ELECTRICAL STANDARD SPECIFICATIONS FOR WASTEWATER PUMP STATIONS

DEPARTMENT: MECHANICAL AND ELECTRICAL BRANCH

WATER AND SANITATION

ELECTRICAL STANDARD SPECIFICATION

INDEX

STANDARD SPECIFICATION

MC1 **OVERVIEW**

This section specifies general requirements of electric equipment and the installation thereof. It is to be read in conjunction with the Project Specification which has precedence in the event of conflict.

MC2 **COMPLIANCE WITH STANDARDS**

Equipment and methods of installation shall comply with the latest edition and/or amendment of:

Electrical Design Norms and Standards

a) All EWS Electrical Standards and Particular Specifications applicable to eThekwini Water and Sanitation Installations

b) OHS Act: Occupational Health and Safety Act.

c) SANS 10142-1: Code of practice for the wiring of premises – Low voltage installations.

d) VC8008: NRCS Compulsory safety specification.

e) SANS 61439 – 1: Low-voltage switchgear and control gear assemblies - General rules.

f) SANS 61439 – 2: Power switchgear and control gear assemblies.

g) SANS 61439 – 3: Distribution boards intended to be operated by ordinary persons (DBO).

h) SANS 1973 – 1: Type tested assemblies with stated deviations and a rated short circuit withstand strength above 10kA.

i) SANS 1973 – 3: Safety of assemblies with a rated prospective short circuit current of up to and including 10kA.

j) SANS 1973 – 8: Safety of minimally tested assemblies with a rated busbar current of up to and including 1600A AC

k) SANS 60947-1: Low-voltage switchgear and control gear. Part 1. General Rules.

l) SANS 60947-2: Low-voltage switchgear and control gear. Part 2. Circuit breakers.

m) SANS 60947-3: Low-voltage switchgear and control gear. Part 3. Switches, disconnectors, switch-disconnectors and fuse combination units.

n) SANS 60947-4: Low-voltage switchgear and control gear. Part 4. Contactors and motor starters.

o) SANS 60947-5: Low-voltage switchgear and control gear. Part 5. Control circuit devices and switching elements.

p) SANS 60947-6-1: Low-voltage switchgear and control gear Part 6-1: Multiple function equipment - Transfer switching equipment.

q) SANS 60947-7-1: Low-voltage switchgear and control gear Part 7-1: Ancillary equipment - Terminal blocks for copper conductors.

r) SANS 556-1: Low-voltage switchgear Part 1: Circuit-breakers.

s) SANS 1091: SA National Colour Standard for Paint.

t) SANS 1195: Standard Specification for Busbars.

u) SANS 1411: 1-2 Materials of insulated electric cables and cords.

v) SANS 1507: 1-4 Electric Cables (300/500V to 1,900/3,300V).

w) SANS 1574: Electric Cables: flexible cords and flexible cables.

x) SANS 60044-1: Instrument transformers Part 1: Current Transformers.

y) SANS 60044-2: Instrument transformers Part 2: Voltage Transformers.

z) SANS 60269: Low Voltage Fuses.
aa) SANS 60079-14: Explosive atmospheres: Electrical installations design, selection and erection.
bb) SANS 60529: Degrees of Protection.
cc) SANS 60614: Conduits for Electrical Installations.
dd) SANS 60695-2: Fire Hazard Testing – Part 2: Glowing / hotwire test methods. Glow wire flammability test method for end products.
ee) SANS 61000: Electromagnetic compatibility (EMC). Part 1. General.
ff) SANS 10292: Earthing of low voltage distribution systems.
gg) SANS 61213: Mechanical Glands.
hh) SANS 1274: Coatings applied by the powder coating process.
ii) IEC TR 61641: Enclosed low-voltage switchgear and control gear assemblies - Guide for testing under conditions of arcing due to internal fault.
jj) SANS 10131: Above-ground storage tanks for petroleum products.
kk) SANS 10108: The classification of hazardous locations and the selection of equipment for use in such locations.
ll) SANS 60079-10-1: Classification of areas — Explosive gas atmospheres.
mm) SANS 60439-1/IEC 60439-1, Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies

MC3 **QUALITY**

Material and equipment shall be new and unused and of the best quality available.

SYSTEMS AND OPERATING/ENVIRONMENTAL CONDITIONS

The Motor control centre is for in indoor installations which form part of eThekwini Water and Sanitation Low Voltage (400/440/230V) system and shall be designed to operate satisfactorily when subjected to the following operating conditions:

Description	Detail
Climate	humid and sub-tropical
Altitude	from sea-level to 1 000 m
Ambient temperature	from 0°C to 50°C
Maximum relative humidity	99 %
Highest system phase-to-phase voltage	440 V
System frequency	50 Hz
System neutral earthing	Solid
Fault level	TBA
Service configuration of switchboard	In-line extendable to form a continuous bank
Mean annual value of solar radiation	1.0 kW/m^2
Average total annual rainfall figure	1 000 mm
Lightning level/lightning ground flash density	High/up to 5 flashes per km^2 per year
Line configuration	Triangular, horizontal and vertical
Number of phases Plus Neutral	3 + N

MC4 MOTOR CONTROL CENTRES

MC4.1 Overview

The motor control centre (MCC) shall incorporate all equipment necessary for the control and protection of the electric motors.

Indoor panels shall be totally enclosed and flush fronted. Outdoor panels shall have an outer hinged door, free of equipment, providing a weatherproof enclosure for the inner door. All equipment shall be mounted within the panels and connections and terminals shall be easily accessible. Pilot lights, instrumentation, control switches etc. shall be mounted on a hinged door.

The incoming switch, control equipment, distribution equipment and starters shall be housed in separate metal enclosed panels.

With the starter main isolator in the OFF position there shall be no live wires entering the starter cubicle.

With the incoming main switch in the OFF position there shall be no live wiring entering the entire panel.

Live incoming cable terminals are to be located in separate panels to outgoing terminations and are to be effectively shrouded against inadvertent contact.

Equipment shall have adequate current carrying capacity and shall be labelled corresponding to line and schematic diagrams.

The form of internal separation (in accordance with SANS 60439-1) shall be as specified in the Project Specification. Form 4a as appropriate, shall be considered the minimum allowable internal separation for DBs and MCCs.

An earth bar shall be fitted, to which all non-current carrying metal parts are bonded. As a standard a separate earth bar shall be provided for connecting equipment requiring a clean earth or an intrinsically safe earth directly to the main incoming earth terminal. The earth bar shall be located through out the MCC.

Panels shall not be moved onto site until finishing trade work has been completed in the room where the panels are to be installed. The supplier shall allow in his pricing for storage under suitable conditions until delivery.

MC4.2 Shop Drawings

Three copies of shop drawings shall be submitted to the Engineer for approval, two weeks in advance of manufacture.

Shop drawings shall include at least:

(a) substantiation of the short circuit capabilities of the busbar support system in the form of authority test reports.

(b) substantiation of the full load rating of the busbars.

(c) time - current characteristics of the protective devices including, fuses, circuit breakers, and protective relays.

(d) front and side elevations of equipment and component layout.

(e) construction, dust proofing, vermin proofing, cable access and cable termination details.

(f) power single line diagrams drawn to the IEC system

(g) control schematic diagrams drawn to the IEC system

(h) cable termination diagrams

(i) component schedules cross referenced to drawings and equipment.

(j) component layout drawings showing the position and designation of all components.

MC4.3 **Installation Drawings**

Three copies of installation drawings shall be submitted to the Engineer for approval two weeks in advance of manufacture. The drawings shall include at least :

(a) adjacent trenches, penetrations, walls, cable trays and other equipment.

(b) surrounding space available for access and maintenance

(c) cable routing and cable entry details

(d) details of supports required, other than those built into the control panel.

(e) details of cable trench covers.

(f) Drawings to be submitted in electronic format Autocad(.dwg)

MC4.4 **Enclosures**

Panels in existing installations shall match existing panels in general appearance.

3CR12 stainless steel shall be at least 1.5 mm thick for panels up to 0,75 m^2 and at least 2mm thickfor larger panels.

There shall be no lap-welding of the steel frame or steel panels. Burrs, sharp edges, blemishes and welding slag shall be removed prior to painting. Construction shall be dust and vermin proof and suitable for ambient conditions.

Floor standing panels shall be provided with a removable steel channel base.

Panels in excess of 100 kg shall be provided with a removable steel channel base.

Panels in excess of 100 kg shall be provided with removable lifting eyes.

Covers and doors shall be hinged. Lift-out covers will not be accepted.

Panels shall be extensible in both directions.

The finished metal work is to be approved by the Engineer prior to painting.

MC4.5 **Ventilation**

All enclosures shall be ventilated without degrading dust and vermin proofing.

Location	Description	Minimum rating
Indoor	Clean, dry areas (e.g. inside substations or motor control rooms)	IP54 (doors closed) IP2X (inter-compartment & doors open)
Outdoor	Located outside buildings	IP65 (doors closed) IP2X (inter-compartment & doors open)

Minimum levels of ingress protection

Enclosures containing heat producing equipment shall be louvered such that adequate upward and cross ventilation is obtained.

Ventilation shall ensure that the temperature at any point within the enclosure does not exceed 40^{o}C, irrespective of the ambient temperature, when the equipment is operating

at full load.

Outdoor panels shall be fitted with heaters and thermostats to effectively prevent condensation within the panels.

MC4.6 **Vermin Proofing**

Panels shall be protected against the entry of vermin.

Non-hardening compound shall be supplied with the panels to permit sealing of entries after installation of cables.

MC4.7 **Space Requirements**

The panel shall be sized to allow for the following clearances:

(a)	bare conductors or terminals to earth	45 mm
(b).	insulated busbars to earth	40 mm
(c)	equipment to metal work	50 mm
(d)	vertical distance between horizontal rows of equipment	75 mm
(e)	When installing equipment in the MCC the equipment shall be install as per the manufactures specifications.	

Cable entries and equipment shall be so disposed that the minimum bending radius of cables is not exceeded.

MC4.8 **General and Installation Arrangement Details**

Large circuit breakers and switch fuse units shall be positioned at low level.

Sufficient space shall be allowed between equipment for routing of conductors and expansion of ionised gas.

Flash barriers shall be installed between items of equipment where operation of one item is likely to cause an insulation breakdown in the other.

Control fuses shall be base mounted on busbars. Unprotected wiring may not be run to remote fuses or equipment.

All parts of the control panel metal work shall be electrically continuous and studs shall be provided for earthing the enclosure.

Flexible copper straps shall be used for earthing hinged doors carrying control equipment.

MC4.9 **Cable Gland Plate**

A removable cable gland plate shall be installed across the full width of the panel at a height appropriate to the bending radius of the cables and the manner of approach of the cables.

A channel iron cable support and saddles shall be provided to carry the mass of the cables and remove mechanical stress from the glands.

MC4.10 **Paint Finish**

An electrostatically applied powder coating is the preferred finish. Baked enamel finishes will not be accepted.

Care shall be taken that all edges and corners are properly covered.

Panels shall be electric orange device plates shall be white.

The painting process shall include at least the following steps:

(a) metal work is to be derusted by complete submersion in phosphoric acid.

(b) thorough rinsing

(c) metal work has to have an anti-corrosive coating applied by complete submersion in zinc phosphate followed by thorough rising.

(d) metal work is to be passivated by submersion in chromic acid

(e) metal work is to be thoroughly dried

(f) metal work is to have a 10 micron primer coat applied

(g) primer coat is to be thoroughly rubbed down with fine abrasive paper and dusted off.

(h) polyurethane powder is to be applied to a thickness of 100 microns plus or minus 10 microns

(i) the metal work is to be baked at a temperature and for a duration recommended by the supplier of the paint

(j) painted surfaces are to be cleaned and touched up to the above standard prior to handover.

The contractor shall obtain written approval of the painting process from the paint manufacturer and submit this to the engineer.

MC4.11 **Accessories**

Door locks shall be of the Barker Nelson square key type. Hinges shall be of the D hinge type, permitting doors to be lifted off.

Hinges and door locks shall not be welded on.

Hinged doors shall not scratch painted surfaces during repeated opening and closing.

Sealing gaskets shall be of durable non-hardening synthetic rubber and shall be uniformly compressed along the entire length of the gasket without deflecting or buckling panels.

For applications outdoor, bolts, nuts, washers shall be of 316 L stainless steel.

Screws, bolts and nuts must not be in direct contact with paint work.

Self tapping screws shall not be used.

Tapped holes shall have a thread length equal to the diameter of the hole and shall be rust protected by TECTYL.

Busbar bolts shall be of mild steel and shall be fitted with lock nuts and lock washers.

MC4.12 **Wiring**

Wiring shall be arranged in horizontal and vertical rows and shall be bound with plastic straps or enclosed in wiring channels. PVC tape shall not be used for bunching or for colour identification.

Bunched conductors shall be uniform and neat and conductors shall enter and leave the harness adjacent to the chassis.

Conductors to hinged doors shall be secured at the door and the frame and the loop between the fixed points shall be covered in a flexible sleeve.

For wiring in trunking the summated cross sectional area of the conductors measured over the insulation shall not exceed 40% of the cross sectional area of the trunking.

Power and control wiring shall not be installed in the same channel.

Holes in metal work shall be fitted with rubber grommets.

Wiring shall not be subjected to pressure points.

Wiring and terminations shall be readily accessible and shall be installed away from terminals or other current carrying parts. Wiring shall not block access to equipment.

Conductors damaged during removal of insulation will be rejected as will insulation stripped beyond the leading edge of terminals.

No joints will be permitted in the run of conductors.

Not more than two conductors shall be connected to a single terminal.

Conductors shall be stranded annealed copper, PVC. Insulated, 600/1000 volt grade to SABS 150.

The minimum conductor size shall be 2,5 mm^2

Screened cables shall enter panels through compression glands. Conductors shall remain within the screen at terminations for as great a distance as possible and shall leave the cable through the braid without damage to the braid. Screens shall be earthed in the control panel only.

Neutral conductors which are looped between terminals shall have the two ends crimped in a common terminal.

Conductors shall be derated and protected in accordance with the following table. It is to be noted that the maximum temperature within the panel shall not exceed 40^{o}C.

NOMINAL CROSS SECTIONAL AREA (mm^2)	CONDUCTOR RATING (AMPS)				
	NUMBER OF CONDUCTORS IN BUNCH				
	1	03-Feb	05-Apr	09-Jun	>10
1	13	12	10	9	8
1.5	17	15	14	12	10
2.5	23	21	18	16	14
4	31	28	25	22	19
6	40	36	32	28	24
10	55	50	44	39	33
16	72	65	58	50	43

MC4.13 **Busbars**

Busbars shall be installed along the full length of the control panels and shall be shrouded over that length by an enclosing chamber through which pass only connections to the busbars.

Busbars shall be insulated in heat shrink sleeving and the minimum clearance to earth or between live conductors shall be 40 mm. Breaks to the heat shrink sleeving shall be taped using two layers of self-adhesive PVC. tape over non-hardening compound.

Busbars and busbar supports shall be electrically and mechanically designed to withstand the dynamic and thermal short circuit stresses occurring at the specified fault level.

Busbars shall be rated for the full load current of the busbar protective device such that the internal temperature of the control panel remains below 40^{o}C.

Busbars shall be of hard drawn, high conductivity copper and shall be of uniform cross section throughout the run.

Tufnol busbar supports may not be used above 10 kA.

Busbar support systems shall have been tested by a recognised authority and a certificate shall be submitted as evidence of the test. The test certificate and support system shall be identified and cross referenced.

Busbar support spacing shall not exceed the spacing used for the test.

MC4.14 **Colour Coding**

Busbar phase identification shall be red, white, blue from top to bottom, left to right and front to back when facing the panel.

Conductors shall be identified as follows:-

220/110 volt AC control	Orange
50 volt DC control	Purple (+) and Blue (-).
PLC wiring	Grey
Earth wires	Green/Yellow
Neutral wires	Black
Telemetry wiring	Yellow

MC4.15 **Equipment Identification**

All equipment and components used in the control panel shall be identified using the IEC system of identification.

Labels shall be black on white traffolyte and fixed to the panel by bolts and nuts in the close proximity of the component in a position where they may be easily read.
The size of the characters shall be such that they may be read from a distance of 1m by a person with normal eyesight.

MC4.16 **Wire Identification**

All wire ends shall be identified using engraved interlocking ferrules which shall be cross referenced to schematic diagrams.

MC5 CABLE LADDERS AND TRAYS

Cable ladders, trays, hangers and fixings shall be of 3CR12 in both indoor and outdoor applications. Cable ladders, fittings and fixtures shall be the product of one manufacture.

Purpose made bends, tees, offsets and the like shall be used in preference to site manufacture. Cable ladders shall be earthed at a point closest to the source of supply and continuity shall be maintained across joints by means of jumpers. The minimum size of the earth continuity conductor shall be 16 mm^2, the bonding conductor shall be 10 mm^2 and it shall be green PVC insulated. Cable ladders shall be run horizontally or vertically within tolerances that can be detected on a 1 metre spirit level.

MC6 CABLE WORK

MC6.1 General

Low voltage power and control cables shall be 600/1000 volt grade and shall have stranded copper cores, PVC insulation, PVC bedding, PVC sheath, galvanised steel wire armour, and a PVC outer serving.
Low voltage cables shall carry the SABS mark of approval.

MC6.2 Cable Laying

The contractor shall be equipped with the equipment recommended by the cable manufacturer for laying cables. This shall include at least a pulling sock, winch, pulling tension measuring device, cable rollers, corner skids and cable drum support with a means of braking.
Cables shall be laid straight. Power cables shall be spaced 100mm. Control cables may be close spaced. There shall be no cable to cable contact in crossing cables.
Cables which cross pipes shall do so below the pipes.

Signal cables shall be laid at a separation of at least 1000mm from power cables. Signal cables shall be run in PVC conduits below ground through drawboxes located above ground. Drawbox spacing shall not exceed 50m in straight runs and shall be located after every second bend. The conduit diameter shall be agreed with the engineer before installation. Conduit joints shall be well glued, taped with 2 layers of rubber tape, 1 layer of bitumen tape and shall be reinforced by being strapped to a 2 m length of 38 x 38 batten. Drawboxes shall be mounted above ground in a manner to be agreed with the Engineer and shall be watertight. A test for water tightness shall be conducted on each draw box with a fire hose.

MC6.3 Cable Joints

Cable joints will only be permitted in cables where the cable length exceeds a drum length.

The minimum drum lengths shall be 500 m for cable of 35 mm^2 and below and 300 m for larger cables.

All cable, irrespective of length, shall be delivered on drums. Cable delivered in coils will not be accepted irrespective of how short the length is.

Cables in excess of a drum length shall be jointed in a manner recommended by the manufacturer of the cable. This recommendation shall be documented.

Cores shall be ferruled and crimped. A sample crimp of each size core used shall be submitted to the engineer for approval. The sample shall be cut through and dressed after initial inspection.

MC6.4 Cable Duct

Cable ducts shall be laid under hardened surfaces which shall include tiled and/or loose paving.

The cable duct diameters shall be appropriate to the cable diameters and are subject to the approval of the Engineer.

Cable pipes shall be of PVC and of a strength sufficient to withstand compaction. The integrity of cable pipes shall be examined after compaction and excavation on both sides of the pipes shall be allowed for in the tender price.

The number of ducts shall be sufficient for the cables to be installed plus twenty five percent.

MC6.5 **Sheath Integrity**

The integrity of the sheath is regarded as important.

The minimum acceptable insulation resistance between armouring and the general mass of the earth is 100 mega ohms. Cables which have insulation resistance below this value shall be replaced. The insulation resistance shall be measured with a hand cranked megger.

MC6.6 **Documentation**

As built drawings shall show:-

(a) Cable routes fixed to permanent structures.

(b) The disposition of each cable by cable identification number.

MC6.7 **Cables Within Buildings**

Cables run within buildings shall be run on cable ladders. Cable ladder routes shall be co-ordinated with other services by the contractor. There shall be easy and safe access to cable ladders after installation of all other services.

All accessories shall be the product of the ladder manufacturer and there shall be no site fabrication of bends, tees, fixings, fastenings and the like.

Cable ladder routes shall be agreed with the engineer before installation.

Cable ladders shall be sized to allow 50mm spacing between power cables, and for close spacing of control cables.

Power and instrument cables shall be run at the spacing recommended by the supplier of the instrument but with a minimum spacing of 500mm.

Cables shall be individually strapped to ladders using self locking, plastic straps. Cable routes shall be planned to obviate unnecessary cross over of cables.

Cables entering enclosures shall be straight for a minimum distance of 300mm above the point of entry.

MC6.8 **Terminations**

Only Pratley Enviroglands shall be used.

Compression lugs shall be embossed with the size of the compression die.

The compression tool design shall prevent release of the tool before the crimp is complete.

The compression equipment and method of use shall be recommended by the manufacturer of the lug.

Equipment shall be inspected by the engineer before use.

A sample lug shall be crimped and presented to the engineer for inspection. After inspection, the contractor shall cut through the sample at 45 degrees, dress the surface and present the sample for inspection.

MC7 **STATING DEVICES**

MC7.1 **VARIABLE SPEED DRIVES**

Standard Specification for Variable Frequency Drives (VFDs)to be used in eThekwini Water and Wastewater applications

This shall be used to specify the required features of VFDs that are designed for use with standard IEC and/or NEMA AC induction motors, synchronous reluctance motors (SynRM) and permanent magnet motors (PM) in Water and Wastewater applications.
Any deviations from this specification must be:

A) LISTED and
B) APPROVED
by the specifier PRIOR to the quotation.

PART 1 - GENERAL

1.01 DESCRIPTION

This specification is to cover a complete Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with a standard AC induction motor, synchronous reluctance (SynRM) and permanent magnet (PM) motors in Water and Wastewater applications.

The VFD manufacturer shall supply the VFD and all necessary options as specified. VFDs that are manufactured by a third party and “brand labeled” shall not be acceptable. All VFDs installed on this project shall be from the same manufacturer.

1.02 TERMINOLOGY USED

A. Cabinet: Enclosure into which the VFD may be built
B. Control panel: Device to be used in controlling and/or monitoring the VFD; normally attached on the VFD cover or on the cabinet door
C. Motor: Induction motor (IM), Permanent magnet Motor (PM) or Synchronous reluctance motor (SynRM), typically IE2, IE3 or IE4 efficiency class
D. THDi: Total Harmonic Distortion of current
E. VFD: Variable Frequency Drive (aka: AFD, ASD, VSD, inverter, drive, etc)

1.03 QUALITY ASSURANCE

A. Referenced Standards and Guidelines:
1. International Building Code (IBC)
a. IBC 2012 Seismic – referencing ASC 7-05 and ICC AC-156
2. International Electro-technical Commission (IEC)
a. IEC/EN 61800-3, Adjustable speed electrical power drive systems
b. IEC/EN 60529:1992 + A2: 2013 (IP), Degrees of protection provided by enclosures
c. IEC 60664-1:2007, Insulation coordination for equipment within low voltage systems
d. 2014/35/EU Low voltage directive
e. 2014/30/EU Electromagnetic compatibility (EMC)
f. 2006/42/EC Machinery directive
3. Institute of Electrical and Electronic Engineers (IEEE)
a. IEEE 519, Guide for harmonic content and control
4. International Organization for Standardization (ISO)
a. ISO 9001:2015, Quality Management System

b. ISO 14001:2015, Environmental Management System
c. ISO 45001:2018, OHSMS Management System
5. National Electric Code (NEC)
a. NEC 430.120, Adjustable-Speed Drive Systems
6. National Electrical Manufacturer's Association (NEMA)
a. ICS 7.0, AC Adjustable Speed Drives
b. NEMA 250:2008, Enclosures for Electrical Equipment
7. Underwriters Laboratories (UL)
a. UL508A, Industrial control panels
b. UL508C, Power conversion equipment
c. UL61800-5-1, Standard for adjustable speed electrical power drive systems

B. Qualifications:

1. The VFD manufacturer shall:
a. have a minimum of 40 years of experience in VFD design and manufacturing and
b. have adequate business volume in order to provide credibility in its commitments and capability for long-term support,
b. be able to make identical products in more than one location, in order to ensure production capacity at all times,
c. have a Functional Safety Management system and valid IEC 61508-1 certificate available,
d. have a valid ISO 9001:2008 certification and an applicable quality assurance system and certificate available,
e. have a valid Environment Certification ISO 14001:2014 and certificate available,
f. have an Occupational Health and Safety Management system and valid OHSAS 45001 certificate available.

2. The VFD shall comply with the technical requirements specified in IEC/EN 61800-5-1:2007 (Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy).

3. The VFD shall with the technical requirements specified in EN 61800-3:2004 + A1:2012 (Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods).

4. CE mark - The VFD shall comply with the following directives, required for the CE mark:
a. Low Voltage Directive 2014/35/EU of the European Parliament and of the Council of the European Union.
   1) The VFD shall have the manufacturers name and postal address printed on the VFDs type label and package label according to LVD 2014/35/EU.
   2) The contact details shall be clearly printed and not removable from the VFD.
   3) VFDs without the manufacturer's name and contact details are not acceptable.
b. Electromagnetic compatibility (EMC) Directive 2014/30/EU of the European Parliament and of the Council of the European Union.
c. Machinery Directive 2006/42/EC of the European Parliament and of the Council of the European Union.

   A manufacturer's Declaration of Conformity to confirm compliance with mandatory directives shall be available for public access. The Declaration of Conformity of Machinery Directive shall specify the person authorized to compile the VFDs technical file for safety functions. Contact details shall be included in the Manufacturers Declarations.

5. CULUS approval

a. The VFD shall comply with the technical requirements of UL according to UL61800-5-1. A UL listing document shall be available to confirm VFDs compliance with the requirements.
b. In lieu of UL61800-5-1 compliance, the VFD shall comply with the technical requirements of UL according to UL508C. A UL listing document shall be available to confirm VFDs compliance with the requirements.
c. Along with the declaration, there shall be the UL (Underwriters Laboratories) mark on the VFDs type label to identify the compliance.
d. Pending UL approval is not accepted.
e. The VFD shall be UL labeled 100 kA SCCR, RMS Symmetrical, 600V max.

6. Environmental Manufacturing

a. The VFD shall comply with Restriction of Hazardous Substances in Electrical and Electronic Equipment directive 2011/65/EU requirements, so called RoHS II requirements.
b. The VFD shall be easy to recycle. The manufacturer shall make recycling instructions publicly available. The recycling instructions shall provide recycling information in accordance to Waste Electrical and Electronic Equipment directive 2012/19/EU (WEEE).
c. The VFD shall not contain toxic or hazardous substances or elements above the maximum concentration values as specified in the People's Republic Electronic Industry Standard (SJ/T 11364-2014). The EIP (Electronic Information Products) mark shall be on the VFDs type label to identify EIP compliance.

7. Functional Safety

a. The VFDs shall support 'Safe Torque Off' (STO) function capable for safety related applications up to SIL 3, SILCL 3 and PL e.
b. The VFD shall comply with the following standards
1) IEC 61508:2010; SIL
2) ISO 13849-1:2006; PL e
3) IEC 62061:2005; SILCL 3
4) IEC 61800-5-2:2007; SIL 3
c. There shall be a 3rd party statement of compliance available to confirm the VFDs compliance. Manufacturer's statements are not accepted to confirm compliance

1.04 SUBMITTALS

A. The Submittals shall include the following information:
1. Product Overview
2. Dimensional Drawings
3. Control Circuit Drawings
4. Engineering Data including rating tables and weight
5. General Notes

PART 2 - VARIABLE FREQUENCY DRIVES (VFD)

2.01 GENERAL

A. The VFD must be designed specifically for the Water and Wastewater market. General purpose products are not acceptable.

B. The VFD shall have the same customer interface, including control panel, I/O connections and firmware, regardless of power, voltage rating or harmonic mitigation solution.

C. The VFD shall be solid state, with a Pulse Width Modulated (PWM) output. The VFD shall

be a Sensorless Vector AC to AC converter utilizing the latest Insulated Gate Bipolar Transistor (IGBT) technology. The VFD shall employ a Sensorless Vector inner loop torque control strategy that mathematically determines motor torque and flux. The VFD must also provide an optional operational mode for V/Hz operation.

D. Electrical network

1. The VFD shall be rated to operate from:
a. 3-phase, 380 to 480 VAC, +10%...-15%

2. The VFD shall operate with supply frequencies from a minimum range of 47.5 to 63Hz. Nominal power ratings shall be met in the allowed frequency range.

3. The VFD shall operate should a minimum +/- 3% of nominal phase to phase input voltage imbalance exist. Nominal power ratings shall be met at all times.

4. The VFD shall be allowed to be used on TN (grounded), IT (ungrounded) and corner grounded TN systems without options or hardware modifications.

5. The VFD shall employ a full wave rectifier to prevent input line notching and operate at a fundamental (displacement) input power factor of 0.98 at all speeds and nominal load.

6 The VFD shall be designed to be used in, and to meet the requirements of, public low voltage networks. VFDs designed only for industrial electrical networks are not accepted.

7. The VFD must comply with SEMI F47 – the semiconductor industry standard for voltage sag immunity. Compliance shall be verified by a third party.

E. EMC, Electromagnetic compatibility

1. The VFD shall have inbuilt EMC/RFI filters as standard.
a. It shall be possible to disconnect the EMC filters without specific tools (for IT and corner grounded TN electrical systems).

2. The VFD shall conform to the European Union Electro Magnetic Compatibility (EMC) Directive EMC 2014/30/EU, a requirement for CE marking.

3. The VFD shall comply with the EMC Product Standard for drives EN 61800-3 Class C3 (2nd environment, restricted distribution) as standard.

4. The manufacturer shall provide suitable cable glands for EMC compliant installation.

F. Harmonics

1. The VFD shall comply with mandatory Equipment Standard IEC/EN 61000-3-12:2007: Limits for harmonic currents produced by equipment connected to public low voltage systems.

2. The manufacturer shall provide a tool for calculating the current and voltage harmonics at the input terminals of the VFD.

3. The VFD shall not contribute any significant harmonics at the input terminals of the VFD and shall maintain harmonics levels at the VFDs input terminals to levels at or below

those listed in “Harmonic Control in Electrical Power Systems, IEE Std. 519-1992” in the system that is already in compliance with the said standard.

4. The input current to the VFD shall have a total harmonic content less than 5% of full rated capability at the input terminals of the VFD on a power system sized according to IEEE 519-1992 at a line voltage unbalance up to 3% and under all motor load conditions.

5. The VFD design shall not compensate for existing harmonic content in the distribution system.

6. The VFD harmonic solution shall be contained within the VFD, not require external hardware (ie transformers, filters, etc) and not require additional wiring (ie 3 power wires in, 3 motor wires out).

7. Regenerative front end VFDs used as harmonic solutions are not acceptable, due to possible regeneration on to power distribution network. The VFD shall not interfere with the Emergency Back-up Generator’s voltage regulator.

8. VFD without DC Bus capacitors are not acceptable.

G. Environmental conditions

1. Temperature

a. The VFD shall have a minimum temperature range for transportation and storage from -40 to 70 °C.

b. The VFD shall operate without disturbances in continuous ambient temperatures with a minimum range from -15 to 50 °C (no frost allowed).

2. Altitude

a. The VFD shall be suitable for safe operation up to a minimum of 4000 m (13,000 ft) altitude in neutral grounded TN electrical systems.

b. The VFD shall be suitable for safe operation up to a minimum of 2000 m (6,500 ft) altitude in corner grounded TN electrical systems or IT systems.

3. Humidity

a. The VFD shall be designed to operate in ambient conditions of relative humidity with a minimum range from 5 to 95% (without condensation).

b. A motor heater function shall be supported to prevent condensation and corrosion of the motor.

4. Vibration

a. The VFD shall be designed to operate in vibrating environments with vibration limits allowed per IEC 60068-2 (modules) or IEC 60721-3-3 (cabinets).

5. Contamination

a. The VFD shall operate in contamination levels according to IEC 60721-3-1, IEC 60721-3-2 and IEC 60721-3-3; Chemical gases min. class 3C2, Solid particles class 3S2.

b. All printed circuit boards (PCB) shall be conformal coated to extend the electronics lifetime in harsher environments.

H. The protection class of the VFD (class defined by IEC/EN 60529:1989 + A1:1999 + A2:2013) shall not reduce the output current rating nor any environmental condition ranges.

I. The VFD output frequency shall be adjustable between 0 to 500Hz, forward or reversing. Operation above motor nameplate shall require programming changes to prevent inadvertent high-speed operation.

J. Maintenance

1. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without removing the VFD from the wall or removal of circuit boards.

2. The VFDs main cooling fans for the power electronics shall be speed controlled based on the cooling need. Fan speed should be controlled to extend the fan and fan bearing operating lifetime.

3. The VFD shall record a) VFD on-time, b) VFD run-time and c) cooling fan on-time for maintenance logging purposes.

4. The VFDs cooling fans shall have a minimum expected lifetime of 6 years.

5. Any battery used in the VFD shall have a minimum expected lifetime of 6 years.

6. For cabinet-built VFDs, all heavy components shall have a service position for safe maintenance operation.

2.02 MOTOR CONTROL

A. The VFD shall be capable of controlling an induction motor, permanent magnet motor and synchronous reluctance motors as standard.

B. It shall be possible to commission an induction motor, permanent magnet motor and synchronous reluctance motor with the motor nameplate values only, without the need to get the motor values from other sources.

C. The VFD shall include scalar and vector control modes with independent control chains and parameters for each control mode.

D. The overload rating of the VFD shall be 110 % of its rated normal duty current for 1 minute every 10 minutes and with a minimum of 130 % for 2 seconds every 1 minute. Overload ability shall be available at all times - not only at start.

E. The VFD shall be capable of sensing the loss of load (broken belt / broken coupling / dry pump) and signal the loss of load condition. The VFD shall be possible to be programmed to signal this condition via a control panel warning, relay output and/or over the serial communications.

1. Relay outputs shall include programmable time delays that will allow for VFD acceleration from zero speed without signaling a false underload condition. Underload and overload curves shall be user-definable.

F. It shall be possible to disconnect a motor running full speed by opening an optional contactor between motor and VFD without causing any damage to the VFD.

G. The VFD shall include a standard embedded functional safety feature Safe Torque Off, (STO), to make the motor mechanically safe.

H. The VFD shall include an energy optimization circuit (flux optimization) that will automatically reduce applied motor voltage to the motor to reduce energy consumption by up to 10% and lower audible motor noise.

I. The VFD shall be capable of starting into a spinning load (forward or reverse) up to full speed and accelerate or decelerate to a set-point (flying start) without tripping or component damage.

J. The VFD shall restart after a power loss without the need to resend the start command. This feature shall be there regardless of the control source, control panel, I/O or fieldbus.

K. Flux braking shall be available, where the VFD controls the motor to dissipate the extra rotary energy as heat whenever braking is required. It shall be possible to use this flux braking feature to decelerate the motor from one speed to another – not only for stopping the motor.

L. Power Loss Ride-Through shall be programmable. If the incoming supply voltage is cut off, the VFD continues to operate using the kinetic energy of the rotating motor. The VFD continues to be operational as long as the motor rotates and generates energy.

M. The VFD shall include a switching frequency control function. This adjusts the switching or carrier frequency, based on actual VFD temperature and allows the highest carrier frequency without de-rating the VFD or operating at high carrier frequency only at low speeds (temperature fold-back). It shall be possible to set a minimum and a reference switching frequency.

N. The VFD shall include a noise smoothing function, which distributes the acoustic motor noise over a range of frequencies instead of a single tonal frequency resulting in lower peak noise intensity.

O. The VFD shall have three programmable critical frequency or critical speed lockout ranges to prevent the VFD from operating the load continuously on an undesirable speed range (skip frequencies)

2.03 STANDARD CONTROL HARDWARE FEATURES - ADJUSTABLE BY THE USER

A. General I/O

1. All I/O terminals shall be color coded to simplify wiring and troubleshooting.
2. All I/O shall be accessible (monitor and control) for fieldbus protocols (pass-through I/O).
3. It shall be possible to monitor status of the I/O from the control panel.
4. The VFD shall have a special mode for testing the I/O and VFD configuration without requiring external equipment connected.

B. Analog I/O

1. The VFD shall have at least two programmable analog inputs. Both inputs shall accept

current (0 to 20 mA or 4 to 20mA) or voltage (0 to 10 VDC) signals. The signal type selection, current or voltage, shall be made via the VFD user interface; DIP-switches or jumpers are not allowed.

2. The analog inputs shall be freely programmable to be used e.g. as speed reference, frequency reference, pressure monitor or PID loop controller's setpoint reference or feedback signal.

3. The VFD shall have at least two programmable analog outputs (0 to 20 mA or 4 to 20 mA); out of which one shall be configurable to be either a current or voltage (0 to 10 VDC). The signal type selection, current or voltage, shall be made via the VFD user interface; DIP-switches or jumpers are not allowed.

4. The analog outputs shall be freely programmable to give an output signal proportional to any data available via the VFD user interface (including, but not limited to: frequency, motor speed, output voltage, output current, motor torque, motor power, DC bus voltage, active reference and other data).

5. Analog I/O signals shall have an accuracy of > 99% of full scale in both current and voltage modes.

6. If the input reference (4 to 20 mA or 2 to10 VDC) is lost, The VFD shall give the user the option of: (1) stopping and displaying a fault; (2) running at a programmable preset speed and displaying an alarm; (3) hold the VFD speed based on the last good reference received and displaying an alarm. It shall be possible to program the VFD to signal this condition via the control panel, relay output and/or over the serial communication bus.

C. Digital I/O

1. The VFD shall have at least six programmable digital inputs (24 VAC and 12 to 24 VDC, PNP or 5 pcs NPN) to connect to external devices, as follows:
a. All inputs can be configurable for PTC sensors.
b. There shall be a programmable run permissive circuit.
c. Up to four programmable free text interlock inputs shall be available.
d. The VFD shall have at least one digital input which can be configured to receive a pulse signal up to 16 kHz.

D. Relay I/O

1. The VFD shall have at least three programmable digital Form-C relay (changeover) outputs. The relays shall include programmable on and off delay times.

E. I/O Optional Extension Modules

1. The following I/O option modules shall be available:
a. A module with two relay outputs and one digital output.
b. A reinforced insulated PTC input module for up to six PTC sensors with the capability to trigger the STO circuitry of the VFD.
c. A module to provide an additional six digital inputs which can be operated with 115 VAC or 230 VAC voltage.
d. An ATEX (EU directive 2014/34/EU) certified Ex II (2) GD PTC input module for up to 6 PTC sensors with the capability to trigger the STO circuitry of the VFD.

2.04 SOFTWARE FEATURES

A. Water specific features:

1. The VFD shall have specific pump control functionality to control up to six pumps with one VFD to allow distribution of pump usage in a multiple pump system.

2. The VFD shall have multipump functionality with an intelligent master/follower configuration for controlling up to eight parallel pumps equipped with own VFD without additional devices:

a. The VFD shall have a parameter synchronization feature to broadcast PID, Multipump and Analog Input parameters to ensure system parametrization is equal in the parallel VFDs
b. The VFD shall have specific functionality to start and stop the pumps based on the required pumping capacity. In order to balance the operating time of the pumps, the VFD shall have the capability to change the order in which the pumps are started and stopped.
c. The VFD shall have the capability to give priorities for parallel pumps in the system to enable the most efficient pumps to be operated the most.
d. The VFD shall have the capability to set a maximum stationary time to ensure all pumps get exercised regularly, regardless of their priorities.
e. The VFD shall have the capability to control across-the-line pumps instead of parallel VFDs, in order to resolve the system demand.

3. The VFD shall have a level control function with operation modes for optimal tank filling or emptying supporting up to eight parallel pumps.

a. User–programmable start level shall indicate the point at which the pump will start.
b. The pump(s) shall operate in user-programmable “efficient speed”.
c. If the level keeps raising, more pumps will be started based on unique start levels.
d. There shall be a possibility to connect high- and low-level limit switches, which will trigger either full speed pumping or pump stop, depending if the application is for filling or emptying a tank

4. The VFD shall have the ability to calculate the flow based on the measured pressure difference (using pressure sensors) or the power curve of the pump (sensorless).

a. There shall be a multiplier parameter to enable correction for the calculation.
b. There shall be a specific energy parameter to measure actual flow per input power ratio. The motor speed can be adjusted to locate the most economical pumping point.

5. The VFD shall have two additional ramps for quick acceleration and two additional for deceleration in order to reduce wear of the mechanical parts in submersible pumps.

6. The VFD shall have soft pipe filling function with flexible user parameter settings to protect the system. There shall be a configurable pipe fill time to ensure the setpoint is reached within a desired time.

7. The VFD shall have a specific “Pump cleaning” functionality, based on a series of rapid reverse and forward rotation of the impeller, to prevent pump and pipe clogging.

a. The VFD shall have the cleaning cycle counter and user-programmable cleaning count time to give a warning and indicate the need for manual inspection.
b. The cleaning function shall consist of forced stopping, reverse and forward rotations to allow debris to be removed from the impeller.
c. There shall be a cleaning cycle status visible on the control panel screen when the cleaning function is active for monitoring the cleaning progress.
d. The VFD shall resume normal operation after the cleaning cycle is complete.

8. The VFD shall have a programmable Sleep functionality for PID control in pumping systems to stop the pump during low demand.

a. The VFD shall have a specific “Sleep Boost” functionality to minimize the amount of unnecessary pump starts and stops during periods of low demand. The sleep boost function is used to boost the pressure or water level up before the pump shuts down in order to extend the pumps sleeping time.

9. The VFD shall support a torque boost function for applications where boosting of the torque is required for initial starting of the pump.

B. PID control

1. The VFD shall have a minimum of two independent process PID controllers as standard, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control.

a. The VFD shall have 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by other suppliers.

b. The loop controller setpoint shall be adjustable from the VFDs control panel, analog inputs, or over the serial communications bus.

c. The VFD shall have a minimum of four constant setpoints available for each loop controller.

d. The setpoint shall be possible to be set and displayed in engineering units. Using only percentage as setting and display unit is not acceptable.

e. There shall be two parameter sets for the first PID loop controller. Switching between the sets shall be possible via digital inputs, timed function, and serial communications or from the control panel.

2. All setpoints, process variables, etc. shall be accessible from the serial communication bus.

3. The VFD shall have the ability to calculate air or water flow from pressure difference. There shall be the possibility to use a differential pressure transducer or two separate pressure transducers. The control panel shall be able to display the flow in engineering units.

4. PID controller shall be standard in the VFD, allowing an analog input signals to be connected to the VFD for the closed loop control. The VFD shall have 250 mA of 24 VDC power to power an external transmitter supplied by others. The loop controller set-point shall be adjustable from the VFD control panel, analog inputs, or over field bus. The set-point shall be set and displayed in engineering units.

C. Function block programming

1. The VFD shall provide a PLC-like programming capability as standard.

2. It shall be possible to use different kinds of arithmetic, logical, selection, comparison and operation function blocks to monitor and control the VFD, functions, inputs, outputs and variables.

3. There shall be a possibility to run different kinds of function block programs in different states and to set the criteria, when to change the state.

D. Timed functions

1. A real-time clock and calendar shall be available as standard for giving true time and date information to fault event history. The real-time clock shall have a minimum of 10 years power-off back-up without optional components. Back-up battery shall be replaceable without opening the VFD enclosure

2. A real-time clock shall be possible to use with timed functions, which shall allow controlling the VFD and its functions based on: time of the day, day of the week, seasons of the year, holiday periods and holiday dates and special working periods and working days

3. Timed functions shall be possible to use for: starting and stopping the VFD, for selecting the speed reference, for selecting the PID loop controller's set-point, for controlling the relay outputs, for selection the control location, for giving the run permissive or interlock signal to the VFD, etc.

4. There shall be the ability to temporarily override the time controlled start and start the and/or its functions regardless of: the time of the day, day of the week, season of the year, holiday, or workday.

E. Fault Logger: A fault logger shall accommodate seven diagnostic values together with a date and time stamp.

F. Built in Energy Calculators: There shall be built-in counters for calculating energy savings achieved with the VFD.

1. Used and saved energy
2. CO2 reduction
3. Saved money
4. Programmable kW rate

G. Pre-Set Speeds: There shall be a minimum of seven programmable pre-set speeds or frequencies.

H. Operating Values: All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. Engineering units shall be freely configurable for the user to display.

1. Output frequency
2. Motor speed (RPM, %, or engineering units)
3. Motor current
4. Calculated motor torque
5. Calculated motor power (kW)
6. DC bus voltage
7. Output voltage
8. Energy Consumption

I. Underload and overload curves shall be user-definable.

J. Independently adjustable acceleration and deceleration ramps with 1 to 1800 seconds adjustable time ramps. There shall be a possibility to use start delay before acceleration to ensure that all start conditions have been fulfilled.

K. Changed parameters list shall be available in order to assist commissioning and troubleshooting.

L. The VFD shall include pass code protection against unauthorized parameter changes. The pass code and the protection level shall possible to be defined by the user.

M. The VFD shall have ability to use any internal parameter value as input for any other parameter.

N. The VFD shall have the capability to fault or to show warning when triggered from external sources.

2.05 PROTECTIONS

A. The following protection functions shall be available:

1. Dry pump Protection: (Prevent the pump from running dry. Protects the pumps bearings and shaft seal from damage when there is no water in the pump)

2. Overvoltage and under-voltage controller

3. Ground Fault (Earth-leakage) supervision

4. Motor short-circuit protection

5. Output and input switch supervision

6. Overcurrent protection

7. Phase-loss detection (both motor & line)

8. Underload and overload supervision

9. Freely configurable supervisions for any parameter or signal to trigger an action.

10. Communication loss functionality to ensure uninterrupted operation.

a. The VFD shall have the capability to change the control location from PLC to another external location identified by user, e.g. VFDs embedded PID/loop controller and change back when communication is recovered.

11. The VFD shall have pump protection functions for flow and pressure to avoid damages of the pump and for leakage detection.

a. Inlet protection for avoid dry run, cavitation and blocked pipe.

b. Outlet protection for avoid high pressure and leakages.

c. Stall protection for avoid running locked pump.

2.06 USER INTERFACES

A. Detachable control panel

1. The control panel shall be detachable in all types of VFD protection classes and/or enclosures, without tools to allow easy commissioning and programming of multiple VFDs.

2. The control panel shall include a backlit LCD.

3. The control panel shall have a real-time clock with battery backup for adding time stamps

to events, as well as for use with timer functions.

4. The control panel shall provide a clear, interactive, context sensitive menu based user interface to make it easy to adjust the settings of the VFD.

5. The display shall be in complete words, in a language selectable by the user, for programming and fault diagnostics (alphanumeric fault codes are not acceptable).

6. The control panel shall provide interactive assistants (wizards) to help to commission and use the VFD.

7. A dedicated “Help” button shall be available on the control panel. The Help button shall provide context sensitive assistance for programming and troubleshooting.

8. The control panel shall provide an easy to use I/O menu, where the user can see the status and function of all the analog and digital inputs and outputs.

9. The control panel shall have a menu, which contains diagnostic data about the VFD operation. The data shall include data about active faults, warnings and events. In addition the data shall contain a summary of VFD active control sources.

10. There shall be an editable home-view in the control panel to allow different customer specific configurations.

a. A minimum of three operating values shall be capable of being displayed at all times.

i. All applicable operating values shall be capable of being displayed in engineering (user) units.

ii. Engineering units shall be freely configurable for the user to display.

11. The control panel shall include Hand-Off-Auto selections and manual speed control.

a. The VFD shall incorporate “bump-less transfer” of speed reference when switching between “Auto” and “Hand” modes.

b. It shall be possible to disable the Hand and Off buttons of the control panel.

c. As a safety feature, the control panel’s Hand and Off buttons shall have clear symbols to allow non-English speaking people to understand the meaning of the buttons. English text only is not acceptable in the Hand and Off button marking.

12. There shall be a possibility to reset the VFD from the control panel.

13. The VFD shall have the capability to change the output phase rotation sequence by use of a parameter. This parameter must be independent from, and not affecting, any speed reference or direction input to the VFD.

14. The VFD shall have the capability to run the motor in either direction, forward or reverse. Additionally, the VFD shall allow for forcing the direction in a given direction, regardless of the speed reference or direction input to the VFD.

15. A listing of changed parameters shall be readily available in order to assist with commissioning and troubleshooting.

16. The VFD shall have flexible selections within a parameter. Not only shall the parameter have a list for easy selection, when applicable, but also the ability to choose any other signal/parameter that may not be within the list.

17. The VFD shall include pass code protection against unauthorized parameter changes. The pass code and the protection level shall possible to be defined by the user.

18. The control panel shall contain at least one back-up of the VFD settings. Back-up information shall be possible to be saved on the control panel both manually and automatically.

19. The control panel shall have the capability to copy VFD settings from one VFD to another VFD, regardless of the VFD power, voltage or enclosure rating.

20. The control panel shall have an editable “Contact info” that shows up in case of a fault.

21. The user shall be able to take a screen capture snapshot of the display with the control panel and be able to download the screen capture for user’s computer for further purposes.

22. The user shall be able to connect a PC tool with a standard USB cable to the control panel in order to set up and control the VFD. It shall be possible to connect the USB cable without using any tools.

23. The VFD shall provide a possibility for wireless communication to allow working outside the arc flash boundary area and/or when there is no easy or safe access to the VFD. Wi-Fi connection is not acceptable because of its cyber security limitations.

a. For safety reasons, the VFD supplied with wireless communications shall have a local control panel with control buttons regardless of the wireless connection possibility.

B. Serial communications

1. The VFD shall have an EIA-485 (RS-485) port for serial communications as standard.

2. The VFD shall be equipped with built-in fieldbus communication of type Modbus RTU

3. There shall be following optional protocols available as plug-in and inbuilt options:

a. EtherNet/IP, Modbus/TCP, CANopen, DeviceNet, PROFIBUS-DP, PROFINET.

b. Protocols that have a governing authority shall be certified. Use of non-certified protocols is not allowed.

c. The use of third party gateways or multiplexers is not acceptable and all communication modules shall fit inside the enclosure of the VFD.

d. Serial communication capabilities shall include, but not be limited to: run-stop control, speed set adjustment, proportional/integral/derivative (PID) control adjustments, loop controllers’ set-point adjustment, current limit, acceleration/deceleration time adjustments and lock and unlock the control panel.

PART 3 - EXECUTION

3.01 DOCUMENTATION

A. Documents to be delivered with the VFD:

1. Multi-lingual quick installation and start up guide.
2. Mounting template in case of wall mountable VFD.
3. Hardware and firmware manuals on request, describing step-by-step how to install, start-up, trouble-shoot and maintain the VFD.

B. Documents to be delivered per request

1. Dimensional drawings (dwg and pdf formats).
2. Dimensional drawings 3D (stp format).
3. Customer connections and power wiring diagrams (dwg and pdf formats).

4. Cooling air requirement (xls and pdf formats).
5. Manufacturer's statement on output currents available continuously in different ambient temperatures up to 40 °C. Type of product needed at 50 °C continuous (24/7/365) operation must be clearly listed.
6. Environmental information / Recycling instructions of the VFD.
7. Semi F47 statement.
8. Harmonics statement EN61800-3-12.
9. Routine test reports.

C. ePlan macros shall be available for all the wall mountable frames and modules.

A.02 INSTALLATION

A. Installation shall be the responsibility of the installation contractor. The contractor shall install the VFD in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.

B. Power wiring shall be completed by the electrical contractor, adhering to local electrical codes, wiring requirements based on the VFD input current. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.03 START-UP

A. A factory-authorized service technician shall perform start-up on each VFD.

3.04 PRODUCT SUPPORT

A. The VFD manufacturer shall have an international sales, service, training and support network. These services shall be available in the local language.

1. The VFD manufacturer shall supply 24/7/365 technical phone support at no additional expense.
2. Training shall include installation, programming and operation of the VFD, and serial communication. Factory authorized start up and owner training to be provided locally upon request.

B. The VFD manufacturer shall be capable to offer spare parts support the product.

C. The VFD manufacturer shall have an analysis laboratory to evaluate the failure of any component within the VFD.

3.05 WARRANTY (SELECTION REQUIRED)

A. The VFD shall be covered with a worldwide warranty of a minimum of 36 months from the date of delivery.
An optional extension of warranty of up to 60 months shall be available.

COMPULSORY: WHEN SELECTING VSD'S, CABLING AND ANCILLARY EQUIPMENT, TENDERERS MUST TAKE COGNISANCE OF THE POINTS BELOW

1. High performance VSD cables with significant excesses of ground potential copper must be chosen.
2. In noise sensitive environments strong consideration must be given to the selection of a foil braid construction with enhanced common mode current control.

3. The cable voltage rating must be high enough to support voltages generated by the VSD.
4. A round cable should be selected to provide a good seal as the cable passes through circular openings and connection glands.
5. Consult the drive manufacturer who will provide the specific information needed to make decisions about gauge size and cable run length. Note: if a cable length is too long, it will act like a large capacitor that must be charged up when the system is turned on. After that initial phase, electrical energy continually pumped into the cable from the drive can surge into the motor.
6. Provide an effective earthing system to guard against stray currents affecting the bearings/ motor.
7. The tenderer shall choose a well-designed, robust VSD cable which must ensure motor uptime and reliability of the VSD system and also provide protection for any sensitive instrumentation and adjacent control systems.
8. The tenderer in his design shall choose the appropriate filter if the VSD is mounted a significant distance away from the motor.
9. Defects which can be proved from an independent report that the bearing/motor failure is the result of stray currents, the remedial cost thereof shall be paid by the tenderer for not providing an effective design solution.
10. A separate instrument earth bar must be provided.
11. All VSD must be wall mounted and rated accordingly.

MC7.2 **SOFT STARTER**

Conformity of standards

IEC
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, Finish, 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℃ with de-rating of maximum 0.8% per ℃ above 40℃
- 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

MC8. MOTOR STARTER CONTACTORS , INTELIGENT MOTOR CONTROL UNITS ,

Motor starter contactors, short circuit protective devices, electronic and thermal overloads shall be selected so as to provide Type 2 Co-ordination in accordance with SANS 60439-4-1. The minimum starter contactor utilisation category shall be AC3.

Intelligent Motor Control units shall only be used for starters irrespective of Killowatt Rating where it is critical to the process for feedback otherwise the motor shall be protected by an electronic or thermal overloads.

MC8.1 CCTV AND FIRE PROTECTION EQUIPMENT

CCTV and Fire protection equipment such as automated fire suppression systems shall only be incorporated into a design upon the outcome of a HAZOP, Risk Assessment and Hazardous Areas study. This shall be confirmed with the responsible EWS Electrical Engineer before such decision is made

LABELLING

MC9

a The text of every label, excluding individual internal component identification labels, shall be as agreed with the Engineer.

b Every Assembly shall be provided with a name plate detailing the following:

NAME PLATE DETAILS

The main name plate should be riveted on to the main incomer door. The name plate shallbe made of stainless steel plate one mm thick and the descriptions etched on the plate in Black. It shall have the following details on it where applicable.

Description	Details
Name Of Pump Station	TBA
Year Of Manufacture	TBA
Manufacturers Name	TBA
Manufacturers Drawing No:	TBA
Standards Manufactured	SANS 60439-1
Current	TBA
Frequency	50Hz
Operational Voltage	400V
Rate Insulated Voltage	TBA
Rated Impulse Withstand Voltage	TBA
Short Circuit With Stand Strength (KA)	TBA
Service Condition	TBA
Pollution Degree	3 or 4 when used outdoors
Type Of System Earthing	TN-S
Dimension Of Switchgear	
Weight	
Form Of Separation	4b
Environment	IP 54.
EWS Electrical Engineers Name	

MC10 **STANDARD SPECIFICATION- GENERATOR**

1.1 **GENERAL**

2.1 **OVERVIEW**

This section specifies general requirements of electric equipment and the installation thereof. It is to be read in conjunction with the Project Specification which has precedence in the event of conflict.

2.2 **COMPLIANCE WITH STANDARDS**

Equipment and methods of installation shall comply with the latest edition and/or amendment of:

(a) Act No. 85 of 1993 Occupational Health and Safety Act.

(b) SANS 0142 Code of Practice for the Wiring of Premises

(c) Relevant SABS specifications and Codes of Practice

(d) Relevant BSI Specifications and Codes of Practice in the absence of published SABS documents.

(e) Relevant IEC Specifications and Codes of Practice in the absence of published SABS and BSI documents.

(f) Comply with SANS 1473-1 LV Switchgear and Control Gear.

(g) Comply with SANS 10131

2.3 **QUALITY**

Material and equipment shall be new and unused and of the best quality available.

2.4 **DIESEL CONTROL AND CHANGEOVER PANEL**

2.4.1 **Overview**

The diesel control and changeover panel equipment necessary for the control and protection of the diesel generator

Indoor panels shall be totally enclosed and flush fronted. Outdoor panels shall have an outer hinged door, free of equipment, providing a weatherproof enclosure for the inner door. All equipment shall be mounted within the panels and connections and terminals shall be easily accessible. Pilot lights, instrumentation, control switches etc. shall be mounted on a hinged door.

The incoming switch, control equipment, distribution equipment and starters shall be housed in separate metal enclosed panels.

With the starter main isolator in the OFF position there shall be no live wires entering the starter cubicle.

With the incoming main switch in the OFF position there shall be no live wiring entering the entire panel.

Live incoming cable terminals are to be located in separate panels to outgoing terminations and are to be effectively shrouded against inadvertent contact.

Equipment shall have adequate current carrying capacity and shall be labelled corresponding to line and schematic diagrams.

An earth bar shall be fitted, to which all non-current carrying metal parts are bonded.

Panels shall not be moved onto site until finishing trade work has been completed in the room where the panels are to be installed. The supplier shall allow in his pricing for storage under suitable conditions until delivery.

All incoming live sections of fuse switches, circuit breaks and isolators shall have perspex barriers installed to limit expose. This barrier should have a danger live label attached to it.

2.4.2 **Shop Drawings**

As per MCC requirements

2.4.3 **Installation Drawings**

As per MCC requirements

2.4.4 **Enclosures**

As per MCC requirements

2.4.5 **Ventilation**

As per MCC requirements

2.4.6 **Vermin Proofing**

As per MCC requirements

2.4.7 **Space Requirements**

As per MCC requirements

2.4.8 **General and Installation Arrangement Details**

As per MCC requirements

2.4.8.1 **General Installation Arrangement Details**

As per MCC requirements

2.4.9 **Cable Gland Plate**

As per MCC requirements

2.4.10 **Paint Finish**

(a) The colour of LV switchboards and equipment enclosures in buildings shall be "Electric ORANGE", colour of SABS 1091 as recommended in SABS 0140.
(b) The standby power section of LV switchboards in buildings shall be coloured "SIGNAL RED", colour of SABS 1091. as recommended in SABS 0140.

The contractor shall obtain written approval of the painting process from the paint manufacturer and submit this to the engineer.

2.4.11 **Accessories**

As per MCC requirements

2.4.12 **Wiring**

As per MCC requirements

2.4.13 **Busbars**

As per MCC requirements

2.4.14 **Colour Coding**

As per MCC requirements

2.4.15 **Equipment Identification**

As per MCC requirements

2.4.15 **Wire Identification**

As per MCC requirements

2.5 **CABLE LADDERS AND TRAYS**

As per MCC requirements

2.6 **CABLE WORK**

2.6.1 **General**

As per MCC requirements

2.6.2 **Cable Laying**

As per MCC requirements

2.6.3 **Cable Joints**

As per MCC requirements

2.6.4 **Cable Duct**

As per MCC requirements

2.6.5 **Sheath Integrity**

As per MCC requirements

2.6.6 **Documentation**

As per MCC requirements

2.6.7 **Cables Within Buildings**

As per MCC requirements

2.7 **TERMINATIONS**

As per MCC requirements

2.8 AUTOMATIC TRANSFER SWITCH

Automatic Transfer Switch (ATS) 4 Pole to incorporate Switch and Controller in one unit and in accordance to IEC 60947-6-1, which will allow for emergency manual operation under load for immediate power restoration in the event of an equipment malfunction without opening the panel door. Should also provide predictive maintenance and modular components to reduce down time and service costs. The ATS Switch should come with detachable HMI, so there is no need for connecting dangerous line voltages to the door and the risk of operator injury due to equipment malfunction is reduced.

ATS to guarantee safe and reliable operation during variations in temperature (-25–+70°C) and voltage (200–480 VAC with +/-20% tolerance), and it's tolerant of vibrations (acc. IEC 60068-2-6) and shocks (acc. IEC 60068-2-27). To also have true short-circuit resilience, and able to take the hit and remain fully operational after exposure to even the most dangerous phenomena.

- Auto config (voltage, frequency, phase system)
- In-phase monitor (synchro check)
- In-built power meter module
- Load shedding
- Real time clock (48h back-up after power outage)
- Event log
- Predictive maintenance
- Harmonics measuring (Voltage, current)
- Padlocking the automatic transfer switch to prevent automatic and manual operation

2.9 CIRCUIT BREAKERS

2.9.1 Metal Clad Air Circuit Breakers (ACBs)

ACBs shall be of the withdrawable type and shall be suitable for use in power distribution systems up to 660V, 50Hz.

The circuit breakers shall comply with IEC 157 and shall have a P2-performance rating.

The ACBs shall be self-contained units of the dead front type, with the necessary mechanical interlocks to prevent: -

Access to "LIVE" terminals when the circuit breaker is withdrawn.

The withdrawal or insertion of the ACB, when the unit is in the closed position.

Closing of the circuit breaker without resetting after a manual trip.

The circuit breaker shall be of the quick-make and quick-break type with a stored-energy spring assisted operating mechanism provided with:

A trip free mechanical hand operated closing mechanism.

A manual operated mechanical trip mechanism suitably protected to prevent inadvertent tripping.

A positively driven mechanical device to provide ON-OFF-TRIP indication.

All non-current carrying metal parts of the ACB shall be solidly interconnected and connected to an earthing contact on the truck that shall engage with a mating contact on the cradle. The cradle itself shall be connected with a solid earthing bar to the protective earth of the control board. The contacts for earthing shall be made in the “racked in” as well in the test position.

The cradle shall be of a sturdy construction and shall incorporate safety shutters.

The “RACKED IN”, “TEST” AND “RACKED OUT” positions shall be clearly marked and visible.

The ACBs shall be designed in such a way, that the direction of the energy flow does not affect the performance of the breaker.

Adjustable thermal overload releases shall be provided to suit the required current range.

In addition, a magnetic short circuit release shall be fitted. This release shall have an adjustable current release value as well as an adjustable time – lag. A minimum of four, time lag settings shall be available.

Care shall be taken to ensure that the magnetic release is set low enough, where required, to operate under the lowest fault level condition (e.g. if ever the plant is supplied from a temporary alternator set).

Each ACB shall be equipped with the following accessories:

- Two normally open aux. contacts - Two normally closed aux. contacts - One alarm contact - One shunt release - Padlocking facility in the “TEST” position and pad lockable shutter gear.

Each ACB shall allow for the fitting of the following options:

- Motor drive for spring charge mechanism - Closing release complete with “ANTI PUMPING CIRCUIT” - Key interlock facility (equal to “Castell”) - Adjustable time delayed under voltage release - Carriage switches for “RACKED-IN” and “TEST” position - Mechanical interlock facility of the Bowden type

Minimum distances between enclosure and arc chutes shall be strictly observed. Full technical information of the ACB’s offered, shall be supplied with the tender.

2.9.1 Moulded Case Circuit – Breakers (Switchboards)

Switchboards shall be suitable for use in power distribution systems up to 660V – 50Hz and for panel mounting. They shall comply with SANS 156:2007. Switchboards of the same frame size and the same fault level shall be of the same manufacturer.

An adjustable release shall be provided where deemed necessary.

Switchboards employed for motor starting circuits shall be rated in such a way that the expected transient currents will not cause any “nuisance tripping”.

Feeder breakers to motor control centres shall be equipped with a thermal release and a time and value adjustable magnetic release. These Switchboards shall be selective towards the upstream and downstream circuit breakers.

Switchboards of the same frame size, where in one application an instantaneous magnetic release is used and in another application a time lagged release is used, shall have plug-in type trip units.

The operating handles of Switchboards shall give a positive indication of the ON/TRIP/OFF status.

Switchboards shall be installed vertically. Horizontally mounting is not acceptable.

Minimum distances from enclosure to arc chutes as required by the manufacturer shall be strictly observed.

Where indicated, circuit breakers shall be of the adjustable type.

The main circuit breaker and generator circuit breakers within XXXX Pump Stations, together with the two-generator standby auxiliary supplies, shall be of the motorized type.

Circuit breakers will be fitted with rated extended tinned copper terminals where necessary, to accommodate multi single core terminations.

Where cascading of circuit breakers is allowed, all equipment shall be coordinated, and discrimination shall be taken into account.

All equipment shall be approved by the Employer in writing and shall bear the SANS mark.

Circuit breakers shall be from the same supplier in one application. Circuit breakers shall be equipped with an instantaneous magnetic release and a thermal release. Circuit breakers for motor circuits shall be suitably rated. Circuit breakers handles shall provide a clear indication of "ON", "OFF" and "TRIP" status. Circuit breakers shall be installed vertically with the upstream terminal on top. Minimum clearances shall be maintained.

All circuit breakers shall be pad lockable in the "off" position or be supplied with means that will enable pad locking.

The Contractor shall supply and install all necessary circuit breakers and equipment required to form a complete functional protection system within each Switchboard complete.

3 ISOLATORS

Isolators shall not be provided in this project. Circuit breakers shall be used instead.

4 ASSEMBLY Construction Drawings – Standard Requirements

All Construction Drawings for ASSEMBLIES (SWITCHBOARDS, DB's, and Instrumentation Panels, etc.) shall contain the following information:

- Project Name and Contract Number
- Manufacturer/Supplier
- EWS Engineer and contact details
- Client details
- Drawing Number and Revision
- Drawing to be Signed
- Source of Supply – SWITCHBOARDS or transformer name etc
- Switchboard General Description
- Fault level (kA and time rating)
- Form factor/Sectioning
- Busbar Details (cross-section, material type, tinned etc)
- Busbar Support Details – type, manufacturer
- Required VFC cooling fan – type, manufacturer
- Earth bar details (cross-section, full-length, front or rear etc) □
- Switchboard Material type, grade, thickness etc.
- Gland Plate details – material type, thickness, mounting etc
- Colour – internal and external
- Switchboard Dimensions
- Base Dimensions and bolting arrangements
- Front door details – hinge and padlock requirements
- Rear door details – hinge and padlock requirements
- End panel details – removable cover details
- Door details - Stiffeners and restrainers installed etc.
- Hinge Details
- Locking Details
- Handle Details
- Cable Entry Details
- All bolts, nuts, screws material type (i.e. 316 Stainless Steel)
- Equipment details – CB ratings, fault levels, type, manufacturer etc

- Equipment Layout details – Cubicle name, function, equipment function etc.
- Section to be provided through switchboard

5. ASSEMBLY Schematic drawings– Standard Requirements

All Schematic Drawings for ASSEMBLIES shall contain the following information:

- Project Name and Contract Number
- Manufacturer/Supplier
- EWS Engineer and contact details
- Client details
- Drawing Number and Revision
- Revision details to be listed
- Drawing Page Number
- Drawing to be Signed
- Reference Grid required on each schematic page
- Source of Supply – Switchboard or transformer name etc.
- Fault level (kA and time rating)
- Voltages for all circuit to be clearly indicated
- All devices to have reference number i.e. relays
- Equipment ratings to be given i.e. motor ratings
- All indication lamps to be labeled including required lamp colour
- Legend to be provided
- Equipment Tag Numbers as per P&ID and Water and Sanitation Plant Numbering System to be provided.

6. STANDARD COLOURS – INDICATION LAMPS AND BUTTONS

The suitability of colours employed is generally based on IEC 60073 (No SANS version/ To be updated with latest Standard).

Due to colour schemes on existing plant and user/operator familiarity, the application of certain colours differs from IEC 60073 (To be updated with latest standard). For clarification, the lamp colours are a reflection of the status of the particular control system (front of panel towards equipment to be controlled).

The following colours shall in general be employed on switchboards for indication lamps, push buttons and selector switches:

COLOUR	**Condition / Meaning / Application**
RED	System stopped/not running or CLOSED
AMBER/YELLOW/ORANGE	Any warning/trip/abnormal condition
GREEN	System running/healthy/normal/ SAFE Condition or OPEN
BLUE	Step/Process change condition
WHITE	

Specifically, the application of colours shall be as follows:

INDICATION	LAMP	COLOURS	Examples/Specifics
Local/Auto/SCADA Mode	Indication Lamp	WHITE	
Bus Bar Alive	Indication Lamp	WHITE	
Capacitor Bank Discharged	Indication Lamp	GREEN	Power Factor Equipment
Closed	Indication Lamp	RED	Valves, penstocks
Differential Pressure – HIGH	Indication Lamp	AMBER	
Differential Pressure – NORMAL	Indication Lamp	GREEN	
Earth Fault	Indication Lamp	AMBER	MV
Equipment Emergency Stop	Indication Lamp	AMBER	
Mechanical Seal Failure Warning	Indication Lamp	AMBER	Sub / Immersible Pumps
Moisture in Coolant	Indication Lamp	AMBER	Sub / Immersible Pumps
Moisture/Water Ingress	Indication Lamp	AMBER	Motor
Winding Over Temperature	Indication Lamp	AMBER	May be flashing AMBER
Open Indication Lamp GREEN	Indication Lamp		Valves
Overload	Indication Lamp	AMBER	
PFC Fault	Indication Lamp	AMBER	Power Factor Equipment
Running	Indication Lamp	GREEN	
Starter Alive (Circuit Healthy)	Indication Lamp	GREEN	
Stepped Function	Indication Lamp	BLUE	Power Factor Equipment
Stopped & Power Available	Indication Lamp	RED	
Tripped	Indication Lamp	AMBER	

PUSH BUTTON/SELECTOR SWITCH COLOURS		Examples/Specifics Emergency	
Stop	Push Button	RED	With yellow backing
Lamp Test Reset Push Button BLUE	Push Button	BLACK	
Start	Push Button	GREEN	
Stop	Push Button	RED	
Up/Down/Left/Right/Forward/Reverse	Push Button	BLACK on WHITE	
Selector Switches/Knobs	Push Button	BLACK	with Black back plates with white lettering

Note: AMBER=YELLOW=ORANGE

For existing plant, lamp/pushbutton colours to be matched accordingly All indication lamps to be accompanied with engraved backing plates

The Engineer shall provide the final confirmation/approval of ALL colours to be employed on all new

7 **Labelling**

7.1 Labels

a) Labels shall be in English and isZulu
b) Labels shall be indelibly and permanently marked, and shall be securely attached to the equipment.
c) A label indicating the grade of oil shall be attached to the diesel engine.
d) All printed-circuit cards shall be clearly identified.
e) All instruments shall be clearly labelled to indicate their function, and all alarm indicators shall be clearly labelled to indicate the alarm they represent.
f) Statutory labels required to be attached to building doors, etc. shall be provided and fitted when applicable.
g) Labels that have red letters on a white background, the lettering being of height at least 10 mm, shall be affixed to all places where danger can exist owing to automatic start-up. The text on these labels shall be as below:

DANGER

THIS MACHINE SHALL START WITHOUT NOTICE. BEFORE WORKING ON THE MACHINE, LOCK THE CONTROL SWITCH ON THE CONTROL PANEL IN THE OFF POSITION

h) A label shall be attached adjacent to each terminal to indicate its function and designation in accordance with the relevant circuit diagram.
i) A graphic diagram with an electric flash in accordance with type designation WW7 of [7] SANS 1186, and a label indicating the voltage shall be placed near all mains terminals.
j) Labels may be engraved on sandwich plastic material that is suitable for tropical outdoor use.

STANDARD SPECIFICATION

AA7 **DIESEL GENERATOR SET**

AA7.1 **Scope**

This specification covers the design, engineering, manufacture, installation, testing and commissioning and maintain of both mobile and stationery standby generators rated for prime power for eThekwini Municipality to maintain its existing infrastructure with emergency electrical supply where required. The equipment must be capable of providing power in the event of a mains failure for lighting and power as well. The set shall be fully automatic, that is, it shall start when any one phase of the main supply fails, **AND** when the pumps is required to start and shall shut down when the normal supply is re-established **OR** after pumps have stopped.

The scope of works is as follows:

- Supply, installation, testing and commissioning of emergency generators for each identified site, according to specification
- Delivery of each generator to the specified site, including all necessary rigging, craneage and transportation means
- Delivery of each mobile generator to the specified site, including all necessary rigging, craneage and transportation means
- Construction of a concrete plinth in a location agreed with the Employer, and according to the generator OEM specifications

- Supply, installation, testing and commission change-over panel which shall incorporate all equipment necessary for the control and protection of the generator
- Supply and installation of all necessary cables, cable trays, conduit, glands as required, including trenching in soft/hard soil
- Tie-in to existing MCC, including panel modification, if required
- Liaison with eThekwini Electricity regarding the necessary isolations
- Preparation and submission of O&M Manuals and drawings
- Training of eThekwini Municipality staff at each specific site
- Submission of an Electrical Certificate of Compliance
- Submission of all associated test certificates for the generator manufacturing and testing process
- Supply of diesel for testing purposes for the Factory acceptance test
- Supply full tank of diesel after the commissioning on site.

AA7.2 **Site and Climatic Conditions**

The Tenderer shall establish site conditions at the site visits.

No.	Description	Detail
4.1.1	Climate	humid and sub-tropical
4.1.2	Altitude	from sea-level to 1 000 m
4.1.3	Ambient temperature	from 0°C to 50°C
4.1.4	Maximum relative humidity	99 %
4.1.5	Highest system phase-to-phase voltage	440 v
4.1.6	System frequency	50 Hz
4.1.7	Earthing System	TNCS

AA7.3 **Maintenance of Equipment**

Equipment offered shall be currently in production and capable of being properly maintained and serviced without the necessity for carrying large stocks of spare par parts. All spare parts required shall be available in Durban.

A written guarantee and commitment from the tenderer concerning the availability of spare parts for the full-service life of the equipment must be submitted and will be taken into consideration in adjudication of this tender. Tenderers shall submit a list of recommended spare parts which should be held by EWS, together with a current price list.

Tenderers shall specify the name, address, telephone and facsimile numbers of local agents or the nearest location of spare parts depot from which components may be obtained, in necessary quantities, and without prior warning, at any time, day or night, in order to ensure the minimum outage time of the equipment.

a) The Diesel Generator System shall be designed to minimize the need for maintenance.

b) Whether preventative or predictive, where maintenance is required, the design shall provide for good ergonomics in order to make it as easy as possible, with due consideration given to personnel safety.
c) The design shall allow for modular replacement of assemblies and components to a level as low as possible.
d) The time to isolate a faulty component shall be reduced by making extensive use of built-in test facilities.
e) Component conditions that may lead to a failure shall be monitored, and an alarm condition generated.
f) Spares and parts availability shall be guaranteed for the designed life of the DG.
g) Warranty on any part of the system shall be at least two years unless specified differently.
h) Tenders shall also price to Maintain, service and do regular start-ups of generator sets as required by acceptable maintenance practices and standards during the latent defect period

AA7.4 **STATIONARY GENERATOR CONTAINER/ENCLOSURES**

Canopies shall be constructed from 1.6mm 3CR12 sheet metal for coastal conditions. Canopies shall be sized to allow recommended maintenance to take place through lockable hinged doors.

Doors shall be secured by double expanding locks and all fittings shall be stainless steel. The canopy shall protect the set-in locations fully exposed to the weather.

The canopy shall be fixed to the plinth.

The plinth shall be in a position to be agreed with the engineer, and shall be shown on site
It shall have a bund wall as per SANS 10131-2004

Canopies shall be vermin proof.

Ventilations openings shall be fitted with Trox AWG type louvers.

The enclosure a shall be cleaned, degreased and painted with strontium chromate primer and finished with 2 coats of twin pack epoxy paint – color Grey C631.

General for each ISO Container where required

One standard modified ISO containers or similar robust steel enclosures will be manufactured, with sound attenuation and suitable doors for ease of maintenance purposes, as is required, complete for this Project. The doors are to be so positioned as to avoid the necessity for removal of major items of equipment in order to affect maintenance. The doors shall be provided to open outward of the container. These doors shall be lockable doors with a suitable door catch arrangement including a padlock cover for anti-vandalism.

The ISO containers a shall be cleaned, degreased and painted with strontium chromate primer and finished with 2 coats of twin pack epoxy paint – color Grey C631.

AA7.4.2 Sound Attenuation for each Container/Enclosure

The prime-mover and alternator-combined noise level, when installed within the container, shall not exceed 70 dBA measured at a distance of 7m from the container in open field, at full load.

The Tenderer shall submit detailed drawings with his Tender Offer.

The sound attenuation louvers will be manufactured from 304 stainless steel and shall be painted with suitable paint that will bond onto the 304 stainless steel.

The Engineer, shall approve each Container/Enclosure prior to the Contractor delivering it to site.

AA7.4.3 Signage for each Container/Enclosure

The Contractor shall fix the following notices (signage) to the inside wall of the Generator Enclosure in four of the official languages, viz English, Afrikaans, Xhosa and Zulu:

- Fire extinguisher location (red and white).
- Danger of electrical shock (yellow and black).
- Hearing protection (blue and white).
- In the event of electrical shock – first aid steps for resuscitation of electrical shock victim.
- First aid steps for burn victims.

Operating signs that are not safety related need only be in English.

The contractor shall supply and mount a suitably rated fire extinguisher for each stationary and mobile generator set.

AA7.6 **Electrical Equipment**

Alternators shall have rated Prime Power outputs, 1500rpm, at 0,8 lagging power factor. The machines shall deliver a three-phase, four-wire 50Hz supply at 400 Volt and shall be suitable for powering Variable Frequency Controller equipment. The alternator output voltage shall not drop by more than 15% under worst-case step loading.

AA7.6.1 Licenses

The Contractor shall supply to the eThekwini Municipality, Sanitation Mechanical and Electrical Branch, all original software licenses for any equipment installed and used for the control of each alternator.

AA7.6.2 Over current and short circuit protection

Alternators shall each have one suitably rated main circuit breaker for alternator main output circuit protection. This main circuit breaker shall be mounted within 300mm (max) of the alternators output terminals and shall supply the new alternator change over switches installed within each new switchboard within each ISO container or enclosure.

Each alternator main circuit breaker shall be of such a design so as to allow for shunt tripping from any emergency stop switches, or the emergency stop situated in the alternator control panel.

AA7.6.3 Alternators shall meet the following requirements

The following requirements shall be met for each alternator.

1. Synchronous.
2. Operating at a speed of 1500 rpm.
3. Each alternator shall be capable of delivering 115% of its continuously rated power output, on the site, for a minimum of 15 minutes at the rated voltage, without damaging the alternator or shortening the life span.
4. Seals shall be provided to prevent the lubricating grease from migrating along the shaft to the rotor windings.

5. Grease cups shall be provided for each bearing in readily accessible positions, even if this means remotely mounting the cups.

6. The shaft-mounted fan shall be fitted at the air intake end of the machine and preferably this shall be the non-drive end.

7. The exciter shall be of the brushless construction, inboard of the bearings, of three-phase full wave rectification design with silicon rectifying diodes.

8. Insulation shall be non-hygroscopic, non-nutrient Class B on the exciter, Class F on the stator and Class H on the rotating pole pieces.

9. Each alternator shaft shall be rolled steel. The rotating field pole shall be bolted to the shaft with all other rotating electrical components. This means that the shaft shall be free from electrical grounds on the shaft.

10. Each alternator shall be 4-wire Y connected with all cable ends brought out to the terminal blocks in the alternator cable end box.

11. The feet shall have machined surfaces at the mounting rail positions for good axial parallelism and shall be designed to minimise noise and vibration transmitted to the bedplate.

12. Each alternator shaft with its rotating equipment shall be dynamically balanced up to 25% over speed condition.

13. A heater shall be provided in the alternator, which shall be arranged to keep the machine warm, to prevent the ingress of moisture. The heater shall be energised whilst the machine is stationary and de-energised when the machine is operating.

14. Measures shall be taken to limit noise emission to an absolute minimum and to achieve this, use of a high efficiency-cooling fan may be necessary.

15. It should be noted that the electric load of each alternator will include harmonic loads (i.e. between 40 kVA and 2 000kVA Prime Power harmonic loading) which will be developed by variable frequency controllers that are employed in the eThekwini Municipality's existing infrastructure irrespective of individual sites starting methods.

16. Each alternator shall have a suitably rated circuit breaker installed in a 3CR12 sheet steel enclosure situated within 300 mm of the alternator output terminals.

17. The components of the voltage regulator shall consist of semi-conductors, completely static and containing no electromechanical relays or fuses. The regulator shall be of the solid-state electronic type. A circuit breaker for protection of the power circuit shall be provided with the voltage regulator.

18. Each alternator windings shall incorporate temperature sensors for temperature monitoring.

19. Response time to changes in load shall be less than 10 milliseconds and shall maintain voltage regulation at 1% R.M.S., when:

    - Load varies between no load and full load
    - The power factor varies between 0,8 and unity

    - A speed change of up to 5% occurs

20. Each alternator shall be designed **without the use of "dummy loads"** to operate supplying load/s that are less than 40% of the alternator's rated kVA rating, without any long-term damage to the alternator.

AA.8 **CHANGEOVER PANEL**

A change over panel shall be supplied in a location to be indicated at the site visit.

Automatic Transfer Switch (ATS) 4 Pole to incorporate Switch and Controller in one unit and in accordance to IEC 60947-6-1, which will allow for emergency manual operation under load for immediate power restoration in the event of an equipment malfunction without opening the panel door. Should also provide predictive maintenance and modular components to reduce down time and service costs. The ATS Switch should come with detachable HMI, so there is no need for connecting dangerous line voltages to the door and the risk of operator injury due to equipment malfunction is reduced.

ATS to guarantee safe and reliable operation during variations in temperature (-25–+70°C) and voltage (200–480 VAC with +/-20% tolerance), and it's tolerant of vibrations (acc. IEC 60068-2-6) and shocks (acc. IEC 60068-2-27). To also have true short-circuit resilience, and able to take the hit and remain fully operational after exposure to even the most dangerous phenomena.

- Auto config (voltage, frequency, phase system)
- In-phase monitor (synchro check)
- In-built power meter module
- Load shedding
- Real time clock (48h back-up after power outage)
- Event log
- Predictive maintenance
- Harmonics measuring (Voltage, current)
- Padlocking the automatic transfer switch to prevent automatic and manual operation

The changeover panel shall include metering CT's and isolating links all to the approval of eThekwini Electricity Department. The tenderer shall carry out all liaison with eThekwini Electricity Department including supply of metering CT's, submission for approval and testing.

AA.9 **DIESEL CONTROL PANEL**

The diesel control panel shall be integral with the enclosure. A "Deepsea Controller (latest) or equivalent controller shall be installed for generator supervision and control, within each generator set. The control equipment shall be so designed as to protect the standby generator set against damage due to failure of any of the sub-systems comprising the set. The control system shall allow for automatic starting and stopping.

Each distribution panel shall be suitably divided into two sections, one for" Deepsea Controller (latest) or equivalent controller, selector switches and indication and the other section for the distribution equipment and load circuit breakers.

The Alternator Control Panel shall include the following:

- A "Deepsea (latest) or equivalent controller for the supervision and control, accessed and operated from the interior of the canopy.
- Emergency stop.
- Battery charger.
- Monitoring System
- Immersion heater control equipment
- Alternator temperature display

The following facilities, components and constructional items shall be supplied: but not limited to it

1. Current transformers suitably rated.

2. Line, neutral and earth busbars.

3. Automatic constant voltage battery charger.

4. Control circuit breakers for instruments, etc.

5. 24 Volt fuel/crank relays.

6. Terminal strips.

7. Signals required for control of the changeover panel.

Door Mounted Components

The following constructional items shall be supplied/used:

1. 3 off flush mounted M.D.I. 76mm x 76mm dial ammeters suitably scaled.

2. 1 off flush mounted 76mm x 76mm dial voltmeter, 0 to 500V AC.

3 off flush mounted voltage selector switch with off, phase to phase and phase to neutral positions.

4. 1 off flush mounted 76mm x 76mm dial vibrating reed frequency meter, scaled 47 to 53 Hz.

5. 1 off flush mounted voltmeter, 0 to 30 V DC - Battery volts.

6 1 off alternator “Heater on“indicator.

7. 1 off flush mounted running hour meter.

8. 1 off manual “start” push button.

9. 1 off manual “stop” button.

10. 1 off emergency “stop” button : “latching type”.

11. 1 off engine alternator charge indication.

12. 1 off Automatic mains failure engine protection microprocessor control unit.

13. 1 off Engine temperature gauge.

14. 1 off lubricating oil pressure gauge.

An external power source shall be used for the battery charger, when the generator is in storage and unattended.

Where it is required to synchronize sets Deep Sea Electronic latest or equivalent controllers shall be used to facilitate load sharing.

AA.9.2 **Control Equipment Requirements**

AA.9.2.1 **INTRODUCTION**

Control systems may not consist of the electromagnetic relay type. Only the Deepsea(latest) or equivalent solid-state programmable systems complying with the following specification will be accepted.

The solid-state control systems shall be available “off the shelf” and shall have a proven local operating history of at least five years. The control systems shall consist of a single unit including all indicators/switches and allow for quick installation using locking connectors.

Imported or specially made solid state control systems or engine control and/or management systems will not be acceptable under any circumstances. The control systems shall consist of a single unit including all indicators/switches and allow for quick installation using locking connectors. The solid-state controller and associated systems wiring shall be to the control system manufacturer’s guidelines and shall be adequately protected against transient over voltages arising from lightning effects, switching surges, power system surges or mains and alternator borne noise/interference. Full details of the suppression systems are to be provided at tender. Wiring to and from the solid-state programmable controller is to be screened as necessary to prevent electrostatic and magnetic interference from adjacent wiring/systems. The solid-state controller must be able to communicate via ethernet, mod bus TCP/IP as minimum protocol.

AA.9.2.2 **SPECIFICATION**

a. Front Panel Indicators

These indicators are not limited to the table below

CONDITION	ALARM	SHUTDOWN
High Temperature	X	X
Low Oil Pressure	X	X
Overspeed	X	X
Under speed	X	X
Manual/Test Mode		
Heater Fault	X	
Low Fuel	X	
No Fuel	X	X
Low Water	X	X
Low Bulk Tank/Spare 2	X	
Start Fail	X	X
Manual Stop		
Emergency Stop	X	X
Mains Phase Fault		
High Mains Volts		
Low Mains Volts		
Mains On		
Mains on Load		
Coolant Level		
Alternator On		
Alternator Phase Rotation Fault	X	X
High Alternator Volts	X	X
Low Alternator Volts	X	X
Battery Volts Fault	X	
Alternator Charge Fault	X	
Control System On		
Excess electrical load on alternator.	X	X
Battery voltage low at starter motor cranking speed.		
Failure of supply to engine immersion element.		
Start system inhibited (excessive start attempts).		
Alternator output under frequency.		
Alternator output over frequency.	X	X
Alternator temperature (with temperature display on control panel)		

All trip conditions shall not be resettable unless the fault has been cleared.

b. Front Panel Switches

The following switches shall be included on the control system front panel:

Lamp test push-button
Alarm mute push-button
Four position mode selector switches: “off/reset, auto, manual, test”

c. Plant Operation

The mode selector switch functions shall be as follows: -

OFF/RESET	Control System off and alarm condition reset.
AUTO	Automatic starting and stopping of the set dependant on the mains supply.
MANUAL	Starting and stopping activated manually (two panel mount pushbuttons) for maintenance purposes. In this mode the load will not be transferred in the event of a mains failure.
TEST	The set will start automatically in this position. The load will be taken by the alternator in the event of a mains failure.

d. Logging Events

All events relating to the status generator set shall be logged with date and time in a non-volatile memory (which can retain information for a period of 6 months in the absence of power to the controller)

g. Control System DC Supply Voltage

The control system must be able to operate with a minimum DC supply voltage of 4 volts (without making use of either an internal or an external auxiliary battery) to allow cranking and starting under conditions of low battery capacity.

h. RS-232 Serial Port

The control unit shall have an RS-232/RS-485 serial port allowing various options to be added as listed below.

Equipment connected at each end of the RS-232/RS-485 cable shall be adequately protected against transient over-voltages, lightning effects (particularly if the set and remote alarms are in separate buildings), switching surges, power system surges or mains and alternator borne noise/interference.

AA.9. 3 TELEMETRY

The following signals wired via potential free contacts must be taken to the telemetry unit for all stationary generators

- Intrusion alarm
- Low battery voltage
- Engine failure
- Fuel level (40 %) requires refueling
- Diesel Generator on Manual

- No Fuel
- Manual Stop
- Emergency Stop
- Mains Phase Fault

AA.9.4 **Earthing**

The successful tenderer shall ensure that provision is made for the satisfactory earthing of the machine which shall be bonded to the earthing system of the electrical installations of the building. The control panel shall also be earthed.

AA.10 **PRIME- MOVER FOR THE STATIONARY GENERATOR SETS**

- The prime mover shall be a diesel engine specifically designed for the purpose of driving an alternator at a class AO governed speed of 1500 revolutions per minute.

- The derating of the engine for site conditions shall be strictly in accordance with BS 5514 as amended.

- The engine shall be freely available in the Republic of South Africa, including spares, servicing and workshop facilities.

- The engine of the standby generator set as supplied and installed shall be suitably rated to meet the requirements of this specification.

- The exhaust gas temperature, measured in or on the manifold, shall not exceed the manufacturer's stated limit, and in any case shall not exceed 500°C at 100% of the specified generator rating.

- Turbo-charged engines will only be accepted provided the engine is designed and manufactured as such. The turbo-charger shall be fitted with a heat shield if near any combustible material. Turbocharged engines shall be suitably sized to meet the step load performance specified. Reaction time of the turbo-charger shall not exceed the time specified in BS 5514, for class AO governing.

- The Contractor shall ensure that the manufacturer of the prime-mover shall provide the prime-mover intake and exhaust silencing, to ensure compliance with standards and specifications pertaining to the prime-mover considered. Should 'add on' silencing equipment be necessary for sound attenuation, then the 'add on' shall be to the approval of the manufacturer of the prime-mover.

AA.10.1 Engine

The engine shall comply with the requirements laid down in BS 5514 and shall be a multi-cylinder diesel fueled engine of the direct injection, compression ignition type, running at a speed not exceeding 1 500 rpm. The engine shall be amply rated, to start and supply the load. The engine shall have a one-step loading acceptance of at least 60% from cold start. The delay between of mains supply and the diesel alternator accepting full load shall not exceed 30 seconds. The net power rating of the engine at 1500rpm with all driven accessories connected shall be at least 15% greater than the full alternator power output (in kilowatts).

Preferred diesel engine suppliers are :Caterpillar, Cummins and Perkins.

The engine shall be provided with the following:

- An enclosed flow, force feed lubrication system by a positive displacement type oil pump fed from engine oil sump.

- A low oil pressure protection alarm.

- Fuel and lubricating oil filters with replaceable elements and pressure by-pass.

- An air-inlet manifold filter of the dry element type.

- A fuel injection pump with a suitable governor, capable of controlling the engine speed in accordance with BS 5514 class AO.

- A continuously rated fuel solenoid required for engine cut out. The control arm shall have only one knuckle joint and should an external spring be required it shall be anchored to a purpose made bracket.

- A heavy-duty 26-volt charging alternator, regulator and batteries for engine starting. Batteries shall be capable of at least 6 consecutive start attempts, each attempt at cranking calculate for duration of 10 seconds.

- Provision shall be made to adequately protect the engine against failure of the cooling system (i.e. high temperature protection and alarm).

- "EMERGENCY STOP" push button shall be fitted within the alternator/generator control panel, affording maximum safety to the operators of the standby generator set.

- A rotary pump, with pipe, for the removal of the crankcase oil where oil is difficult to drain.

- An acceptable over speed sensing device.

- The engine shall be supported at the front by mounting brackets. An acceptable method of supporting the back of the engine in the event of alternator removal shall be supplied, such as loose mounting brackets.

- The flywheel shall have a moment of inertia, which shall allow the cyclic irregularity of the set to fall within the limits specified by BS 5514 as amended and meet the specified performance. The flywheel shall be both statically and dynamically balanced.

- The engine shall be fitted with the necessary devices to automatically protect the engine against low oil pressure, excessive temperature rise, etc. Further, suitable gauges shall be mounted on a suitable purpose made bracket, mounted within the prime-mover area, to afford visual inspection of the state of the standby generator set, operating parameters.

AA.10.2 Exhaust and Silencing System

All piping required for the exhaust system, silencers and all pipe support brackets shall be grade 304 stainless steel.

The exhaust system, including silencers, shall be acoustically insulated with a preformed mineral wool inner layer sealed with asbestos free finishing plaster in order to satisfy the OHS act requirements.

The silencer will be mounted within the ISO container and the exhaust outlet shall exit the trailer on the side and shall be fully protected against the ingress of rain.

The silencing system shall include a reactive silencer and an absorptive type silencer, and all support brackets and a flexible connection of the bellows type shall be installed as close to the manifold(s) as possible to limit vibration transfer and to allow expansion under heating. The standard reactive (i.e. pulsation damper type) silencer shall be installed downstream of the flexible connection. The distance between the engine and the reactive silencer shall be designed to avoid resonance and additional absorptive silencer, burgess or equivalent, shall be installed downstream of the reactive silencer. The tail pipe shall have a length of at least 15 times the pipe diameter, measured downstream of the absorptive silencer.

AA.10.3 Starting and Stopping

The engines shall be easily started from cold, without the use of any special ignition devices, under summer as well as winter conditions, against full load. To ensure easy starting in cold weather the engines shall each be provided with a thermostatically controlled 230-250-volt AC. electric immersion heater fitted to the water jacket. The electric circuits for these heaters shall be taken from the respective battery charger control board and shall be de-energized once the alternator has reached a ‘steady state’ output. Circuit-breaker protection (with earth-leakage) is required for each immersion heater circuit. The starting control for the prime mover shall make provision for three consecutive start attempts of 10 seconds duration, each with 10 seconds rest periods in between. After a 3-minute rest period provision shall be made for a further three start attempts also of 10 seconds duration. If the prime mover fails to start after these six attempts, the control circuit shall inhibit further start attempts until the reason for the failure to start has been traced and rectified, whereupon it shall be possible to reset the inhibiting device. When the set fails to start a visual alarm shall indicate the fault.

AA.10.4 Prime-Mover Batteries

The prime-mover batteries shall be deep charging lead acid type batteries. The Contractor shall ensure that the batteries are rated for the application intended in this specification.

The battery stand shall incorporate a protective cover to prevent accidental contact with the battery terminals. The batter stand shall be lockable to prevent theft of the batteries and supplied with a lock and keys (3).

AA.10.5 Battery Charger

Automatic battery charging equipment of the constant current, voltage, monitoring type, shall be provided in a compartment, within the control panel. The battery charging equipment shall be isolated, with sheet steel barriers, from the remainder of the equipment in the control board. When the battery voltage reaches a predetermined high level, the charger shall be switched off, thus enabling the battery to discharge to a predetermined lower point, whereupon the charger shall again be switched on.

The battery charger circuit shall incorporate a "boost charge" with a lock out key switch, thus ensuring only authorized persons have access to the "boost" facility.

In the event of a mains failure, the supply to the battery charger shall be arranged to change over to the standby power output when the diesel engine driven alternator set is switched to its load, thus obviating the necessity for a separate charging device mounted on the engine.

AA.10.6 Cooling Systems

The prime-mover shall be of the water-cooled type and shall incorporate a built-on, heavy duty pattern, pressurised radiator, suitable for ambient temperatures up to 450°C. The cooling system shall be arranged to draw the air over the prime-mover and to force the cooling air through the radiator and into the duct which shall direct the air to the outside of the container. Temperature sensing devices shall be provided which shall monitor temperatures in both the engine cooling and exhaust systems. The temperature monitors shall be provided with alarm and “shut down” features. The temperatures at which the alarms are set shall be adjustable within the range 85% to 98% of the value set for the temperature at which “shut down” occurs. The temperature at which “shut down” occurs shall be similarly adjustable but shall be set and sealed by the manufacturer. Should a high temperature be monitored, an alarm shall be provided. If the temperature continues to rise the alternator set shall automatically shut down when the “shut down” temperature setting is attained. Audible and visual alarms shall be indicated and enunciated when “shut down” occurs. The audible alarms, at all levels, shall be provided with accept facilities but the visual alarms shall remain displayed until the cause is removed. All alarms and settings shall be provided on the control board. (The visual and audible alarm will be transmitted to a central control as described elsewhere)

AA.10.7 Lubrication

Each lubrication system shall comprise: -

- a self-lubricated, positive displacement gear driven oil pump with a pressure relief valve

- full flow engine mounted oil filter of the replaceable element type equipped with an manual by-pass valve (direct engine mounted no exposed oil lines)

- full flow oil cooler with an automatic by-pass valve

- pressure lubricated main, connecting rod, gudgeon pin, camshaft and rocker arm bearings

- Spray oil cooled piston under crowns

- Positive crankcase ventilation.

- Low engine oil level sensor

Protection shall be provided against low oil system pressure. This protective device shall shut down the engine and give a visual and audible indication on the control board. The detection system shall be manually reset before the engine may be re-started.

The Contractor shall provide details of the recommended lubricants specified by the manufacturer in the installation, operation and maintenance manual.

AA.10.8 Fuel System

The fuel system shall comprise:

- One base tank consisting of a 304 stainless steel inner fuel tank and a 304 stainless steel bund. The safety tank shall have a stop-cock for draining any diesel or oil leakages.

- Manual, self-lubricated, positive displacement, gear driven fuel transfer pump requiring no adjustment where applicable.

- One primary and one secondary fuel filter of the replacement element type, and a water trap of the "Automatic" type or equivalent.

- An approved water trap / trap.

- An indicating fuel level gauge.

- A fuel sensor which shall provide the following indications:

a) A low fuel level (when level reaches 10% capacity) alarm giving an audible and visual signal. The diesel generator must be inhibited to start unless the tank is full. A cancel device for the audible alarm is required once the above condition is met. The low-level alarm must be sent to the telemetry unit as an alarm requiring action.
b) An alarm signal stating the tank is at 50% capacity, this signal must be a visual signal as well as signal sent to the telemetry. This alarm condition can only be reset when the tank is a 100% full.

- A drain cock shall be provided on the fuel tank to permit the tank to be drained and cleaned. The drain cock shall be fitted with a padlocking facility.

- A visual fuel level indication (non- electric or electronic).

AA. 10.9 Base Fuel Tank

The fuel tank requirement is:

- The tank capacity should be designed for 12 hours standby
- The fuel tank shall be designed, constructed and installed in accordance with SANS 10131:2004. “The Storage and Handling of liquid Fuel, Part ll – 1979 Large Consumer Installations”.
- Manufactured from 304 stainless steel plate.
- Exterior of the tank to be painted with a suitable diesel resistant paint.
- Tank will be mounted within a “bunding” type tank, manufactured from 304 stainless steel plate (complete with drain plug).
- Pad lockable arrangement for fuel cap (Contractor to furnish details for approval).
- All fuel lines to be mechanically protected to prevent damage and breakage.
- An analogue fuel level indication transducer shall be installed in the proposed fuel tank and shall be compatible for use with the proposed controller. It is preferable that actual fuel in liters be indicated and not as percentage of the tank volume.
- The capacity of the fuel tanks shall be stenciled on the outside of the tanks.
- The fuel tank shall be supplied with fuel for four hours of commissioning.
- For mobile generators the fuel tank shall be installed in a suitable position on the trailer and be easily removable. The position shall be compliant with all Road Traffic Regulations.

AA.10.10 Spare Parts

The Contractor shall ensure that the supplier of the prime mover considered for the alternator shall be able to supply any spare parts within 24 hours of placing an order for spare parts should the need arise at a later date after the defect’s notification period has expired.

AA. 10.11 Water Heater

The Contractor shall manufacture a heater reservoir from 304L stainless steel. The water heater reservoir shall have a 3kW dry element installed into a suitable heater pocket within or under the water volume to be heated.

The water heater reservoir shall have all hose connecting attachments match the existing water-cooling system hoses. The water inlet must be at the lowest point of the reservoir and the outlet

at the highest point, ensuring proper heat transfer. The design must ensure that no air is captured inside the reservoir.

AA.10.12 Load Banks

NO LOAD BANKS WILL BE USED

AA.10.12 **Test Data**

The tenderer shall provide the manufacturer's test certificate with all relevant information for performance including all curves, etc., relative to the engine supplied.

AA.11 **PLINTHS FOR THE STATIONARY GENERATOR SET**

Appropriately sized concrete plinth slabs required for each Stationery Generator Set shall be designed and constructed as per the OEM of the generator set. Unless otherwise stated/approved, excavations for the plinth slabs shall be carried out to a depth of 150mm below natural ground level or as otherwise indicated. A 150mm compacted thickness gravel base layer shall be constructed using G5 quality processed crushed stone and compacted to 95% Mod AASHTO. A Damp-Proof Membrane (DPM), 250 microns thick, is to be laid on the gravel base layer prior to casting of concrete. All seams in the DPM shall be sealed with pressure sensitive tape that is suitable for this type of application. The concrete plinth slab shall be constructed with a suitable MPa concrete and mild steel mesh reinforcing, all in accordance with good engineering practices.

It's compulsory that all plinths shall have bund walls as per SANS 10131-1

AA.11.1 Power Connectors and connection panels for each Mobile Generator Set

The single pole power "Panel Mounted Source" connectors and "Line Drain" connectors shall conform to the following:

400A/800A capacity at 600V

IP67

Secondary locking

Dead front contacts

High impact insulation

Multi-point contacts

Integral location keys

Waterproof when coupled

Colour coded

AA.12 **Wiring, Cable Terminations and Glanding**

AA.12.1 Mobile Standby Generator Sets

The Contractor shall make up sets of ***20-meter-long*** H07RN-F single core Cu trailing cable leads, run in parallel for each red, blue, white phase, neutral and earthing cable. The cable leads shall be fitted with correctly selected colour coded "Powersafe Phase 3" (or equivalent), "Line Drain Connectors" (on both ends), with dead end contacts and current carrying contacts of between 400A and 800A capacity. There will be colour coded "Powersafe Phase 3" (or equivalent), "Panel Mounted Source" connectors on both the generator load panel and the generator connection box.

All wiring within panels may be enclosed in PVC slotted ducting. The exception is signal and instrumentation cabling passing through power compartments or cubicles, which shall be in galvanised screwed conduit. Wiring outside of panels and switchboards shall be run within galvanized ducting or conduit.

Alternatively, signal and instrumentation wiring may be run in a channel at either the front or the rear of the busbar chamber, accessible from that respective side of the switchboard within the busbar chamber. The channel shall be manufactured of 304 stainless steel and shall be welded into position. The channel shall contain a cover that is screwed into position.

All wiring and terminations shall be labelled with identification tags corresponding to the wiring diagrams. Cable terminations shall be marked with an identification label externally to the switchboard indicating the source of supply as well as the equipment being fed for feeder cables.

For example: “FED FROM SWITCHBOARDS A” and “SUPPLY TO LINE FEEDERS”.

All glands for cable shall be nickel-plated brass and fitted with waterproof neoprene shrouds.

AA.14 ENVIRONMENTAL REQUIREMENTS

The equipment, comprising diesel engine, alternator and ancillary equipment, shall be fixed to a base frame and placed on anti-vibration pads of the Teeco type.

The engine and alternator shall be directly coupled, by means of a flexible coupling, via the engine flywheel.

The equipment assembly shall be so designed that no harmful vibrations are transmitted to other equipment which may be mounted on the equipment, or the building.

The engine/alternator base shall be shot blasted and etch primed and coated with a twin pack epoxy paint, colour grey.

AA.15 INSPECTION AND TEST

The successful tenderer shall arrange, at his own expense,for **THREE** representatives of eThekwini Water and Sanitation to carry out a pre-delivery inspection, at the manufacturer’s factory. At this time the complete set must be load tested to 100% of its rated capacity for a period of at least 1 hour. The Contractor shall carry out any tests, which, in the opinion of the Engineer, are necessary to determine that the electrical work complies with the Drawings, the Specification and SANS 10142-1.
The Contractor shall notify the Engineer at least 2 weeks in advance, for inspections or witnessing of tests.
Continuity, phase rotation and pressure testing shall be undertaken by the Contractor, to the Engineer’s specifications, prior to energising any equipment.
Works acceptance (function) tests shall be performed, which shall be witnessed by the Engineer.
In the event that tests fail, the Contractor shall be required to perform such tests again. Should these tests require the Engineer to be present again, the Engineer’s cost for time and travel shall be recovered from the Contractor at rates as set out by the Engineering Council of South Africa (ECSA).
The fact that the plant and equipment has satisfactorily passed any test made at the Contractor's works shall in no way lessen the responsibility of the Contractor to obtain the same results after it has been delivered and erected permanently on site.
All test certificates required in terms of the current SANS regulations shall be furnished before the project can be completed. These shall also be bound into the installation, operating and maintenance manuals.

AA.16 CERTIFICATE OF COMPLIANCE

A certificate of compliance is required for the Installation. Due allowances in the tender price shall therefore be made for testing.

AA.17 **TECHNICAL DOCUMENTATION**

Tenderers are required to provide full details of the electrical and mechanical equipment proposed for installation in the project.
Tenderers shall also state the names of suppliers and manufacturers of switchboard, instrumentation equipment, etc.
The Engineer reserves the right to accept or reject any equipment offer made and, if equipment is rejected, to call upon the Tenderer to submit further details of similar or more suitable equipment, without affecting the tender price.
Furthermore, as the work proceeds the Contractor shall submit samples or technical literature, of all equipment, for approval, prior to purchase and installation.
The Contractor shall submit detailed working drawings of all cubicles, boxes, boards, panels, brackets, trays, etc. to the Engineer for approval prior to manufacture. The drawings shall be not less than A2 in format and shall clearly indicate the principal dimensions. At least two cross sections shall be provided on the drawings. Door and cover plate details shall be given, together with hinges and catches.
The work may not proceed until the drawings have been properly scrutinised.
The lead-time for approval of drawings shall not be more than 21 (twenty one) days from the date of receipt. The Contractor shall make the necessary allowance for this in his work program.

AA 18 **SCHEDULE OF EQUIPMENT**

A complete list of fittings and other equipment intended for use on this Contract is to be submitted with the Tender. This list shall contain manufacturers' names, catalogue numbers, etc. Where any item offered is not to specification, prior approval shall be obtained in writing from the Engineer prior to acceptance.
Should any item supplied after acceptance of this tender not comply with the specification, an alternative which meets the specification is to be approved by the Engineer and provided at no additional cost.

AA 19 **EVERYTHING NECESSARY**

The Contractor will be deemed to have visited the site and to have satisfied himself as to the nature of the work, to have acquainted himself with any limitations which may be imposed upon him and to have provided for any additional costs which he may consider necessary for the proper completion of the work. No claim will be recognised or considered after submission of price on the grounds of lack of knowledge of site conditions or limitations.

The installation shall include everything necessary whether specified in detail or not and shall be carried out in the best possible way to ensure a complete and first-class installation to the approval of the Engineer.

AA 20 **UNIFORMITY**

All items of the same type of equipment shall where at all possible, be of the same make and type for each item throughout the installation, to ensure interchange ability and ease of maintenance.

AA 21 **DELIVERY**

The Contractor must co-ordinate the delivery dates for all items of equipment supplied by him to allow adequate time for installation, commissioning and testing prior to the issue of the Completion Certificate. To this end, the Contractor must ensure that shop drawings are presented to the Engineer for comment timeously, and a programme of submission of such drawings must be commented on by the Engineer as specified in the Scope of Work. Documentary proof is to be supplied of the placing of all orders for equipment having a protracted

delivery period. No substitution of specified items will be allowed due to the late placing of orders, and no delay claims in this regard will be entertained.

AA 22 **INSTALLATION, OPERATION AND MAINTENANCE MANUAL**

AA 22 .1 Miscellaneous

The Manual shall comply with the following:

(a) A Manual for the complete Works (covered by this specification) is required.

(b) Three draft copies of the Installation, Operation and Maintenance Manual hall be provided prior to commissioning of the Works. Two copies shall be submitted for acceptance by the Engineer and will be returned to the Contractor. The third copy will be used by the operational staff on Site during commissioning. Unless otherwise specified, six copies of the final version of the Installation, Operation and Maintenance Manuals shall be provided prior to the issuing of the Taking-Over Certificate and the commencement of the Defects Notification Period. All information shall also be recorded on compact disk of which two copies shall be provided.

(c) The Manuals shall be of a standard acceptable to the Engineer. At least one set shall contain original copies and this set shall be marked "Original". The other sets shall be marked "Copies 2 to 6".

(d) Binders shall have hard, plastic protected covers utilizing four- ring, spring- clip holders. Sufficient binders shall be used to make each volume easy to use. One spare, empty binder shall be provided for every three used. A title label shall be affixed to the spine of all binders. This shall indicate contract number, title and location, Contractor's name and, where required, plant description, volume number and contents.

(e) Labelled separator sheets shall be provided between each section and sub-section and also wherever volume or complexity makes this advisable.

(f) 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.

(g) Where standard equipment manuals are used in any sections, these shall be marked up to be unambiguously applicable to the equipment installed and marking up shall be done in a manner which will be transmitted to photocopies.

(h) 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.

(i) 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 in AutoCAD format.

(j) Where practical, each section shall form a separate volume

The Manual shall be divided into sections and shall include the information described below.

Section 1 – General

The following shall be provided:

(a) Contents List for the complete Manual. This shall consist of:

- An overall contents list.
- Detailed contents list in front of each section and/or sub-section.
- A comprehensive list of all drawings.
- The Contents Lists shall be structured so as not to be affected if volumes are added or subtracted from the Manual.

(b) 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. The design duty, the position of the unit's installation and its design purpose in the system shall be given. A schedule of corrosion protection systems used shall be provided for fabrications such as tanks, supporting structures, clarifier bridges, etc.

(c) Drawing list of all Contractor's and Tender drawings.

(d) 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.

(e) Drawings:

- Cable routes.

Section 2 – Process, Operation and Control

The following shall be provided:

(a) Description of plant and process design and including all design parameters.

(b) A description of each system supported by drawings, process flow or circuit diagrams and explanatory sketches to assist operating staff.

(c) Description of control system, including control panels, as applicable and including controls, Instruments, settings, indications, alarms, trips, etc. Functional Specification. List of protections, including description, sensor, operating limits, settings, etc.

(d) Straight forward, step by step, initial startup instructions for commissioning. These shall include Operating steps, precautions, settings, adjustments, observations, etc.

(e) Normal start up, adjustment, operating and shut down procedures for the system as installed and Including settings, adjustments, observations, etc. The procedures shall highlight any safety precautions to be observed.

(f) An Instrument List giving a description of the duty as well as the serial number, normal operating Reading, maximum or minimum permissible readings, set-points (activation, warning and trip), etc.

(g) Trouble-shooting guide, including symptoms, causes and solutions.

(h) Drawings:

- As-built system, layout and GA drawings.
- Plant circuit or flow diagrams and P&IDs.
- Control panel layouts.
- System control diagram and logic sequence chart, as applicable.

Section 3 - Maintenance Schedules

The following shall be provided for all mechanical, electrical, instrumentation and control equipment:

(a) A comprehensive lubrication schedule of recommended and initial lubricants, capacity, lubrication periods, etc., for all items.

(b) A comprehensive maintenance schedule of routine maintenance by time period for the new installation and including information for individual items.

These schedules may cross-refer to supplier's standard Manual

Section 4 - Mechanical Equipment

The following shall be provided for each item of mechanical equipment:

(a) A copy of the information applicable to the item and appearing in the Equipment List.

(b) A separate table containing the unit's nameplate information; or, a photograph of the nameplate.

(c) Technical and descriptive literature, including principle of operation and construction.

(d) Installation instructions. (e) Detailed operating instructions.

(f) Control and electrical details, including logic sequence, circuit diagrams and software, as applicable.

(g) Full technical and maintenance information including instructions for assembly, disassembly, lubrication, adjustment, calibration, reconditioning, repair, etc.

(h) A spares list giving the item number, part number, description, quantity and materials. A list of recommended spares. Tenderers must submit a written assurance that spare parts for the plant offered by them as a whole are readily available within the Republic of South Africa and state from where these are available.

(i) Factory and Site test results.

(j) Corrosion protection systems used, coating supplier's data sheets and coating repair procedures.

(k) Drawings:

- Performance curves.
- Layout drawings.
- 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.

Section 5 - Electrical Equipment

The following shall be provided for each item of electrical equipment:

(a) A copy of the information applicable to the item and appearing in the Equipment List.

(b) A separate table containing the unit's nameplate information; or, a photograph of the nameplate.

(c) Technical and descriptive literature, including principle of operation and construction.

(d) Control and electrical details, including logic sequence, circuit diagrams and software, as applicable.

(e) Installation instructions.

(f) Detailed operating instructions.

(g) Full technical and maintenance information including instructions for assembly, disassembly, lubrication, adjustment, calibration, reconditioning, repair, etc.

(h) A spares list giving the item number, part number, description, quantity and materials. A list of recommended spares.

(i) Factory and Site test results.

(j) Drawings:

- ¤ Equipment overall dimensions.
- ¤ Circuit diagrams.
- ¤ Switchboard layout drawings and SLDs.
- ¤ Electrical panel construction drawings.
- ¤

Section 6 - Instrumentation Equipment

The following information shall be provided for each item of instrumentation equipment:

(a) A copy of the information applicable to the item and appearing in the Equipment List.

(b) A copy of the relevant information in the table of instrumentation in the sub-clause “Operation Section” and including all settings.

(c) Installation instructions.

(d) Descriptive and technical literature giving full details of performance, operation, calibration, setting, service, maintenance and spares including suitable assembly drawings

(e) Technical and descriptive literature, including principle of operation and construction.

(f) Control and electrical details, including logic sequence, circuit diagrams and software, as applicable.

(g) Factory test results.

(h) Full technical and maintenance information including instructions for assembly, disassembly, lubrication, adjustment, calibration, reconditioning, repair, etc.

(i) Drawings:

- ¤ Circuit diagrams of both instrumentation systems and individual instruments.
- ¤ Overall dimension and installation drawings.

Section 7 - Control Equipment, Network and Software

The following shall be provided:

(a) A copy of the information applicable to the item and appearing in the Equipment List.

(b) Cross-referenced listing of all I/O used.

(c) An annotated program listing.

(d) Loop drawings showing field terminal numbers, marshalling terminal numbers and PLC rack/slot/terminal numbers.

Section 8 - Drawings

All drawings not filed elsewhere shall be filed in this section.

AA 23 **TRAINING**

After the three draft copies of the Installation, Operation and Maintenance Manual have been received prior to the commissioning of the Works, the Contractor shall train Employer’s staff in the operating and maintenance

departments of the plants in the day to day operation as well as the maintenance of the newly installed equipment. This training shall be done during the Trial Operation Period.

AA.24 GUARANTEE AND MAINTENANCE

AA.24.1 General

The tenderer shall guarantee and maintain the complete installation, i.e. as defined within the scope of this contract, for a period of twelve months after commissioning and acceptance of the plant by eThekwini Water and Sanitation. During the maintenance period the installation shall be maintained as specified by the tenderer and any defective material, equipment or workmanship (excepting proven, wilful or accidental damage, or fair wear and tear) shall be made good with all possible speed at the tenderer's expense and to the satisfaction of the Engineer.

AA.24.2 Making Good

When called upon by the Purchaser, the tenderer shall make good on site and shall bear all expense incidental thereto including making good of work by others, arising out of removal or re-installation of equipment. All work arising from the implementation of the guarantee or maintenance of equipment shall be carried out at times which will not result in any undue inconvenience to users of the equipment, or occupants of the premises.

If any defects are not remedied within a reasonable time, the Engineer may proceed to do the work at the tenderer's risk and expense, but without prejudice to any other rights which the Engineer may have against the tenderer.

AA.24.3 Latent Defects and Failure to Comply with Specification

The Purchaser reserves the right to demand the replacement or making good, by the tenderer at his own expense, of any part of the installation, including the diesel alternator, which is shown to have any latent defects or not to have complied what the Specification, notwithstanding that such work has been taken over or that the guarantee period has expired.

AA.25 Maintenance

The Tenderer shall maintain the supplied range of standby generator sets during the ***LATENT DEFECT PERIOD, STARTING A MONTH AFTER THE SET HAS BEEN COMMISSIONED*.** The required maintenance shall include the following:

(1) THREE MONTHLY INSPECTION

UNIT STATIONARY:

1) Check the oil level.

2) Check the radiator water level.

3) Check battery water and specific gravity or indicator in case of sealed maintenance free batteries.

4) Check operation of automatic battery charger.

5) Check operation of jacket water heater.

6) Check condition of jacket water heater hoses.

7) Check radiator core for cleanliness.

8) Check tension and condition of fan belts.

9) Check diesel fuel level.

10) Check tightness and condition of battery terminals, clean and seal.

11) Check for presence of water in primary fuel/water separator filter.

UNIT RUNNING (MANUAL START)

1) Check oil pressure.

2) Check water temperature.

3) Check engine speed.

4) Check AC voltage.

5) Check for exhaust gas leakage.

6) Check operation of set mounted DC charging system.

7) Test operation of engine safety systems.

8) Check for visible oil, water and fuel leaks.

9) Return generator selector switch to auto function.

LOAD TEST (AUTOMATIC FUNCTION)

A: Isolate incoming mains supply and witness the following:

1) Start delay.

2) On load timing.

3) Load acceptance of connected load.

4) AC voltage.

5) Engine speed in Hz.

6) Record amperage drawn per phase.

7) Run unit for 1 hour checking water temperature and oil pressure.

B: Re-instate incoming mains supply and witness the following:

1) On load run times.

2) Cool down times.

3) Engine shut down.

(2) ANNUAL SERVICE OR AFTER 250 RUNNING HOURS

1) Proceed as per monthly service procedure.

2) Drain lubricating oil.

3) Replace oil and fuel filters.

4) Refill lubricating oil.

5) Check and clean primary fuel/water separator filter. Replace if necessary.

6) Remove clean and check air filter element. Replace oil in oil bath type air cleaners.

7) Drain coolant refill and add coolant conditioner.

8) Check for perished or damaged radiator hoses.

9) Tighten all jubilee clamps on radiator and intake systems.

10) Remove access covers and check for litter in air cooled engines.

11) Check for perished or damaged fuel lines and tighten jubilee clamps.

12) Check engine wiring looms for chafing and loose connections.

13) Check AC alternator for cleanliness and loose connections.

14) Check automatic mains failure panel for loose or hot connections.

15) Grease service points as required.

16) Check fuel tank level and dip to check for presence of water. Drain off water if necessary.

17) Clean unit and plant room

The cost of such inspections, maintenance, adjustments, repairs, etc., shall be included in the tender price, but the cost of renewing any part which may become worn through fair wear and tear, or damage beyond the control of the tenderer or not a latent defect (provided this is not due to unsuitable design), shall be excluded.

GENERAL QUALITY ASSURANCE REQUIREMENTS

The appointed contractor shall provide the following .

TABLE OF CONTENTS		
TASK	DESCRIPTION	WHEN REQUIRED
	Design Calculations	
	General Assemenbly	3 Weeks after kick off
	Detail Drawings	
	AS Built Drawings	
	Technical Brochures	
	Sketches	
	Schematics	3 Weeks after kick off
Drawings and design ,3 Sets Each	Risk Assessemnet	
Quality Control Documents , 3 Sets	Quality Control Plan	3 Weeks after kick off
	Manufacturing Program	3 Weeks after kick off
	Procurement Program	3 Weeks after kick off
Material Certificates		At Factory Inspection
Certificates of Inspection , Testing and Acceptance	Presure Test Certicate	Three Weeks before Hot comissioning
	Electrical Hazardous Certificate	Three Weeks before Hot comissioning
	Electrical Test Certificate	Three Weeks before Hot comissioning
	Instrumentation Calibration Certificates	Three Weeks before Hot comissioning
	Vendor Certificate of conformance	Three Weeks before Hot comissioning
	Non Conformity/Concession Reports	Three Weeks before Hot comissioning
	All electronic Programming , VSD, Soft Starters , Instruments etc	Three Weeks before Hot comissioning
	PLC ,SCADA , Software and hardcopies of programming	Three Weeks before Hot comissioning

Manuals 5 set each	Operating Manual	Three Weeks before Hot comissioning
	Maintenance Manual	Three Weeks before Hot comissioning
	Training Manual	Three Weeks before actual training
	Schematics	Three Weeks before Hot comissioning