WM 2.11 Electromagnetic Flow Meter Measurement and Payment

An item has been scheduled in the Bill of Quantities for the supplying, installing, installation of transmitter, cabling, calibrating, testing, and commissioning of all the necessary flow measuring and recording/display equipment as specified. The rates tendered shall be deemed to include for all labour, plant, materials, and equipment necessary to complete the work. Unit: No.

PA WM 3 Mechanical Flow Meters

Meters of a type and size shall comply with the flow requirements specified in the table below. In this regard the following definitions shall apply:

1) Q_p – Permanent/ Continuous Flow Rate

the flow rate for which the meter is designed and at which the meter is required to give indication within the permissible tolerances which for this Contract is 2% and under normal conditions of use e.g. under steady or intermittent flow conditions.

2) Q_{min} – Minimum Flow Rate

the lowest flow rate at which the meter is required to give indications within the permissible tolerances which for this Contract is 5%. It is determined in terms of Q_p .

3) Q_t – Transitional Flow Rate

the flow rate that occurs between the overload flow rate and the minimum flow rate and at which the flow rate range is divided into two zones, the upper zone (which for this Contract is 2%) and lower zone (which for this Contract is 5%), each characterized by a specific permissible tolerance on flow rate indication.

4) Q_s – Overload Flow Rate

the flow rate that represents the highest flow rate at which the meter is required to operate in a satisfactory manner for a short period of time without sustaining any damage to an accuracy of 2% (Q_{max}).

Table 1: Mechanical Flow Meters Performance

Meter Size (mm)	$Q_p \geq$ (m ³ /hr)	$Q_t \leq$ (m ³ /hr)	$Q_{min} \leq$ (m ³ /hr)	$Q_s \geq$ (m ³ /hr)
40	30	0.15	0.10	50
50	35	0.15	0.15	55
80	120	0.51	0.20	200
100	230	0.81	0.30	300
150	450	1.60	0.80	600
200	800	4.00	2.00	1200
250	1250	6.30	3.50	1600
300	1400	16.00	9.00	2000

PA WM 3.1 Mechanical Flow Meters Specifications and Requirements

Mechanical flow meters shall comply with the following:

- 1) Contain a minimum of wearing parts; be capable of correctly recording low rates of flow and withstanding flows in excess of the maximum rated capacity for short periods without damage to the mechanism.
- 2) Record through flow in cubic meters.
- 3) Be suitable for operation in water at all temperatures between 2°C and 40°C.
- 4) Have straight reading pattern cyclometer counters indicating completed m³, having a reading sequence from left to right, with one colouring system to indicate m³ and another colouring system or multi-pointer counters for sub multiples.
- 5) Have inlets and outlets to each meter supplied sealed against ingress of foreign matter with rigid metal or plastic blanking caps.
- 6) Have robust hinged covers of adequate strength to protect the meter counters.
- 7) Have a body free of blow holes and other flaws and be accurately machined.
- 8) Be suitable for use under a maximum pressure of 1600 kPa.
- 9) Have underwater fittings manufactured from DZR brass (complying with SANS 6509) or other approved non-corrosive materials.
- 10) Have all threads other than inlets and outlets compatible with ISO metric sizes; and
- 11) Have no screwed connecting pieces.
- 12) Be flanged in-line through-flow type, mechanical turbine bulk water meters and shall comply with the requirements of SANS 1529.
- 13) The meter bodies must be coated with a high quality sintered epoxy powder coating, both internally and externally, to provide maximum protection against corrosion. The coating dry film thickness is to be a minimum of 200µm to permit installation above ground without further protection. The cover bolts must be stainless steel to facilitate easy removal of mechanisms and must be installed with stainless steel washers.
- 14) Meters shall be fitted with hermetically sealed, copper can, dry dial, glass faced registers sealed to IP68 protection to prevent ingress of dirt or moisture. These meters must be equipped with registers, which comprise 6-digit cyclometer-type totalizers, registering in m³.
- 15) The meters shall have body lengths that comply with the following table.

Table 2: Mechanical Flow Meters Body Length

Meter Size (mm)	Body Length (mm)
40	220
50	200
80	200
100	250
150	300

- 16) The meters shall have flanged inlets and outlets in accordance with SABS 1123 Table 1600 and capable of withstanding a nominal working pressure of at least 1600 kPa.

- 17) All internal plastic components to be constructed of virgin materials.
- 18) The meter shall be clearly and indelibly marked with the following information.
 - Name or trademark of the manufacturer
 - Meter serial number where first two digits indicate year of manufacture.
 - Direction of flow on both sides of the body
 - Unit of measurement
 - Meter type and size
 - Maximum admissible pressure
 - Client specific meter number stamped onto a plate and attached the body/ flange
- 19) The performance of the meters offered shall not be affected by outside electromagnetic influences.
- 20) The registers must have HRI pick-up as a standard feature as well as optical pulsers type OD so that the flow can be logged.
- 21) Flanged meters are to be supplied complete with gasket sets.
- 22) Meters up to DN150 shall be able to be installed with 0 x DN unrestricted straight pipe upstream and downstream, Tenderers must provide full details of the minimum lengths of straight pipe required for greater than DN150 meter for upstream and downstream from each type of appertunance, so that the accuracy of the meters remains within the specified accuracies.
- 23) Meters shall be able to be installed both in the horizontal and vertical position.

PA WM 4 Cathodic Continuity Across Meter Installations for Steel Pipeline Installations

This specification shall be used in the absence of a Cathodic Protection specification for the installation of flow meters assemblies on steel pipelines. The requirements mentioned below are deemed inclusive of the supply of the meter.

PA WM 4.1 Cathodic Continuity Description

All inline equipment (buried or in a chamber) along a steel pipeline such as joints, flanged joints, valves, meters, and specials which have flanged connections with gaskets usually have an electrical resistance which encourages the electrical current to jump off the pipeline. All valves, meters, specials, and flanged joints require an electrical cabling anti-corrosion by-pass to ensure the current remains on the pipeline.

PA WM 4.2 Cathodic Continuity Bonding of Buried Joints

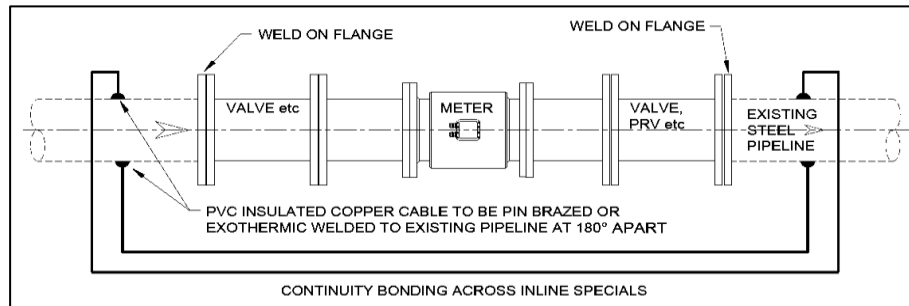
All pipe joints shall be continually bonded by means of 2 x 16mm² black PVC insulated copper cables pin brazed or exothermic welded to the steel pipeline either side of the joint.

All bonding of cables to the pipeline must be in accordance to PA WM 4.4 below.

PA WM 4.3 Cathodic Continuity Bonding of Inline Pipework Assemblies

All inline equipment, specials, and/ or pipework assemblies shall be continually bonded by means of 2 x 16mm² black PVC insulated copper cables pin brazed or exothermic welded to the steel pipeline either side of the inline equipment, specials and/ or pipework assemblies. The cables shall run in a 25mm diameter PVC conduit with a minimum offset of 350mm from the pipeline as illustrated below and shall have electrical warning tape placed 500mm above conduit during backfilling. conduit ends shall be sealed with polyurethane Foam.

All bonding of cables to the pipeline must be in accordance to PA WM 4.4.



PA WM 4.4

Cathodic Continuity Cable Connection to Steel Pipe Connection

Insulated PVC copper cable shall be pin brazed or exothermic welded to the steel pipeline. The technique used shall ensure that metallurgical contact is achieved between the cable and the pipeline while care is taken to (re)insulate the pipeline coating and the weld to prevent currents going to earth and to prevent corrosion. All wires to be crimped at ends with electrical type copper lugs or ferrules. Contractor shall submit details of the technique and equipment to be used.

The minimum amount of coating to bare pipe shall be removed. After connecting the cable, the entire exposed area shall be encapsulated in epoxy. The procedure for this is as follows:

- 1) Clean the pipeline coating to a minimum of 50mm beyond the final repair limits in accordance to PSL 3.9.
- 2) Construct a dam from a suitable material around the coating repair area.
- 3) Apply squish pack Copon Hycote 151 epoxy or similar approved non-conductive epoxy over the entire repair area, ensuring a minimum 5mm cover over the cable connection. A minimum overlap of 50mm shall be made over the existing coating.

All cable to pipe connections and coating repairs shall be witnessed by the Employers Representative.

PA WM 5

Data Sheets

The Tenderer shall complete in full the information on the following data sheets in respect of the equipment offered.

Ultrasonic Datasheet

Description	Offered
Meter Type	
Name of Manufacturer	
Country of Manufacture	
Meter Description	
Diameter of Meter	
Overall Length of Meter	
Pressure Class	
Maximum recommended flow in l/s	
Maximum recommended flow in m ³ /hr	
Turn down ratio	
Accuracy at flow rates (m ³ /hr):	
___ m ³ /hr	
___ m ³ /hr	
___ m ³ /hr	
___ m ³ /hr	
Loss of Head at flow rate (m ³ /hr)	
___ m ³ /hr	
___ m ³ /hr	
___ m ³ /hr	
___ m ³ /hr	
Factory Body Test Pressure (kPa)	
Type of Transmitter	
Minimum Pipe Lengths (x DN):	
Upstream of meter	
Downstream of meter	
Further Details	

Electromagnetic Flow Meter Datasheet

Description	Offered
Meter Type	
Name of Manufacturer	
Country of Manufacture	
Meter Description	
Diameter of Meter	DN???
Overall Length of Meter	
Pressure Class	PN??
Maximum recommended flow in l/s	
Maximum recommended flow in m ³ /hr	
Turn down ratio	
Accuracy at flow rates (m ³ /hr):	
___ m ³ /hr	
___ m ³ /hr	
___ m ³ /hr	
___ m ³ /hr	
Loss of Head at flow rate (m ³ /hr)	
___ m ³ /hr	
___ m ³ /hr	
___ m ³ /hr	
___ m ³ /hr	
Factory Body Test Pressure (kPa)	
Type of Transmitter	
Minimum Pipe Lengths (x DN):	
Upstream of meter	
Downstream of meter	
Further Details	

Mechanical Flow Meter Datasheet

Description	Offered
Meter Type	
Name of Manufacturer	
Country of Manufacture	
Meter Description	
Diameter of Meter	
Overall Length of Meter	
Pressure Class	
Maximum recommended flow in l/s	
Maximum recommended flow in m ³ /hr	
Turn down ratio	
Accuracy at flow rates (m ³ /hr):	
___ m ³ /hr	
___ m ³ /hr	
___ m ³ /hr	
___ m ³ /hr	
Loss of Head at flow rate (m ³ /hr)	
___ m ³ /hr	
___ m ³ /hr	
___ m ³ /hr	
___ m ³ /hr	
Factory Body Test Pressure (kPa)	
Type of Transmitter	
Minimum Pipe Lengths (x DN):	
Upstream of meter	
Downstream of meter	
Further Details	



Project Particular Specification

Brickwork

PA BR

Tongaat Water Treatment Works Functional Upgrade

Revision 0

October 2022

NAIDU
CONSULTING
ENGINEERING DEVELOPMENT

ISSUED AND PREPARED BY:
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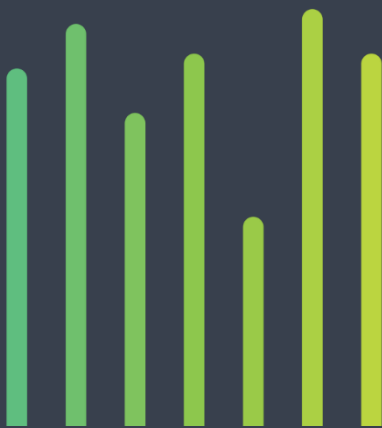


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PABR BRICKWORK

PABR 1 SCOPE

This section of the Specification covers all aspects of brickwork including building in of various items, reinforcing of brickwork etc as well as the supply of all materials and labour.

PABR 2 MATERIALS

PABR 2.1 Standards

All materials used shall comply with the following standard specifications, the latest of which shall be held to apply:

SABS 28	Metal ties for cavity walls
SABS 227	Burnt clay masonry units
SABS 471	Portland cement
SABS 626	Portland blast-furnace cement
SABS 831	Portland cement 15 and rapid-hardening Portland cement 15
BS 1200	Sand for plaster and mortar Concrete Masonry Assoc: The Masonry Manual

PABR 2.2 Masonry Units

PABR 2.2.1 General

Bricks shall be free from cracks, chips or other defects and at least one end of 20% of the bricks shall have the same general colour and texture as the faces.

Special care shall be exercised in loading, stacking and handling face bricks as no damaged bricks shall be used and bats may only be used where required to obtain bond.

General-purpose stock bricks or common bricks shall have a minimum average compressive strength of 7MPa unless otherwise specified. Where stock bricks are required for load bearing walls or foundations then the compressive strength shall be 28MPa.

Facing bricks shall be of the type, origin and colour specified in the Schedule of Quantities or on the drawings and shall be selected for uniformity of dimension and colour.

Satisfactory proof of load bearing capacity of bricks offered shall be submitted before deliveries are made to the site.

For samples, 6 units of each type of brick shall be submitted to the Employer's Agent for approval. All subsequent deliveries shall be to the standard of the approved samples.

All bricks which, in the opinion of the Employer's Agent, do not comply with the abovementioned requirements, shall be removed from the site forthwith at the Contractor's cost.

PABR 2.2.2 Burnt Clay Bricks

Burnt clay bricks shall comply with SABS 227 and:

Engineering bricks shall be of high compressive strength and durability, with 49MPa minimum average compressive strength and selected for their uniformity of dimension and shape. Bricks shall be clay and pressed or wire cut. Water absorption after a

24-hour test shall not exceed 12% by mass.

Facing bricks shall have a minimum average compressive strength of 28MPa. Bricks shall be clay and pressed to wire cut. Water absorption after a 24-hour test shall not exceed 12% by mass. Bricks shall have sharp, clean and well defined arises.

General purpose stock bricks or common bricks suitable for general building work shall be clay, pressed or wire cut, even in size, smooth in texture and with sharp well defined arises. Water absorption after a 24-hour test shall not exceed 14% by mass.

PABR 2.3 Cement

Cement used in masonry shall comply with the requirements of SABS 471, SABS 626 and SABS 831.

PABR 2.4 Fine Aggregate (Sand)

Fine aggregates used in mortar shall be naturally occurring sand or consist of crushed rock or gravel, or a combination thereof with naturally occurring sand being hard, clean and free from dust, shale, clay, loam roots and other impurities.

Fine mortar aggregates shall comply in all respect with SABS 1090.

PABR 2.5 Water

Water shall be clean and free from injurious amounts of acids, alkalis, sugar and other organic substances. Water suitable for drinking purposes shall be acceptable. If required by the Employer's Agent, the suitability of water shall be proved by tests carried out by an approved laboratory.

PABR 2.6 Mortar

Mortar shall unless otherwise specified, be Class II mortar and shall consist of 1-part Portland cement, one part hydrated lime and 5-parts of sand by volume for normal brickwork. Mortar for foundations, lintels and for all load bearing walls higher than 3000mm shall be Class I mortar and shall consist of 1-part Portland cement, ¼-part hydrated lime and 4-parts sand. The ingredients shall be measured in proper gauge boxes on a timber or steel-mixing platform with water added and thoroughly mixed in to obtain a uniform consistency throughout. Alternatively, mixing may be by means of an approved mechanical batch mixer.

In the case of a cement-milled slag mortar, the sand and slag shall be mixed first and then the cement added.

Cement mortar shall be used within two hours of the first contact of the cement with water. No mortar which is older than two hours or has begun to set shall be used.

PABR 2.7 Wall Ties

Metal wall ties in brickwork and blockwork shall be galvanised crimped steel, single wire type, 4mm diameter minimum, complying in all respects with SABS 28.

Ties cavity walls shall be PWD butterfly type formed of 4mm diameter steel wire galvanised Class A for coastal conditions and to such lengths that no less than 75mm can be built in at each end.

PABR 2.8 Reinforcement

Wall reinforcement shall consist of two 3.15mm diameter longitudinal wires are appropriate centres for the thickness of the wall and with 2.80mm diameter cross wires welded to the longitudinal wires at 300mm centres. All wire used shall be of high tensile steel.

PABR 2.10 Concrete to Brickwork Ties

End of junctions of brick walling to concrete are to be tied to the concrete by means of 1.6 x 32 x 500mm galvanised hoop iron ties.

Brick linings to concrete are to be tied with 4mm diameter crimped galvanised wire ties to SABS 28.

PABR 2.14 Storage of Materials

Cement and aggregates shall be stored in such a manner as to prevent deterioration or contamination by foreign matter, damp and chemicals spilled on the ground or which may settle out of the atmosphere.

Perishable materials likely to be damaged by exposure shall be stored under cover.

PABR 3 EQUIPMENT

The Contractor shall provide and maintain in good working order, adequate equipment for carrying out the required work in accordance with this specification in a safe efficient manner.

PABR 4 CONSTRUCTION

PABR 4.1 Brickwork Generally

All brickwork shall be laid in stretcher bond, plumb and true to line. Mortar beds shall be 10mm thickness, unless otherwise described, and are not to exceed 12mm in thickness, and no four successive joints shall rise more than 40mm (for 10mm joints). Clay bricks are to be well wetted (saturated in hot weather) with water before being laid and the course of bricks laid last shall be well wetted before fresh bricks are bedded upon it. Bricks shall be well buttered and laid on a full bed of mortar and joints shall be flushed up. Bricks in foundation walling are to be extra hard. Beam filling is to be built to walls 106mm thick and the space between beam filling and roof covering shall be filled with a stiff mixture of 1:3 cement mortar tightly pressed in. The brickwork shall be carried up in a uniform manner, no one section being raised more than 1200mm above another section at one time and no brickwork is to be carried more than 4 courses above immediately adjoining or intersecting brickwork. Block bonding or toothed and keyed construction will only be allowed in alterations to existing work.

One-brick walls (230mm) built stretcher bond in two skins shall be tied together with galvanised wall ties staggered not more than 1.0m apart horizontally and every fourth course vertically with extra ties at reveals and openings etc. as may be necessary. Brick linings to concrete walls shall similarly be tied together, while galvanised hoop iron ties cast into concrete columns, shall be built into the joints of butting brick walls as specified. Where specifically required the outer face of the inner skin of all external one-brick walls above damp course level shall be waterproofed before the outer skin is built up. The face to be treated shall be bagged over until all crevices are filled. When thoroughly dry the face shall be twice coated with an approved liquid bituminous compound and worked around wire ties to produce an unbroken waterproof coating.

Where called for on the drawings wall and concrete ceiling surfaces shall be bagwashed with a wet sack dipped in liquid cement grout whilst the mortar in the brickwork joints is still soft until all joints and crevices are eventually filled. Projections of concrete shall be rubbed off and any defects shall be made good in cement mortar.

PABR 4.2 Reinforced Brickwork

Brickwork over door and window openings shall be reinforced with welded wall reinforcement placed in each course of brickwork over openings for a minimum of 4 courses or as shown on the drawings. Reinforced brickwork shall continue at least 1½ bricks on either side of the opening. Where two or more openings are less than 675mm apart, the reinforced brick lintels shall be continuous over all such openings and their dividing piers, plus 1½ brick bearing at both extreme ends.

Brick lintels in cavity walls, which are exposed to the weather, shall have a continuous damp-proof course built into the outer skin of the wall immediately above the lintel to cover the top of the lintel, raked up one course and carried through the inner skin.

Where called for on the drawings, brickwork shall be reinforced with wall reinforcement laid in every fourth course of all brick walling or as directed by the Employer's Agent. The reinforcement shall be built in truly central to the wall and all longitudinal laps shall not be less than 450mm. Reinforcement in half-brick walls shall be built 106mm into main cross walls.

PABR 4.3 Face Brickwork

All facings shall be kept clean during the progress of the work and face-brick surfaces with mortar spattering will not be accepted. Unless otherwise specified, the horizontal and vertical joints shall be pointed and finished with a round key joint and both rubbed smooth

as the building work proceeds.

The various colours of the face bricks shall be selected and mixed at random to prevent portions of the face work showing a preponderance of one colour. Where sufficient storage is available on site the full quantity of face bricks required for the works (or such quantity as to keep supply well advanced of construction) shall be delivered to site.

PABR 4.4 Fairface Brickwork

Where called for on the drawings and in the Schedule of Quantities, internal walls shall be of smooth stock-bricks, built fair and kept clean during construction and jointed as in Clause PABR 4.3.

PABR 4.5 Precast Prestressed Concrete Lintels

Approved precast prestressed concrete lintels of suitable size of the thickness of the wall and the width of the opening shall be used over openings in plastered and bagged walls.

Wherever possible, the minimum bearing for precast prestressed lintels, at their ends and over intermediate supports, shall be:

- | | | | |
|----|----------------------------------|---|--------------------|
| a) | for openings not exceeding 600mm | - | Half-brick (115mm) |
| b) | for openings exceeding 600mm | - | One-brick (230mm) |

Where this requirement necessitates a total lintel length exceeding 6.6 m, a joint may be introduced centrally over an intermediate pier in a position to be approved by the Employer's Agent. Such joints shall be stiffened by the introduction of welded wall reinforcement as specified in PABR 4.2 and extending a minimum of 300mm on either side of the joint, i.e. 600mm minimum total length.

PABR 4.6 Concrete/Brick Ties

At end on junction of brick walls with concrete columns or walls brickwork is to have galvanised hoop iron ties built into the joints for:

Half-brick skin (115mm walls) at maximum 8 course height intervals.

One-brick skin (230mm walls) at maximum 4 course height intervals.

Ties are to be cast into concrete at course heights by tacking L-shaped ties to inside face of shutters and bending down ends for building in after shutters are stripped or shot fixed to concrete with approved nails and strength of shot top provide adequate fixing.

Galvanised crimped wire ties for fixing of brick linings to concrete are to be cast a minimum 75mm deep into concrete at brick course eights (four per square metre staggered), bent down after shutters are stripped and built into brickwork.

PABR 4.7 Doors

Timber for doors shall be selected, well-seasoned kiln dried Red Meranti and shall be treated with an approved oil soluble preservative. The following preservative is recommended : 5% Pentachlorophenol in a vessel consisting of 50% white spirits and 50% power paraffin or 100% white spirits. The Contractor shall obtain and submit to the Employer's Agent a certificate from the supplier of the timber or doors to the effect that the timber has been treated as required.

After erection doors shall be well sanded and prepared and then coated with two coats of an approved penetrating sealer compatible with the treatment applied to the timber.

PABR 4.8 Louvres

Louvres and frames shall be manufactured from prepainted galvanised steel sheet coated on both sides. The coating shall comply with the manufacturers' specifications for 'Chromadek' with PVC Plastisol coating or 'Colomet' and 'Versacor' base and SMP weathering coat, or similar coating approved by the Employer's Agent.

PABR 4.9 Brick Cladding to Exposed Face

Brick cladding shall consist of a single skin of face bricks as obtained from Independent Brick Supplies (or similar approved) and laid in bands as directed by the Employer's Agent. This skin is to be fastened to the concrete as specified elsewhere.

The brickwork shall be in stretcher bond 4:1 cement mortar. The brickwork shall be supported on suitably staggered concrete ledges with cross-sectional dimensions of 150 x 150mm. R10 reinforcing starter bars will be used to tie the ledges into the concrete element and two Y10 bars shall be used in the longitudinal direction.

Payment for the formwork for reinforced concrete ledges shall be per metre and shall include the following:

- the positioning and staggering of the brickwork support ledges to keep a minimum depth to the top of the ledges of 150mm below finished ground level;

- supply erection and stripping the necessary shuttering and temporary supports.

Payment of the brickwork shall be by the square metre and shall include for the supply and laying of all materials including the galvanised steel ties as specified and their installation.

PABR 4.10 Sundries

- a) Rough and fair cutting shall be performed as required and the brickwork fitted around structural steelwork. Face brickwork shall be carefully cut and fitted when next to the finishing.

Chases shall be left or formed in brickwork for edges of concrete floors, roofs, staircases, etc. Vertical chases shall be provided in brickwork and blockwork wherever required for pipes, conduits, switch boxes, distribution boards, etc.

Oversailing courses, corbels, etc, shall be built where required.

Ends of sills, thresholds, sep joints etc shall be built in, cut, or pinned in cement mortar where required.

Steel windows to be built into walls shall be set plumb and true with the sill bar resting on wedges to ensure that it is perfectly level. All lugs shall be bolted up tight and built in solid as walling proceeds, the channel frame of the window being caulked tight with Class B (1-3/4-4) cement mortar, pointed up neatly all round and made watertight.

Passed steel doorframes shall be securely strutted when placed in position to prevent distortion of any kind during building. The frame shall be built solid into the walls and grouted solid at the back with 12:3 cement mortar as the work proceeds and properly pointed all round.

Timber doorframes and windows to be built into walls shall be primed before building in and set plumb and true. The underside of each vertical to the doorframes shall be provided with a 12mm diameter steel peg projecting 75mm from the bottom of the frame and these pegs shall be securely grouted into the floor threshold. 2mm thick hoop iron cramps 40mm wide, screwed to frames shall be built 450mm into walls with ends turned up, four cramps to each jamb. At flush junctions of walls and frames a V-joint shall be ruled between frame and wall rendering. The junctions between timber frames or windows and face brickwork or unrendered concrete on external faces shall be sealed by pointing around the timber frames with an approved polysulphide based waterproofing compound finished off in a neat and workmanlike manner.

All necessary openings for ends of timber, gratings, cramps, holdfasts, dowels, wood plugs and slips for fixing joiner's work, hoop iron ties, etc, shall be formed built in with 1:3 cement mortar, and made good with properly performed rough and fair cuttings.

Damp proof courses shall be formed in the walls as described by building three consecutive bedding joints and all vertical joints between solid walls in 2:1 cement mortar with an approved waterproofing compound added in accordance

with the manufacturer's instructions.

PABR 5 TOLERANCES

PABR 5.1 Tolerances

Tolerances for clay brick dimensions, strength, warpage and efflorescence shall be as SABS 227.

PABR 5.2 Degree of Accuracy

Permissible deviations in the final finished surfaces to the degree of accuracy required will be applied to linear dimensions, position, verticality, level, squareness and bow.

The degree of accuracy may be one of the following:

Degree of accuracy III for use where a high degree of accuracy is unnecessary, e.g.: mass storage warehouse walls and floors.

Degree of accuracy II for what is commonly called "good work".

Degree of accuracy I where the use of special, as opposed to normal, methods and/or materials is required.

PABR 5.3 Table of Permissible Deviations

		Permissible Deviation Degree of Accuracy (mm)			Corobrik Brick Guide
Classification Item Finish		III	II	I	
PABR 5.3.1	Stock brickwork				
	- against earth	20	15	10	NFX
	- to receive plaster	17	10	7	NFP
	- to be bagged	13	8	5	NFP
	- fairface	8	5	3	FBS
PABR 5.3.2	Faced brickwork with bricks				
	- generally uniform in shape and size	8	5	3	FBS
	- high degree of				
	- uniformity in shape & size	5	3	2	FBX
PABR 5.3.3	- non-uniform in shape	13	8	5	FBA
	Out of alignment with				
	Adjoining finishes on	4	3.0	15	FBS
	projecting items	3.5	2.5	1	FBX
PABR 5.3.4	(windows & door frames)	5	3.5	2	FBA
	Out of verticality of perps (dependent on bond)	40	15	5	
PABR 5.3.5	Out of alignment	2.5	2.0	1.5	FBS
	horizontally top edge to	2.0	1.5	1	FBX
	top edge adjoining bricks	3.0	2.5	2	FBA
PABR 5.3.6	Out of trueness vertically	2.5	2	1.5	FBS
	(top edge to lower edge	2.0	1.5	1	FBX
	Of next course)	3.0	2.5	2	FBA
PABR 5.3.7	Squareness of rooms				
	- measured on the diagonals*	20	10	5	
PABR 5.3.8	Out of square or true of a corner or angle				
	measured 300mm from the angle*	7	4	2	

*A similar degree of accuracy will be required to irregular shaped rooms. The governing factor shall be the general appearance and it may be necessary or acceptable to depart

from the above guidelines if required.

PABR 6 TESTING

PABR 6.1 Compressive Strength

Determination of the minimum average compressive strength of clay bricks shall be in accordance with SABS 227 at frequencies required by the Employer's Agent.

PABR 6.2 Costs of Tests

Costs of Tests described above shall be borne by the Contractor who shall be deemed to have included these costs in the scheduled rates for brickwork.

PABR 7 MEASUREMENT AND PAYMENT

PABR 7.1 Brickwork

The unit of measurement for all brickwork shall be the square metre of the specified type and thickness laid. The measurement of the work will be taken net, with door and window openings deducted, but will include for lintels, airbricks, etc.

The rates tendered for ordinary brickwork shall be inclusive of supply of bricks, brickforce, lintels, airbricks, wall ties, damp proof course, mortar and everything necessary to erect the brick work shown on the drawings, and for testing, all plumbing of corners and faces, linings, levelling, ruling of joints, forming reveals and openings, cutting where necessary but not specially scheduled, supply and building in wall plugs, wall ties, etc, hoisting to various levels, soaking all bricks in water before laying, any selecting of face-bricks on site to maintain an even texture when laid and for cleaning down with spirits of salts all facework on completion.

Unit: m²

PABR 7.2 Sills

The unit of measurement for internal and external sills be the linear metre of sill installed. The rate shall include for all materials and work required to construct sills complete in accordance with the drawings and the schedules.

Unit: m²

PABR 7.3 Doors

The unit of measurement for doors shall be the number supplied and stalled complete with frames in accordance with the specifications and the drawings. The rate shall include for supply, delivery, storage, erection, installation complete with hinges and door furniture, preparation and sealing.

Unit: No.

PABR 7.4 Louvres

The unit of measurement for louvres shall be the number supplied and installed complete in accordance with the specifications and the drawings. The rate shall include for supply, delivery, storage, erection and installation in accordance with the specifications and the drawings.

Unit: No.



Project Particular Specification

Colour Coding

PS CLR

NAIDU
CONSULTING
ENGINEERING DEVELOPMENT

Functional Upgrade of Tongaat Water
Treatment Works - Work Package 1

Revision 0

August 2024

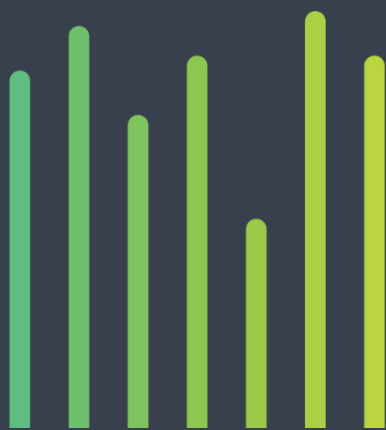


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PREAMBLE

This Project Specification forms an integral part of the contract and supplements the Employer's Standard Specifications where relevant. This specification shall be read in conjunction with the Project And Particular specifications:

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PS CLR 1

COLOUR CODE

The purpose of the colour code is to standardise the usage of colours used on Water Treatment Works.

PS CLR 2

COLOUR AND CODES -

The colours for identification colour marking of pipelines and equipment shall be as indicated in the table below and in accordance with SABS 1091/1092:

Colour	Code	Colour	Code
Arctic Blue	F28	Light Orange	B26
Black	GH19	Light Stone	C37
Brilliant Green	H10	Middle Brown	B07
Canary Yellow	C61	Pastel Grey	G54
Cornflower	F29	Primrose	C67
Crimson	A03	Salmon Pink	A40
Emerald Green	E14	Signal Red	A11
Golden Brown	B13	Verdigris Green	E22
Golden Yellow	B49	White	HG100
Jacaranda	F18		

PS CLR 3

SPECIFIC USE OF COLOURS

PS CLR 3.1

Labelling, Numbering Of Plant, Equipment And Buildings

Room numbers	White on black background
Electrical circuits	Black on white background
Plant equipment stock numbers	Black on yellow background
Room size	White on cornflower (sky blue) background
Distribution board ID	Black on yellow background
Danger Signs	Signal red on white background
Information Signs	White on emerald green background

PS CLR 3.2 Pipelines

Contents of Pipe	Basic Colour	Identification Band (150mm Wide)	Wording
<u>Water</u>			
Potable - cold	Brilliant Green	Cornflower	
Potable - hot	Brilliant Green	Crimson	
Raw	Brilliant Green		RAW
Sludge - (All)	Brilliant Green		SLUDGE
Supernatant Return (From Sludge)	Brilliant Green	Pastel Grey	
<u>Waste Water</u>			
Raw Sewage	Middle Brown	Black	
Raw Sludge	Middle Brown	Golden Brown	
Humus Sludge	Middle Brown	Jacaranda	
Treated Sludge	Middle Brown	White	
Returned Sludge	Middle Brown	Crimson	
Supernatant Liquor	Middle Brown	Arctic Blue	
Final Effluent	Middle Brown	Brilliant Green	
<u>Chemical Solutions</u>			
Alum	Jacaranda	Arctic Blue	
Bentonite	Jacaranda		BENTONITE
Caustic Soda	Jacaranda	Black	
Copper Sulphate	Jacaranda	Light Stone	
Activated Carbon	Jacaranda	Pastel Grey	
Lime	Jacaranda	Crimson	
Polyelectrolyte	Jacaranda	Verdigris Green	
Soda Ash	Jacaranda		SODA ASH
Sulphuric Acid	Jacaranda	White	
Chlorine	Jacaranda	Canary Yellow	
Ferric Chloride	Jacaranda	Brilliant Green	
Sodium Hypochloride	Jacaranda	Canary Yellow	
Sodium Chloride	Jacaranda	Canary Yellow - Brilliant Green	
Chloride of Lime	Jacaranda	Canary Yellow - Crimson	
<u>Gases</u>			
Chlorine	Light Stone	Canary Yellow	
Ammonia	Light Stone	Signal Red	
Ozone	Light Stone		OZONE
Chlorine Dioxide	Light Stone	Canary Yellow/Crimson	
Methane	Light Stone	Black	
<u>Fuel and Oil</u>			
Diesel	Golden Brown	White	
Petrol	Golden Brown	Signal Red	
Hydraulic Oil	Golden Brown	Salmon Pink	
Waste	Golden Brown	Black	

<u>Air</u>			
Blowers	Arctic Blue	Signal Red	
Compressed	Arctic Blue		
Instrument	Arctic Blue	Salmon Pink	
Vacuum	Arctic Blue	Primrose	

Where it is impractical to paint the whole pipeline the basic pipeline colour is to be painted in two 150mm wide bands on either side of the identification bands.

Where there is no identification band but wording is specified, the specified wording shall be stencilled on the pipe, in the largest practicable lettering up to a maximum of 75mm in height, in clearly visible locations on either side of all fittings.

PS CLR 3.3 Plant and Equipment

Items of Equipment	Basic Colour
Pumps	According to pipe contents
<u>Valves</u> (Anti-clockwise opening valves) Body Bonnet, yoke and hand wheel or cap	According to pipe contents Brilliant green
<u>Valves</u> (Clockwise opening valves) Body Bonnet, yoke and hand wheel or cap	According to pipe contents Signal red
<u>Electrical Switchgear</u> (other than starting and stopping devices and emergency stop controls)	Light orange
Exposed moving or rotating machine parts	Light orange
Cable and conduits	Light orange
Starting devices	Emerald green
Stopping devices	Signal red
Emergency stop controls	Signal red
Telemetry	Natural Colour
Fire protection equipment	Signal red
Safety equipment	Emerald green
Handrails	Golden yellow
Handrail stanchions	Black
Crawl Beams	Golden yellow (50mm black diagonal lines optional)
Demarcation of walkways	Golden yellow
Housekeeping markings	Golden yellow

PS CLR 4 DEMARCATION OF “KEEP CLEAR” AREAS

PS CLR 4.1 Fire extinguishers, fire hose reels, electrical distribution boards and other "Keep Clear" areas

The equipment shall have a "keep clear" area demarcated on the floor below its immediate position. The demarcation shall be symmetrically 300mm greater than the maximum width of the equipment and extend 500mm from the supporting wall or fixture. An eighty millimetre wide black line, within the demarcated area shall be painted as a border to the demarcation. The remaining inner area shall be painted Golden Yellow with the words "KEEP CLEAR" and/or "UNGABEKI" stencilled in the yellow block. The lettering shall be 50mm high where possible.

On expanded mesh or similar perforated floor areas a solid metal plate shall be placed below the equipment on which the demarcation shall be painted.

PS CLR 5 SCHEDULE AND DRAWING FOR PIPEWORK PAINTING

The Contractor shall prepare and submit to the Employer's Agent for approval a comprehensive schedule of all pipework, fittings, valves and equipment to be painted. This schedule shall include:

- a) A detailed list of all pipes, specifying their contents, dimensions, material, and corresponding colour codes as per SANS 0140.
- b) Locations and lengths of each pipe section, including critical points such as valves, junctions, and terminations.

In addition, the Contractor shall provide a colour-coded drawing indicating the pipe routes, content identification, and the specified colours and markings. The drawing shall:

- i. Be to scale and clearly depict all pipe runs within the facility.
- ii. Include legends for the colour coding and labeling of pipes, ensuring compliance with this specification.
- iii. Highlight areas where pipework intersects or interfaces with equipment and structural components.

The schedule and drawing must be submitted 60 calendar days prior to the commencement of painting works for review and approval. Any revisions requested by the Employer's Agent and Employer must be incorporated before the start of the work.



Project Particular Specification

Standard Operating Procedures (SOP)

PS SOP

NAIDU
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ENGINEERING DEVELOPMENT

Functional Upgrade of Tongaat Water
Treatment Works - Work Package 1

Revision 0

August 2024

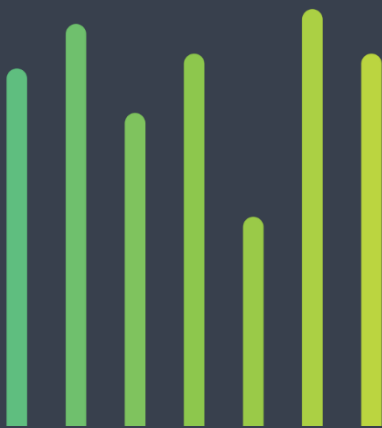


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PREAMBLE

This Project Specification forms an integral part of the contract and supplements the Employer's Standard Specifications where relevant. This specification shall be read in conjunction with the Project And Particular specifications:

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PS SOP 1 General Requirements

The Contractor shall develop Standard Operating Procedures (SOPs) specific to the Tongaat Water Treatment Works, ensuring they are practical, effective, and tailored to the plant's operational and maintenance requirements.

SOPs shall not rely on direct replication of content from existing O&M manuals or any materials provided by the Employer. All SOPs must demonstrate thought, improvement, and customization to reflect the plant's unique design and operational needs.

The SOPs shall incorporate and address findings and recommendations from the design HAZOP (Hazard and Operability Study) and construction HAZOP to ensure all identified risks and operability issues are mitigated.

PS SOP 2 Scope of Work

The Contractor shall develop SOPs for all operational and maintenance activities for the entire plant. Each SOP must provide detailed, step-by-step instructions for operating, maintaining, and troubleshooting equipment, and outline all safety precautions, including personal protective equipment (PPE) requirements.

The SOPs must include mitigation measures for risks identified in the HAZOPs, ensuring operability and safety during both normal and abnormal operations.

Visual aids such as photographs, diagrams, and flowcharts must be included to improve usability and understanding for operators.

PS SOP 3 Incorporation of HAZOP Findings

The Contractor must ensure the SOPs align with all findings from the design and construction HAZOPs. All hazards, operability issues, and recommended control measures identified in the HAZOPs must be incorporated into the relevant SOPs.

Specific focus must be given to:

- i. Hazards.
- ii. Findings from HAZOP.
- iii. Safe working procedures for equipment and confined spaces.
- iv. Emergency shutdown and evacuation procedures tailored to identified risks.
- v. The Contractor shall liaise with the Employer and review HAZOP reports to ensure all findings are reflected in the procedures.

PS SOP 4 Draft Approval

The Contractor shall prepare a draft of the SOP template and submit it to the Employers Agent for approval 90 days prior to any commissioning activities.

The draft format must include:

- vi. The structure and layout of the SOPs, including sections for instructions, safety precautions, visual aids, and references.
- vii. Proposed use of visual elements such as photographs, diagrams, and checklists.
- viii. Demonstrate clarity, usability, and alignment with project requirements.
- ix. The Employer and Employers Agent will provide feedback on the draft format within a timeframe agreed by all parties. The Contractor shall incorporate the feedback and obtain final approval.

PS SOP 5 Review and Approval Process

The Contractor must incorporate all feedback from the Employer into the SOP's. The review process shall include verification that HAZOP findings are appropriately addressed and that the procedures meet operational and safety requirements.

PS SOP 6

Workshops and Stakeholder Engagement

The Contractor shall conduct workshops with the Employer's personnel to ensure the SOP's align with the plant's operational requirements and Employer specific requirements.

Workshops must include:

- i. An initial session during the drafting phase to gather inputs and align on HAZOP recommendations.
- ii. A second session post-draft submission to address comments and finalize alignment.
- iii. A third session with operational personnel.
- iv. Inputs from workshops must be incorporated into the final SOPs.

PS SOP 7

Training Requirements

The Contractor shall provide comprehensive training to the Employer's operational staff on the finalized SOPs. Training must emphasize safety protocols, operational instructions, and associated works.

The training program shall include:

- i. Classroom sessions to explain the content of the SOPs. The Contractor is to provide documentation for the session and arrange for refreshments & cater meals.
- ii. Practical demonstrations at the plant to familiarize staff with procedures and safety measures.
- iii. The Contractor shall develop a training schedule in consultation with the Employer to avoid operational disruptions.
- iv. Competency acknowledgment forms must be signed by all participants upon completion of training.

PS SOP 8

Requirements

Final SOPs must be delivered in both hard and electronic formats, including all visual aids and supplementary documentation.

A training completion report, including attendance records and competency acknowledgments, must be submitted to the Employer.

All documents must explicitly document how HAZOP findings were incorporated.

PS SOP 9

Contractual Requirements

The approved SOP's shall form part of the requirements for Practical Completion.

PS SOP 10

Maintenance Schedules

The Contractor shall develop a comprehensive maintenance schedule for the Water Treatment Works (WTW), covering all process, mechanical, electrical, instrumentation, and civil components (both existing and new). The schedule must ensure optimal functionality, reliability, and compliance with standards and operational requirements.

PS SOP 10.1

Requirements for the Maintenance Schedule

- i. The schedule shall include all planned preventive, predictive, and corrective maintenance activities.
- ii. Each activity shall specify:
 - a. Equipment identification, Equipment Tag/Process Unit and location.
 - b. Civil components.
 - c. Maintenance type and frequency.
 - d. Resource requirements (personnel, tools, materials).
 - e. Safety and environmental precautions.
- iii. The schedule must align with equipment manufacturers' recommendations, design specifications, and industry standards.

PS SOP 10.2 Deliverables and Format

- i. The maintenance schedule shall be submitted as a detailed document and in an editable electronic format (e.g., Excel).
- ii. Include a Gantt chart or similar visual representation of timelines.

PS SOP 10.3 Compliance and Integration

- i. The maintenance schedule must integrate with the Employer's existing asset management systems and align with operational workflows/SOP's.
- ii. The Contractor shall provide training to the Employer's personnel on the use and implementation of the maintenance schedule for all disciplines.

PS SOP 10.4 Performance Monitoring

- i. The Contractor shall implement the maintenance schedule during the trial operation period.
- ii. The Employer reserves the right to audit the schedule and its execution to verify compliance and effectiveness.

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**PROJECT PARTICULAR SPECIFICATION: STARTING,
SITE TESTING AND COMMISSIONING**

PS COM

**Functional Upgrade of Tongaat Water Treatment
Works - Work Package 1**

Contract No. WS7382

Rev 0

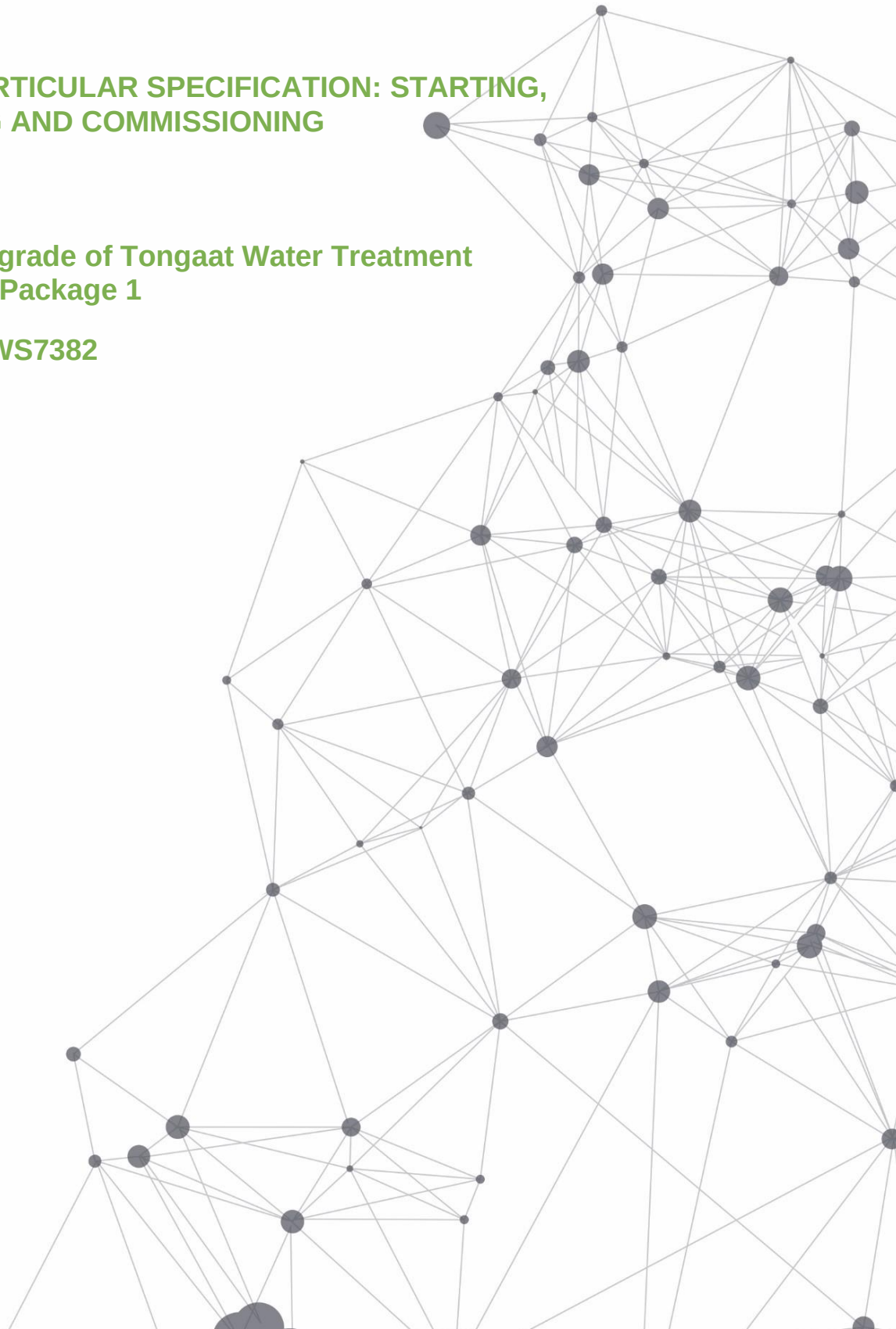


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PREAMBLE

This Project Specification forms an integral part of the contract. This specification shall be read in conjunction with all Project, Client and Particular Specifications.

It is noted that this is a brownfield site and all construction, testing and commissioning will be carried out on a fully operational plant with only a limited number of short duration shutdowns will be permitted.

The Contractor must carry out all construction, testing, and commissioning activities on an operational works with continuous production maintained at all times, except for short, planned shutdowns not exceeding **12 hours**. Any necessary shutdowns must be scheduled in advance and approved by the Employer. Shut downs to be in accordance with PS 4.4.8.

PS COM 1 GENERAL

Before starting up any section of the Works, the Contractor shall make all necessary checks to ensure that the installation has been correctly carried out, that all ducts, pipework, tanks, etc., are clean, that all equipment is correctly aligned, lubricated and connected up, and is in all respects ready to start safely. It shall be noted that all initial fill requirements such as lubricating oil shall be the responsibility and at the cost of the Contractor.

The Contractor shall arrange for the Employer's Agent to be present at initial start up and for the applicable sub-contractors to be present.

The Contractor shall start up and test each section of the Works. These tests will be carried out to certify that the Works is operating in accordance with the requirements specified and must be witnessed by the Employer's Agent. All necessary modifications and rectifications shall be carried out during this period.

When all tests have been completed to the satisfaction of the Employer's Agent, the Works shall be commissioned. Unless the Employer's Agent states otherwise, the complete plant, including all control functions and control systems shall be commissioned as a unit and the process performance requirements shall be achieved during normal operation. The Contractor shall train the operational staff in the starting, operating and stopping of the Works, and shall train the maintenance staff on the routine maintenance requirements, start-up, shutdown and operating procedure.

PS COM 2 OPERATION & MAINTENANCE MANUALS

The Contractor shall prepare a draft copy of the O&M manual and submit to the Employer's Agent at least two months prior to the commencement of any commissioning activities. The Employer's Agent shall solicit comments from the Employer on the draft copy and furnish the Contractor with these comments within 30 days of receipt of the draft. The Contractor shall then incorporate all comments and complete the O&M manuals as specified in accordance with the Particular Specifications.

The Contractor will not be permitted to commence with any commissioning activities until the approval of the draft O&M manuals. Operations and maintenance manuals shall comply with the requirements of the particular specifications.

PS COM 3 TRAINING

Prior to handover of the works to the Employer the Contractor is to ensure that operation and maintenance training is provided to applicable EWS employees on the equipment and operational procedures based on the scope of works of this Contract.

Training activities are to also be conducted during commissioning activities and are to be undertaken on site unless the training specified is for specialised training by an OEM. The Contractor is to ensure that training and guidance is provided to the EWS Operational staff for the entire duration of the Trial Operation period.

The Contractor is to ensure that training is performed by experienced and suitably qualified representatives in their respective field. Where OEM training is required for specialised equipment the Contractor is to ensure that the OEM is present on site to adequately demonstrate and train personnel.

It is a requirement that all training undertaken on this Contract be recorded and included into the O&M manuals. This document is to include:

- a) Date of Training
- b) List of Attendees
- c) Signed Attendance Register
- d) Discipline
- e) Overview of training
- f) Training Manuals

- g) Q&A
- h) Reference documentation

PS COM 3.1 TRAINING MANUAL

eThekwini Operators (Mechanical, Electrical, Process, Control & Instrumentation) must be trained to operate the entire Water Treatment Works and applicable systems. The training manuals are to include, but not limited to:

Process Training Requirements (Works Branch-Process Controller Training)

- a) Train staff on the process flow diagram highlighting the system and any new improvements.
- b) Units to cover:
 - i) Inlet, flow control, operation of the HOW.
 - ii) Manual and Automatic Screening Systems
 - iii) Flocculation tanks and mixers
 - iv) Clarifiers
 - v) Rapid Gravity Sand Filters
 - vi) Pre-Chlorination
 - vii) Chlorination
 - viii) Polymer Storage and Dosing
 - ix) Monitoring of final water quality.
 - x) Standard Operational procedures
- c) How to read the HMI and related signals
- d) Critical control points to monitor
- e) Check points that have to be undertaken on the system and frequency.
- f) Provide examples of common mistakes in the system and what needs to be done to rectify the system.
- g) Basic maintenance required (Lubrication, Adjustments, Settings, Instruments and VSD parameters checking, SCADA parameters setting etc.)
- h) Safety related operational and maintenance requirements.

Control & Instrumentation Training Requirements

- a) Operator Training
- b) HMI operation training (including training manual)
- c) PLC configuration training from the OEM
- d) SCADA training
- e) Basic maintenance required (Lubrication, Adjustments, Settings, Instruments and VSD parameters checking, SCADA parameters setting etc.)
- f) Advanced maintenance required (Specialised maintenance by the original equipment supplier)
- g) Frequency of maintenance for basic and advanced maintenance

M&E Training Requirements

- a) Operator Training
 - i) Overall plant overview/operating/control philosophy using PFD/P&ID
 - ii) Fault finding and corrective actions required
 - iii) Basic maintenance required (Lubrication, Adjustments, Settings, Instruments and VSD parameters checking, SCADA parameters setting etc.)
 - iv) Equipment-critical spare part requirements

b) Electrical

- i) Electrical drawing classroom training (philosophy of operation/control)
- ii) HMI training (same as Operator HMI Training)
- iii) Set-points, safety and process interlocks
- iv) Basic PLC fault-finding (example I/O lists, indication lights etc)
- v) Troubleshooting, common trips/alarms, including resolution of faults
- vi) Motor details (terminal box connections)
- vii) Advanced maintenance required (Specialised maintenance by the original equipment supplier)
- viii) Frequency of maintenance for basic and advanced maintenance
- ix) Equipment-critical spare part requirements

c) Mechanical

- i) Pump operation
- ii) Mechanical equipment operation
- iii) Expected pressures and flows
- iv) Troubleshooting, common trips/alarms, including resolution of faults
- v) Advanced maintenance required (Specialised maintenance by the original equipment supplier)
- vi) Frequency of maintenance for basic and advanced maintenance
- vii) Equipment-critical spare part requirements
- viii) Lifting Equipment

The Contractor's tendered rates shall include for the compilation of this training manual and all the associated costs/works. The training manuals are to be provided in colour printed copies to all attendees. The Contractor shall also be responsible for the compilation of maintenance schedules inclusive of budget costs.

PS COM 4 COMMISSIONING PROCEDURE**PS COM 4.1 GENERAL**

The Contractor shall undertake commissioning in three stages: Pre-Commissioning, Cold Commissioning, and Hot Commissioning. All activities must comply with the Employer's requirements, project specifications, particular specifications and OEM guidelines. The Contractor shall coordinate with the Employer's Operations team at all stages to ensure co-ordination with respect to the potable water reservoirs supplied from the works. The Contractor is to ensure that the operational challenges with the existing system are catered for in planned shut downs and any other works that could pose an impact on the supply of potable water.

The commissioning requirements are stated under this particular specification, together with the requirements specified in the particular specifications for Electrical, Mechanical, Process, and Instrumentation and Control works. The Contractor must make available their installation sub-contractors and experts for commissioning. All required disciplines must attend the commissioning process to ensure comprehensive troubleshooting, corrections, adjustments, and alterations are addressed as required.

Commissioning shall include but not limited to the submission of all required documentation, including Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) results, earth test certificates, load test certificates, wiring diagrams, loop drawings, and other QC/QA documentation as specified.

The commissioning process shall be programmed accordingly with adequate notice to the Employer and Employer's Agent for attendance arrangements. The Contractor shall allow for sufficient time to rectify any findings raised by the Employer and Employer's Agent during commissioning. The Contractor shall conduct each stage of the

commissioning process with the Employer's Agent to address and resolve identified snags. Following this, a separate commissioning session per stage shall be arranged with the Employer for final approval.

Installation work must be complete and approved by the Employer's Agent prior to commissioning. Before starting up any section of the works, the Contractor shall make all necessary checks to ensure that the installation has been correctly carried out, that all ducts, pipework, tanks, etc., are clean, and that all equipment is correctly aligned, lubricated, and connected. The installation must be in all respects ready to start safely. The Contractor is fully responsible for the successful commissioning of the installation, the development of operations manuals for the installations, and the issuing of Certificates of Competency (CoC) where required.

PS COM 4.2 PRE-COMMISSIONING

Pre-Commissioning shall be carried out by the Contractor upon the completion of the installation. The Contractor shall ensure that the following, but not limited to, are accepted by the Employer and approved by the Employer's Agent and forms a hold point during this commissioning stage:

PS COM 4.2.1 Scope of Work

Installation Verification:

- Verify that all mechanical and electrical equipment, including control and instrumentation devices/equipment, are installed according to the approved design drawings and specifications.
- Check that all equipment is properly labeled and identified.
- Inspect that pipe supports, hangers, brackets etc are installed per design.

Testing:

- Conduct pressure tests on pipelines and process tanks.
- Test electrical systems and power supply.
- Ensure grounding and bonding systems meet standards.
- Verify installation of control panels, PLCs, HMIs, and instruments.
- Ensure proper wiring, identification, and connection to the control system.

Alignment and Levelling:

- Check the alignment of rotating equipment (pumps, motors).
- Confirm the proper leveling of equipment foundations and correct coupling alignment.

Corrosion Protection:

- Inspect corrosion protection systems, such as coatings and galvanizing, applied to exposed equipment.

Mechanical and Electrical Systems:

- Inspect bolted connections for proper torque and security.
- Ensure proper installation of gaskets and flanged joints.
- Confirm the mechanical integrity of all components (valves, actuators, pipes, fittings, etc.).

Electrical and Instrumentation Documentation Submission:

- Submit all required wiring diagrams, loop drawings, control panel designs, HMI layout mimics, and associated electrical and instrumentation drawings for review by the Employer's representative and receipt of approval before proceeding with the commissioning.
- PLC & Logic Review: Submit the Functional Design Specification (FDS) and PLC program for review and approval, including control logic and sequencing diagrams.

PS COM 4.2.2 Deliverables

Cold commissioning documentation, including:

- The Contractor must submit the quality inspection report and quality control documentation for review and approval by the Employer and Employer's Agent before proceeding to the next stage.

- The Contractor is to provide all applicable mechanical, electrical, and control & instrumentation drawings for acceptance and approval by the Employer and Employer's Agent, respectively.
- FAT results must be documented, submitted, and approved by the Employer and Employer's Agent before moving on to subsequent commissioning activities.
- The Contractor must ensure all installation and inspection documentation is completed and submitted for review prior to FAT. Any defects or non-conformances identified during inspection and FAT must be rectified by the Contractor at their own cost, with retesting conducted, as necessary.
- SAT results must be documented, submitted, and approved by the Employer and Employer's Agent before moving on to subsequent commissioning activities.
- The Contractor must ensure all installation and inspection documentation is completed and submitted for review prior to SAT. Any defects or non-conformances identified during inspection and SAT must be rectified by the Contractor at their own cost, with retesting conducted, as necessary.
- The Contractor must submit a final commissioning report for review and approval by the Employer 5 calendar days post commissioning activities.
- The Contractor is responsible for validating all emergency and safety procedures, conducting a full-system test, and documenting all final adjustments and calibrations.
- The Contractor must ensure that relevant personnel are trained in the operation and maintenance of the system during commissioning.
- The Contractor must ensure that the Employer's operational personnel witness and are informed on the fault finding and rectification procedure.

PS COM 4.3 COLD COMMISSIONING

Cold-Commissioning shall be carried out by the Contractor upon the completion of the Pre-Commissioning stage. The Contractor shall ensure that the following, but not limited to, are accepted by the Employer and approved by the Employer's Agent and forms a hold point during this commissioning stage:

PS COM 4.3.1 Scope of Work

System Testing:

- Conduct no-load tests on pumps, motors, actuated valves, and instrumentation to verify functionality.
- Validate SCADA system functionality, including control logic, alarms, and interlocks.
- Verify the correct operation of PLCs, logic, and control sequences. Test the interlock sequences, feedback loops, and alarms.
- Verify equipment operation under cold conditions (no load or partial load).

Mechanical Checks:

- Inspect rotating equipment for alignment and vibration during cold commissioning.
- Verify rotation of equipment.
- Ensure proper lubrication points and correct application of lubricants.
- Confirm the integrity of bolted connections by torque testing to specified values.
- Inspect lubrication systems to ensure proper application and levels in accordance with OEM guidelines.
- Test the operation of valves, actuators, and mechanical linkages for correct functionality and responsiveness.
- Conduct hydrostatic pressure testing on pipelines, tanks, and pressure vessels to validate integrity and compliance with design specifications.
- Check the installation and condition of seals, gaskets, and flanged joints to ensure proper assembly and leak prevention.
- Perform vibration checks on rotating equipment to identify imbalances or misalignment.
- Verify the functionality of safety and relief devices such as pressure safety valves and non-return valves.
- Test cooling and lubrication systems to confirm proper flow, pressure, and

operation under initial conditions.

Electrical Checks:

- Confirm electrical connections, including earth continuity and resistance testing.
- Verify and inspect the installation of all electrical equipment to ensure compliance with approved design drawings, specifications, and applicable standards.
- Conduct continuity testing of all power, control, and signal circuits to confirm proper connections.
- Perform insulation resistance testing on cables, switchgear, and transformers to validate compliance with design specifications and industry standards.
- Verify grounding and bonding systems through earth continuity and resistance testing, ensuring results meet specified thresholds.
- Confirm correct phase sequence and polarity for three-phase systems to ensure proper operation.
- Execute high-potential (Hi-Pot) testing on cables to verify voltage endurance and insulation integrity.
- Test the tripping mechanisms and protection settings of circuit breakers and switchgear to confirm compliance with design requirements.
- Perform no-load motor testing to verify correct rotation, proper alignment, and functionality under initial conditions.
- Inspect power distribution boards and control panels for compliance, including wiring terminations, relay operations, and proper labeling.
- Verify the functionality of process lighting, auxiliary systems, and associated controls.
- Conduct PLC input/output tests, including analog and digital signals, and confirm proper SCADA integration for plant operations.
- Validate the functionality of alarms, interlocks, and emergency stop systems as per the approved control philosophy.

Control and Instrumentation checks:

- Test the functionality of Programmable Logic Controllers (PLCs), including control logic, interlocks, and sequencing.
- Validate Human-Machine Interface (HMI) displays, alarms, and mimics for correct configuration and operation.
- Check the installation, calibration, and integration of field instruments such as flow meters, pressure transmitters, level sensors, and temperature probes.
- Perform loop testing to confirm continuity, accuracy, and responsiveness of signal transmission between field devices, PLCs, and the SCADA system.
- Test the functionality of alarm systems, ensuring proper activation and recording in the control system.
- Verify the operation of PID control loops for stability, accuracy, and performance against design parameters.
- Conduct electrical continuity and insulation resistance testing for control system wiring to ensure compliance with SANS standards.
- Ensure redundancy and fail-safe systems, such as backup power supplies and interlocks, are operational and meet design specifications.

Process checks:

- Conduct pressure testing of process pipelines and tanks to identify any leaks or defects.
- Check the functionality of actuated valves, including open/close operations and signal feedback to the control system.
- Test chemical dosing systems, ensuring correct calibration, dosing accuracy, and integration with process control systems.
- Verify that aerators, mixers, and other process machinery operate as intended, free of mechanical defects or abnormalities.
- Ensure process flow paths are unobstructed and free of debris, with all required cleaning and flushing completed prior to testing.
- Confirm the functionality of flow measurement devices and ensure accurate readings against design flow rates.
- Test process interlocks and controls to ensure proper sequencing and fail-safe

operations.

- Validate the operation of all process safety systems, including emergency shutdowns and overflow prevention measures.

Functional Testing:

- Conduct functional tests for equipment and instrumentation to verify compliance with design specifications.
- Control & Instrumentation Functional Tests:
 - Test PID loops, HMI mimics, and SCADA interfaces for proper integration.
 - Verify that the control and instrumentation systems are functioning as per the control logic and design specifications.

PS COM 4.3.2 Deliverables

Cold commissioning documentation, including:

- Results of functional tests and SCADA validation.
- Consolidated FAT/SAT results during cold commissioning.
- Completed Quality Control/Quality Assurance documentation from commissioning activities.
- Updated wiring diagrams and loop drawings, reflecting any changes made during installation or post FAT and SAT.
- Confirmation that control logic and programming, including HMI mimics, are correct and operating as designed.
- The Contractor must submit a final commissioning report for review and approval by the Employer 5 calendar days post commissioning activities.
- The Contractor is responsible for validating all emergency and safety procedures and documenting all final adjustments and calibrations.
- The Contractor must ensure that relevant personnel are trained in the operation and maintenance of the system during commissioning.
- The Contractor must ensure that the Employer's operational personnel witness and are informed on the fault finding and rectification procedure.

PS COM 4.4 HOT COMMISSIONING

Hot-Commissioning shall be carried out by the Contractor upon the completion of the Cold-Commissioning stage. The Contractor shall ensure that the following, but not limited to, are accepted by the Employer and approved by the Employer's Agent and forms a hold point during this commissioning stage:

PS COM 4.4.1 Scope of Work

System Operation:

- Operate the system using raw water to verify treatment performance.
- Conduct full load testing on pumps, motors, and other equipment under operational conditions (auto and manual).
- Test pump flow rates, pressures, and operational cycles to ensure they meet design specifications and capacity requirements.
- Verify that all pumps operate reliably and efficiently at the design duty point.
- Check and calibrate control systems for pump operation, including level sensors, pressure switches, alarm systems and applicable instrumentation and control infrastructure.

Process Testing:

- Validate all treatment processes (coagulation, flocculation, sedimentation, filtration, disinfection) against design parameters.
- Ensure the system meets water quality standards (SANS 241).
- Conduct preliminary performance testing to ensure the plant meets the specified water quality standards, including parameters such as turbidity, pH, etc.
- Analyse performance test results and make necessary adjustments to optimize plant operation, including modifications to chemical dosing, filtration rates, or sludge handling procedures.
- Monitor floc formation and adjust mixing intensity and retention time for optimal results.
- Calibrate and commission dosing equipment.

- Test mixer operation for uniform chemical distribution in the tank.
- Confirm effective floc formation suitable for downstream clarification.
- Ensure optimal floc formation is achieved throughout the flocculation process.
- Monitor the system to ensure correct chemical feed rates and effective disinfection.
- Test chlorine contact tanks to ensure proper contact time for disinfection.
- Check chlorine residual monitoring and control systems for consistent disinfection.
- Adjust dosing rates and contact times to meet water quality standards.

Integration with EWS Systems:

- Verify integration with the Employer's reservoir systems to ensure smooth and coordinated operations.
- Perform synchronization checks with the EWS Bulk Operations team, including alarm systems, interlocks, and control interfaces.

Operational Testing:

- Test SCADA system integration with all plant processes.
- Perform testing of pumps and motors under full operational conditions.
- Verify that all PLC logic functions correctly under full operational loads and integrates with the SCADA system.
- Test and validate HMI mimics, alarms, and graphical displays for accurate real-time reporting.
- Confirm all final set points
- Verify the functionality of all alarms, interlocks, and safety systems

PS COM 4.4.2 Deliverables

Hot commissioning documentation, including:

- Performance test results for all processes, ensuring compliance with design parameters and SANS 241 water quality standards.
- Water quality test results from accredited laboratories.
- Updated commissioning documentation, incorporating resolved Cold Commissioning concerns.
- Final wiring diagrams, loop drawings, and electrical/instrumentation drawings reflecting any changes made during the commissioning process.
- Final PLC programming, logic, HMI mimics, and loops to operate as designed.
- Completed Quality Control/Quality Assurance documentation from commissioning activities.
- The Contractor must submit a final commissioning report for review and approval by the Employer 5 calendar days post commissioning activities.
- The Contractor is responsible for validating all emergency and safety procedures and documenting all final adjustments and calibrations.
- The Contractor must ensure that relevant personnel are trained in the operation and maintenance of the system during commissioning.
- The Contractor must ensure that the Employer's operational personnel witness and are informed on the fault finding and rectification procedure.

PS COM 4.5 COMMISSIONING REPORT

A comprehensive commissioning test report highlighting all challenges, defective equipment, set points, alarms and repairs/remedial measures implemented shall be submitted by the Contractor prior to handover of the works.

PS COM 4.6 COMMISSIONING ACCEPTANCE

The successful commissioning of the system is based on a treatment capacity of 21MI/day (potable water production) through the plant or as per the Employers instruction. This is to be verified by the Employer's Agent and Employer during hot commissioning / performance testing where the required potable water quality shall consistently comply with SANS 241.

PS COM 5
**PS COM 5.1 COMMISSIONING ENGINEER
ROLE AND SCOPE**

The Contractor shall appoint a Commissioning Engineer, who must be a professionally registered engineer. The appointed Commissioning Engineer shall bear full responsibility for overseeing and managing the entire commissioning phase of the Contract. This includes, but is not limited to:

- a) Pre commissioning
- b) Cold Commissioning
- c) Hot Commissioning

The Commissioning Engineer shall act as the sole point of communication for the Contractor during the commissioning phase and will be responsible for coordinating the Contractor's multidisciplinary team to ensure the Employer's specific requirements are met.

PS COM 5.2 QUALIFICATIONS

The Commissioning Engineer must be a professionally registered engineer and have a degree in Process/Chemical Engineering.

PS COM 5.3 MINIMUM EXPERIENCE

The Commissioning Engineer shall have a minimum of 10 years of relevant experience in commissioning water treatment plants with a minimum capacity of 21 ML/day. The Engineer must demonstrate proven experience in managing the commissioning process for water treatment systems, including contactable references. Expertise in troubleshooting and resolving issues during the commissioning phase is mandatory.

PS COM 5.4 DUTIES AND RESPONSIBILITIES**PS COM 5.4.1 Overall Management**

The Commissioning Engineer shall oversee and manage all aspects of the commissioning process, ensuring that the water treatment works are tested, started up, and become fully operational in accordance with project specifications and SANS 241 standards.

PS COM 5.4.2 Planning and Coordination

The Commissioning Engineer shall develop and implement a comprehensive commissioning plan that details the sequence of activities, testing procedures/protocols, and acceptance criteria in accordance with the project and particular specifications. They shall schedule and lead commissioning meetings with all relevant stakeholders, including the Contractor's team, sub-contractors, Employers Agent and the Employer's representatives, facilitating coordination across disciplines to ensure seamless integration of systems and components.

PS COM 5.4.3 Testing and Documentation

The Commissioning Engineer shall ensure that all required tests are conducted, documented, and evaluated to confirm that the water treatment works meets all performance and quality standards. They shall prepare and submit detailed commissioning reports, including test results, observations, and recommendations, collaborating with the multidisciplinary team to address any issues identified during testing and ensuring effective solutions are implemented.

PS COM 5.4.4 Training and Handover

The Commissioning Engineer shall oversee the training of operational staff, ensuring they are knowledgeable about the operation and maintenance of the water treatment works. They shall facilitate the handover process, including the preparation of operation and maintenance manuals and the final acceptance documentation, ensuring that all documentation reflects the multidisciplinary aspects of the plant's operations.

PS COM 5.4.5 Problem Resolution

The Commissioning Engineer shall serve as the primary point of contact for resolving any issues or deficiencies identified during the commissioning process. They shall implement corrective actions as necessary and ensure that all issues are resolved promptly, working with the multidisciplinary team to address any cross-discipline issues that may affect the commissioning process.

PS COM 5.5 COMMUNICATION

The Commissioning Engineer shall be the sole point of communication between the Contractor's team, Employers Agent and the Employer's representatives during the commissioning phase. All correspondence, reports, and updates related to commissioning activities shall be directed through the Commissioning Engineer.

PS COM 5.5.1 Reporting

The Commissioning Engineer shall provide regular progress reports to the Employer's Agent and Employer, including updates on commissioning activities, milestones achieved, and any issues encountered.

PS COM 5.6 PERFORMANCE AND COMPLIANCE**PS COM 5.6.1 Compliance**

The Commissioning Engineer shall ensure that all commissioning activities comply with contractual requirements, industry standards, relevant regulations, project and particular specifications.

PS COM 5.6.2 Performance Review

The performance of the Commissioning Engineer shall be reviewed periodically by the Employer or the Employers Agent. The Employer reserves the right to request the replacement of the Commissioning Engineer. The Contractor shall provide a suitable qualified and experienced replacement in accordance with the Employers requirements.

PS COM 5.7 REPLACEMENT**PS COM 5.7.1 Replacement Procedure**

In the event that the Commissioning Engineer is unable to fulfil their duties due to unforeseen circumstances, the Contractor shall provide a qualified replacement who meets all specified requirements. Any replacement must be approved by the Employer and will be subject to the same qualifications and experience criteria outlined in this specification.

PS COM 5.8 MULTIDISCIPLINARY COORDINATION**PS COM 5.8.1 Integration with Multi-Disciplinary Team**

The Commissioning Engineer shall coordinate closely with the multidisciplinary team, ensuring that mechanical, electrical, civil, process and other specialized systems are effectively integrated and tested. Regular interdisciplinary meetings shall be held to address integration issues and ensure cohesive progress.

PS COM 5.8.2 Cross-Discipline Communication

The Commissioning Engineer shall facilitate communication between different disciplines to resolve any conflicts or issues that arise during the commissioning process, ensuring that all team members are informed of relevant updates and changes that may impact their specific areas of responsibility.

PS COM 5.8.3 Documentation and Reporting

The Commissioning Engineer shall ensure that all commissioning documentation reflects the contributions and requirements of the multidisciplinary team. Comprehensive reports that capture the performance and integration of all systems and disciplines involved in the project shall be prepared and submitted.

PS COM 6 WATER QUALITY

The Contractor is responsible for ensuring that the final water quality from the water treatment works meets all the requirements stipulated in SANS 241.

Compliance with these standards must be achieved and forms part of the requirements for Practical Completion.

PS COM 6.1 TESTING AND CERTIFICATION

The Contractor must conduct regular testing of the water quality during commissioning and submit certified laboratory results for each of the parameters specified.

Independent third-party verification may be required at the employer's discretion to confirm compliance with SANS 241 standards.

PS COM 6.2 MONITORING DURING CONSTRUCTION

Raw water quality testing should be conducted at various stages of the plant's construction to ensure that the final output will meet SANS 241 standards.

All monitoring results must be documented and made available for inspection upon request.

PS COM 6.3 FINAL WATER QUALITY NON-COMPLIANCE

In the event of non-compliance with the stipulated water quality standards, the Contractor will be required to take immediate corrective actions at no additional cost to the employer.

PS COM 6.4 FINAL ACCEPTANCE

Final acceptance of the water treatment plant will only be granted once the water quality consistently meets all SANS 241 standards over a defined performance period of 7 calendar days at an effective potable water production rate of 21Ml/day and forms part of the requirements for Practical Completion.

The Contractor must provide a detailed report and certification of compliance with all water quality standards before final handover.

PS COM 6.5 HANDOVER DOCUMENTATION

The Contractor must provide comprehensive documentation of all water quality testing, including raw data, analysis, and certification, as part of the handover process.

Operation and maintenance manuals must include guidelines for ongoing water quality monitoring to maintain compliance with SANS 241 standards.

PS COM 7 TRIAL OPERATION PERIOD

The Trial Operation Period for the Works shall be 90 calendar days. At the end of the Trial Operation Period, an inspection shall be done by the Contractor, Employer and the Employer's Agent for the purpose of taking over the Works.

The Trial Operation period shall only commence post approval of the commissioning activities and Practical Completion.

During the Trial Operation Period the Contractor shall be required to:

- a) Provide one full time operator for the entire period of the Trial Operation Period. The Operator is to be suitably qualified to address any concerns related to the operation of the system.
- b) Provide one full time assistant for the entire period of the Trial Operation Period.
- c) The working hours are deemed as being 8 hours per day, 7 days a week for both of the above staff members.
- d) The Contractor is to provide weekly reports which are submitted every Monday from the start of the Trial Operation Period.
- e) A team is to be available 24/7 for any equipment failures or malfunctions. The Employer reserves the right to take over the repairs if required. The final process for equipment failures and faults are to be confirmed prior to the commencement of the trial operation period.
- f) The Contractor must undertake any servicing, maintenance and repairs to equipment for the entire period.
- g) The Contractor is to provide on the ground training daily to the Employer's operational team.
- h) A log of all faults is to be completed by the Contractor and remedial measures implemented.
- i) The Contractor is to hold a weekly lessons learned meeting discussing malfunctions, faults and remedial measures. These are to be documented and distributed to the Employer and Employer's Agent.

NAIDU
CONSULTING



**PROJECT PARTICULAR SPECIFICATION:
OPERATING & MAINTENANCE MANUAL**

PS OM

**Functional Upgrade of Tongaat Water Treatment
Works - Work Package 1**

Contract No. WS7382

Rev 0

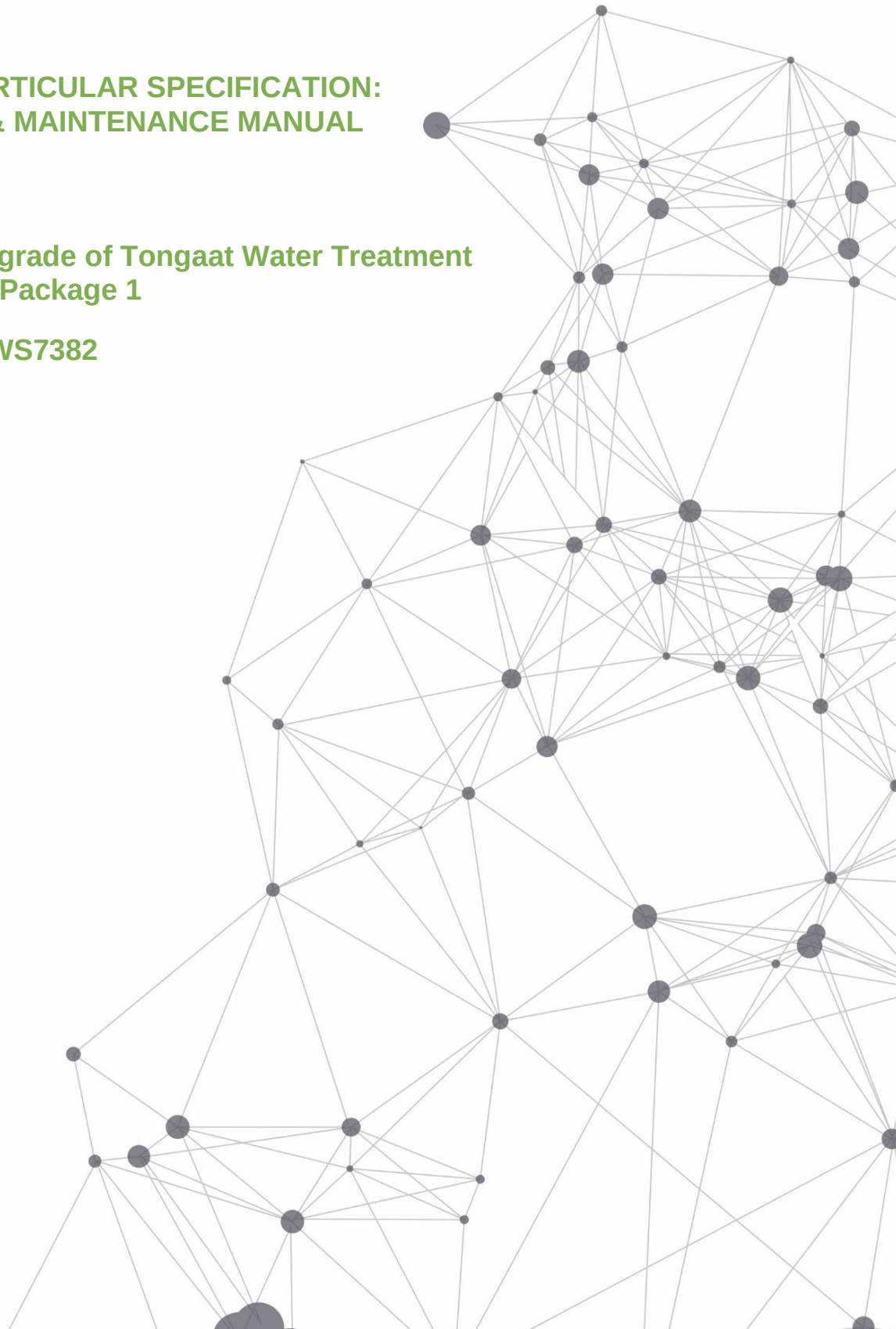


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PREAMBLE

This Project Specification forms an integral part of the contract. This specification shall be read in conjunction with all Project, Client and Particular Specifications.

PS OM 1 SUBMISSION OF MANUAL

The Operating and Maintenance (O&M) manual are to be supplied in triplicate (hard copy) in a hardy bound file/book format which shall withstand day to day use by the EWS maintenance team.

The original copy, which will be identified as the "Master copy" shall contain all original documentation, signed guarantee / warranty forms and the originals of any legislative compliance certificates. The remainder of documents can be duplicates of this "master copy". The other sets shall be marked "Copies 2 to 3".

The volumes of the operation and maintenance manuals and associated drawings shall be supplied as a quality electronic publication on the following media as follows:

- USB flash-drives (Per manual)
- CD/DVD ROM (Per manual)
- The above is to contain an electronic "soft copy" of the entire manual and supplied in a clearly labelled protective storage case per copy of the manual.
- A OneDrive link is to be made available to the Engineer and Employer.

PS OM 2 GENERAL REQUIREMENTS

The Manual shall comply with the following:

- The Manual shall be in English, shall be easy to use, practically and neatly presented, clearly sectionalised and titled, provided with a "Contents List" and shall be specifically applicable to the system as installed.
- A title label shall be affixed to the spine of all O&M manuals. This shall indicate contract number, title and location, Contractor's and all sub-contractor's names and, where required, plant description, volume number and contents.
- Labelled separator sheets shall be provided between each section and sub-section and also wherever volume or complexity makes this advisable.
- All sections and sub-sections shall be numbered. Numbering of the Contents List shall be sequenced so that no two sections have the same number.
- Drawings shall be to a scale, which makes all details clear. Drawings shall be held in plastic envelopes in the Manual. Drawings shall also be provided on CD disk & USB in AutoCAD format.
- Manufacturers product brochures, where covering a range of products, shall be clearly marked to show which particular model has been installed.
- Manuals are to provide concise descriptions, technical details, operating and maintenance instructions and schedules, commissioning records, log books, catalogues, principles of operation, method of operation and other information related to the plant and equipment.
- The comprehensive descriptions are to be accompanied by appropriate as-built diagrams and other necessary illustrations so as to facilitate knowledge and understanding about the operation of the plant and equipment. Examples include hydraulic flow diagrams, electric wiring diagrams, electronic circuit plans and mechanical air flow diagrams etc.
- It is to be ensured by the Contractor that the contents of the documentation is provided by personnel with skill and experience in the operation and maintenance of the equipment, system, installation, etc. and that the content is clear, concise, accurate and relevant. The Contractor is to ensure the terminology is appropriate and the grammar is correct i.e. all information is accurate and up to date at time of installation.
- Any software applications and programs used within the project which would be required to perform maintenance and repair of the equipment should be included. Examples of this are PLC programming applications and equipment specific files.
- Cable schedule for power and instrumentation cables. This shall include the cable type, start and finish points, route length, duty, load, size, voltage drop, number of cores, number of cores used and gland size. For cable voltages above 400 Volts, the schedule shall also include the purchase details, specification and date of manufacture.
- Equipment List for all individual items of mechanical, electrical, instrumentation and

control equipment. The Equipment list shall include the description, make, model, serial number, batch number, size, range, performance data, motor and drive details, supplier's name, address and phone numbers, all as applicable.

- A hard copy shall also be made available to be located at the Treatment Works.

PS OM 3 FORMAT AND CONTENTS

The Manual shall be compiled as per **Table 3.1** below. The Contractor may amplify this breakdown where required.

Table 3.1: Format & Contents of O&M Manual

Item	Section	Details
1.	General	
1.1.	Preamble	• Quality control sign off sheets & list of authors/contributors. • Project intent statement. • Design brief and required purpose.
1.2.	Contents Page	• Index page to be provided where multiple volumes are created. • Numbering to be logical and easily referenced.
1.3.	Description of the Works	• Description of the equipment installation with layout drawings and process flow diagrams. • Process description and performance parameters for the Works.
1.4.	Asset Register / Equipment List	• A comprehensive itemisation of all equipment broken down into logical component level (pump, motor, switchgear, etc.). • List of the make, model, operating range and hazardous zoning of every item of mechanical, electrical, instrumentation and control equipment.
1.5.	Drawing List	• List of the project related drawings.
1.6.	Contact Details	• Contact details for the Employers, Employers Agent and Contractors team • Contact details for all OEM's
2.	General Safety Information	
2.1.	Identified hazards	• Identified hazards on site.
2.2.	PPE requirements	• PPE requirements on site.
2.3.	Evacuation plan	• Evacuation plan considering site access/exit points.
2.4.	Hazardous material information	• Information on hazardous material on site.
2.5.	Alarms, Trips and interlocks	• To be reference to FDS if defined there.
2.6.	Other safety related information.	
3.	Operation	
3.1.	Operating of the System	• Description of the operating system containing: ○ Start-up; ○ Adjustment/Calibration; ○ Normal operating procedures including automatic and manual operations; ○ Shut-down procedures for manual and automatic operation; ○ Operating envelopes/windows;

Item	Section	Details
		- Emergency operating procedures; - Setpoints, protection, alarms and trips; - This document/section shall be suitable for use as a Training Manual.
3.2.	Commissioning	- Commissioning results & findings on mechanical systems. - Commissioning results & findings on process and chemical dosing systems. - Commissioning results & findings on electrical and instrumentation systems.
3.3.	Trial Operation Period	- Results/ Error logs from trial operation period. - Detailed log of faults including rectification/remedial action for faults.
3.4.	Fault Finding	Fault finding procedures and instructions
3.5.	Handover documentation	Quality Control Documentation, etc.
3.6.	Operating and Control Philosophy	Operating and control philosophy for the entire works
3.7.	Set points	Final Set Points
3.8.	Standard Operating Procedures (SOP's)	- Updated and consolidated SOP's for the entire works - SOP's to be tailored to the Employers requirements
4.	Maintenance Schedule	
4.1.	Maintenance and Lubrication (All mechanical, electrical, instrumentation and control equipment)	- The schedule shall be all-inclusive but may refer to manufacturer's standard manuals in other parts of the Manual. - Components to be maintained. - Required maintenance tasks (minimum and optimal). - Required frequency of maintenance (minimum and optimal) – Daily, weekly, monthly annual periods etc. - Lubrication schedule with detailed specification. - Suggested skill level of maintenance personnel. - Operator (functional knowledge, observation skill); - Maintenance assistant (basic skill); - Artisan (qualified trade tested artisan skill level); - Technician (Diploma skill level); - Engineer (Degree skill level). - Spares and consumables required for this maintenance. - Typical measured variables.
4.2.	Maintenance Schedules	Inclusion of maintenance schedules for all works as per project and particular specifications

Item	Section	Details
4.3.	Maintenance manuals	Maintenance manuals for the operational procedures for the entire plant.
4.4.	Operational Manuals	Operational manuals for the operational procedures for the entire plant.
5.	Mechanical Equipment	
5.1.	Mechanical Equipment (Duplicated per item e.g. pump)	- A copy of the information applicable to the item and appearing in the Equipment List (i.e. make, model, serial number, description, size, design range, performance data, motor and drive details etc.). - A separate table containing the unit's nameplate information; or, a photograph of the nameplate. - Technical and descriptive literature, including principle of operation and construction. - Application specific calibrations and equipment/device settings. - Installation instructions. - Detailed operating instructions. - Control and electrical details, including logic sequence, circuit diagrams and software, as applicable. - Full technical and maintenance information/datasheets including: - Maintenance instructions; - Assembly diagrams; - Parts Lists of all equipment components; - Essential spares; - Lubricants; - Calibration/Calibration Certificates; - Reconditioning, repair, etc. - A spares list giving the item number, part number, description, quantity and materials. A list of recommended spares. - Factory and Site test results. - Corrosion protection systems used, coating supplier's data sheets and coating repair procedures.
5.2.	Drawings	- Performance curves. - Performance curves must also include the system curve and pump curve overlaid on the same system of axes, with the BEP, duty point and efficiency at duty point clearly marked. The curves must also include the NPSH3% curve, absorbed power, P1 and P2 and efficiency curve. Multi-speed pump curves shall also be provided, as applicable. - Layout drawings. - Drawings must include, general arrangement drawings, isometric drawings, long-sections and cross sections, construction drawings, as a minimum. - A fully integrated 3D model. - Large scale, dimensioned, cross sectional and arrangement drawings of the item for assembly and spares recognition purposes, cross-referenced to the spares list. - Dimensioned drawings of fabricated equipment. - Circuit layout of any auxiliary systems.

Item	Section	Details
6.	Electrical Equipment	
6.1.	Electrical Equipment (Duplicated per item e.g. MCC)	• A copy of the information applicable to the item and appearing in the Equipment List. • A separate table containing the unit's nameplate information; or, a photograph of the nameplate. • Technical and descriptive literature, including principle of operation and construction. • Control and electrical details, including logic sequence, circuit diagrams and software, as applicable. • Installation instructions. • Detailed operating instructions. • Full technical and maintenance information including instructions for assembly, disassembly, lubrication, adjustment, calibration, reconditioning, repair, etc. • A spares list giving the item number, part number, description, quantity and materials. A list of recommended spares. • Factory and Site test results. • Certificate of Compliance – COC (original in one file to be handed over to Client).
6.2.	Cabling	• Cable specifications and cable schedule.
6.3.	Drawings	• Equipment overall dimensions. • Circuit diagrams. • Switchboard and MCC layout drawings and SLDs. • Cable routing drawings. • As built DB and MCC layouts and wiring diagrams.
6.4.	Other	• MCC quality control documents and test reports.
7.	Instrumentation Equipment	
7.1.	Instrumentation Equipment (Duplicated per item e.g. Ultrasonic Meter)	• A copy of the information applicable to the item and appearing in the Equipment List. • A copy of the relevant information in the equipment schedule and including all settings. • Instrument and electrical device settings and set-points (levels, no-flow, timer settings etc.). • Installation instructions. • Descriptive and technical literature giving full details of performance, operation, calibration, setting, service, maintenance and spares including suitable assembly drawings. • Instrument Data Sheets. • Technical and descriptive literature, including principle of operation and construction. • Control and electrical details, including logic sequence, circuit diagrams and software, as applicable. • Factory test results. • Full technical and maintenance information including instructions for assembly, disassembly, lubrication, adjustment, calibration, reconditioning, repair, etc. • Process & Control information.

Item	Section	Details
		- Functional Design Specification (references to document). - Calibration certificates.
7.2.	Drawings	- Circuit diagrams of both instrumentation systems and individual instruments. - Overall dimension and installation drawings. - Consolidated drawing clearly referencing the associated disciplines and ancillary drawings - Consolidated 3D model.
8.	Control Equipment, Network and Software	
8.1.	Identifying Information	- Make, model and detailed information of PLCs, transmitters, HMIs, etc. as per the Equipment List. - A copy of the information applicable to the item and appearing in the Equipment List.
8.2.	I/O List	Cross-referenced listing of all I/O's used.
8.3.	HMI	- Color prints of HMI mimic screens. - Sequences and trend screens. - Schedule of alarm messages and TAG lists. - File structures. - Lists and naming conventions.
8.4.	Program	- An annotated program listing. - CDs/USB containing all software. - Loop and logic diagrams for each PLC. - Loop drawings showing field terminal numbers, marshalling terminal numbers and PLC rack/slot/terminal numbers. - System control diagram and logic sequence chart.
8.5.	Documents	- Schedule of cable terminals. - Copy of SCADA hardware diagnostic mimic. - Software backup in the exported format.
8.6.	Drawings	- Control Network Overview Layout. - Power Distribution Schematics & Drawings. - PLC Card Wiring Diagrams. - Loop Sheets. - MCC Schematics. - Network Drawings - Cable route layout and hookup drawings.

Item	Section	Details
9.	Process Equipment	
9.1.	Process Equipment	• A copy of the information applicable to the item and appearing in the Equipment List including all dosing equipment, dosing pumps etc (i.e. make, model, serial number, description, size, design range, performance data, motor and drive details etc.). • A separate table containing the unit's nameplate information; or, a photograph of the nameplate/identifier. • Technical and descriptive literature, including principle of operation and construction. • Application specific calibrations and equipment/device settings. • Installation instructions. • Detailed operating instructions. • Diagram of process flow as per on site conditions. • Equipment calibration certificates.
10.	Warranty & Guarantees	
10.1.	Warranty/Guarantee information	• A comprehensive list of all equipment depicting start & end dates for warranties/guarantees. • Information/documentation on guarantees/warranties to be provided. • Potential extensions for warranties/guarantees are to be indicated.
11.	Documents	
11.1.	Drawings	• All as-built Contractor's drawings including MFDs, P&IDs, electrical panel construction drawings etc.
11.2.	Certificates of Compliance	• Electrical COC's (one for each building, structure or pump station)
11.3.	Earth Test Certificates	• Earth test certificates (for buildings, MCCs, transformers, MV switchgear etc.)
11.4.	Load Test Certificates	• Lifting beams load test certificates
11.5.	Training Documentation	• All documentation provided to the Employer during training events. • Registers taken during training.
11.6.	FDS	• As built FDS (control functional design specification and operational specification).
11.7.	P&ID	• As built P&ID

PS OM 4 REVIEW OF O&M MANUALS

The Contractor is to submit a draft electronic O&M manual for review and acceptance by both the Employer and the Employer's Agent prior to the submission and compilation of the final hard & electronic documents. The acceptance and approval of the O&M manuals will be at the Employer's discretion. A draft copy of the O&M manuals are to be submitted and approved prior to the commencement of any commissioning activities.