GEN: GENERATOR STANDARD SPECIFICATION

PREAMBLE

This standard specification covers the requirements for emergency standby generators, including the change-over panel and all associated ancillaries. This specification must be read in conjunction with the project specification and drawings which provide specific detail related to the scope of work.

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

GEN.1 SCOPE OF CONTRACT

The scope of work for the provision of standby generators shall include the following:

- Supply, installation, testing and commissioning of the emergency generator, according to this specification and the project specification
- Delivery of the generator to 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 commissioning of a 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
- Tie-in to MCC, including panel modification, if required
- Liaison with the Power Supply Authority regarding the necessary isolations
- Preparation and submission of O&M Manuals and drawings
- Training of eThekwini Municipality staff in the operation and maintenance of the generator set
- Submission of an Electrical Certificate of Compliance

NO CONSTRUCTION SHALL COMMENCE UNTIL SUITABLE GENERAL ARRANGEMENT DRAWINGS AND CIRCUIT DIAGRAMS HAVE BEEN SUBMITTED TO THE EMPLOYER'S AGENT/REPRESENTATIVE FOR APPROVAL.

GEN.2 DELIVERY SITE, QUERIES AND CLARIFICATION

Generator/s supplied will be delivered to the site/s as identified in the Project Specification.

GEN.3 STATUTORY REGULATIONS PERTAINING TO ELECTRICAL WORK

Except where otherwise specified or implied the contract work and equipment supplied shall comply with the latest revisions of the standard specifications listed, including generally:

- SANS 10142-1:2012 (Edition 1.8) The wiring of Premises, Part 1: Low voltage installations
- SANS 10400-A:2010 (Edition 3) The Application of the National Building Regulations, Part A: General principles and requirements
- Local Fire Regulations
- The Regulations of the Local Supply Authority (Including Noise and Pollution)
- The Regulations of the Department of Posts and Telecommunications

Where a SANS Standard does not exist or if not applicable, the relevant IEC or BS Standard shall be applicable.

The equipment supplied and work carried out shall fully meet and comply with the requirements of the Occupational Health and Safety Act (Act 85 of 1993) and the Construction Regulations 2014 issued in terms of Section 43 of the Act, Standards South Africa (a Division of the South African Bureau of Standards {SABS}) and all other statutory regulations and laws insofar as they may apply to an electrical installation of the type contemplated.

In the event of discrepancy between any of the specifications, regulations and codes of practice, the SANS 10142-1 Code of Practice for Wiring of Premises shall take precedence. All references to “SABS” specifications shall be read as “SANS” in light of the recent changes by the South African Bureau of Standards.

Additionally, the following specifications, whether specifically mentioned within the tender document or not, shall also apply:

- SANS 10111-1:2011 (Edition 3.2) Engineering Drawings, Part 1:General Principles
- SANS 1091:2012 (Edition 2.1) National colour standards
- SANS 156:2007 (Edition 3.3) Moulded case circuit breakers and VC8036:06 Oct 2006 (Edition 3) compulsory specification for circuit breakers
- SANS 60269-1:2010 (Edition 3.1) Low-voltage fuses, Part 1: General requirements
- SANS 60269-4:2012 (Edition 3.1) Low-voltage fuses, Part 4: Supplementary requirements for fuse- link for the protection of semiconductor devices
- SANS 950:2014 (Edition 2.3) Unplasticised polyvinyl chloride rigid conduit and fittings for use in electrical installations
- SANS 1507-1:2007 (Edition 1.1) Electrical cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3300V), Part 1: General
- SANS 1195:2010 (Edition 1.3) Cover plate
- SANS 60439-1:2004 (Edition 3.1) Low voltage switchgear and controlgear assemblies, Part 1: Type-tested and partially type-tested assemblies
- SANS 60439-2:2006 (Edition 2.1) Low voltage switchgear and controlgear assemblies, Part 2: Particular requirements for busbar trunking systems (busways)
- SANS 1973-1:2007 (Edition 1) Low voltage switchgear and controlgear assemblies, Part 1: Type-tested assemblies with stated deviation and a short-circuit withstand strength above 10kA

- SANS 1973-3:2008 (Edition 1) Low voltage switchgear and controlgear assemblies, Part 3: Safety of assemblies with a rated protective short-circuits up to and including 10kA
- BS 4070 Performance of A.C. control gear equipment rated up to 660 V for use on high prospective fault-current systems
- BS 587 Motor starters and controllers
- SANS 60947-1:2012 (Edition 5.1) Low voltage switchgear and control gear assemblies, Part 1: General rules
- SANS 60947-2:2014 (Edition 4.2) Low voltage switchgear and control gear assemblies, Part 2: Circuit-breakers
- SANS 60947-3:2012 (Edition 3.1) Low voltage switchgear and control gear assemblies, Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units
- SANS 60947-4-1:2013 (Edition 3.1) Low voltage switchgear and control gear assemblies, Part 4-1: Contactor and motor-starters – Electromechanical contactors and motor-starters
- SANS 60947-4-3:2012 (Edition 3) Low voltage switchgear and control gear assemblies, Part 4-1: Contactors and motor-starters – AC semiconductor motor controllers and starters
- VC8011: 9 July 1999 Compulsory specification of Lamp holders
- SANS 475:2013 (Edition 1.2) Luminaires for interior lighting, streetlighting and floodlighting – Performance requirements
- SANS 10114-1:2005 (Edition 3 Interior lighting, Part 1: Artificial lighting of interiors
- SANS 10131:2004 (Edition 1) Above-ground storage tanks for petroleum products
- SANS 1084-1/2 :2014 Electric Motor Standards
- SANS 1200:2014 Painting Requirements
- SANS 10198:2014 Cable Trenching

GEN.4 DRAWINGS

The Contractor is required to submit drawings for approval prior to any work being undertaken. The drawings shall show both the mounting and equipment arrangement of the proposed new generator set, the arrangement layout and correct sizing of cables and male sockets/socket outlets, generator connection panels, for both the power system and the control system wiring.

GEN.5 OVERALL GENERATOR REQUIREMENTS

The generator set must be a new, suitably rated, prime rated set @ 0.8 PF or higher, 400V, 50 Hz, three phase, standby generator set, mounted within a sound attenuated weatherproof canopy, with base fuel tank, complete with all ancillary equipment, generator connection panel, switchboard. The unit needs to be positioned and commissioned within the approved position on site.

GEN.6 GENERATOR SWITCHBOARDS AND CONNECTOR PANELS

The Generator Switchboard is required to accommodate the necessary manual and automatic 4-pole change-over equipment, controllers, together with interlocks and the sub-circuit

breakers serving the installation, shall be free standing, designed for floor/wall mounting complete within the generator canopy/elsewhere, as agreed with the Employer's Agent.

GEN.7 POWER AND INDICATION CABLES (1000/600 VOLT)

All PVC SWA power and indication cables shall be of the multi-core stranded soft drawn copper wire PVC insulated PVC bedded, steel wire armoured type with an overall PVC sheath (preferably black) and shall be manufactured and tested in accordance with SANS 1507:2014 for general purpose duty.

Instrumentation Cables (24V / 220V)

Instrumentation cable shall be constructed of multiple twisted pairs of insulated stranded copper wire, PVC insulated with an overall aluminium shield, extruded PVC inner jacket, served with steel wire armour with an extruded PVC outer jacket.

The nominal conductor resistance shall not exceed 3,5 ohms per 100 m at 20ºC.

The complete cable shall withstand a dielectric test conductor to conductor and conductor to shield of 1 000 V dc for one minute.

The insulation resistance of each conductor shall be not less than 8 800 meg ohms/km for 1 minute at 500 V and 20ºC, measured with the remaining conductors in the cable connected to the armouring.

The minimum core size shall be 1,5 mm².

All instrumentation and signal cables (excluding optical fibre cables) shall be installed separate from power cables.

Panel Wiring (24V / 220V)

Further to the abovementioned Clause, all panel wiring shall be of the silicone-insulated type with stranded tinned copper conductors, with a minimum conductor size of 1mm ².

The colour of the conductors shall be as follows:

220V AC control Line	=>	Brown
220V AC Neutral	=>	Black
+24V DC	=>	Orange
-24V DC	=>	Violet or Purple

Spare Cores in all control Cables

All cables installed shall include for spare cores. The spare cores shall amount to 10% of the number of cores used, rounded up to the nearest whole core.

Cable Identification

A suitable tag, onto which the appropriate cable identification number in accordance with the Contractor's detailed cable schedule shall be stamped, shall be adequately secured just below the gland at the ends of each cable.

Where cables deviate from one route to another (e.g. at tee's and on cable trays) additional identification tags with numbers shall be fitted to each cable, within 500 mm of the point of deviation.

Each flexible generator feeder cable supplied within this Contract shall be clearly marked with its designed rating clearly identifiable.

Generator Feeder Cables

The Contractor shall supply and install suitably rated feeder cables for the stationary generator installation. Multi core PVC ECC SWA cables will be run underground in sleeves or on cable trays. These cables will be run from the generator feeder circuit breaker compartment within the generator switchboard and the pump station building main circuit breaker position. The existing main feeder cables currently feeding the pump station, will be removed from the main circuit breaker and joined to each new generator feeder cable.

GEN.8 EARTHING AND LIGHTNING PROTECTION

Earthing of the mechanical and electrical plant, which includes all steel structures, generators, switchboards, etc. shall be carried out in accordance with the requirements of SANS 10142-1. The minimum size of the earth continuity conductor is given as 70mm².

The earthing installation shall comply with the requirements of the latest revision of the Wiring Code of Practice (SANS 10142-1) as well as the requirements of the Local Supply Authority.

All metallic cable support systems, handrails, ladders and access platforms shall be connected to the earthing system.

The resistance measured between the consumers earth terminal and any exposed conductive part of the installation or any other conductive part that needs to be bonded to the earth continuity conductor shall not be more than 2 ohms.

GEN.9 ALTERNATORS

The machine 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.

GEN.9.1 LICENSES

The Contractor shall supply all original software licenses for any equipment installed and used for the control of the alternator.

GEN.9.2 OVER CURRENT AND SHORT CIRCUIT PROTECTION

The alternator shall 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 switch installed within each new switchboard within the enclosure.

The 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.

GEN.9.3 ALTERNATOR REQUIREMENTS

The following requirements shall be met for the alternator.

- Synchronous.
- The 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.
- Seals shall be provided to prevent the lubricating grease from migrating along the shaft to the rotor windings.
- Grease cups shall be provided for each bearing in readily accessible positions, even if this means remotely mounting the cups.
- The shaft-mounted fan shall be fitted at the air intake end of the machine and preferably this shall be the non-drive end.
- The exciter shall be of the brushless construction, inboard of the bearings, of three-phase full wave rectification design with silicon rectifying diodes.
- 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.
- The 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.
- The alternator shall be 4-wire Y connected with all cable ends brought out to the terminal blocks in the alternator cable end box.
- 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.
- The alternator shaft with its rotating equipment shall be dynamically balanced up to 25% over speed condition.
- 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.
- 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.
- The alternator shall have a suitably rated circuit breaker installed in a 3CR12 sheet steel enclosure situated within 300 mm of the alternator output terminals.
- 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.

- The alternator windings shall incorporate temperature sensors for temperature monitoring.
- The 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.

GEN.10 ALARM EQUIPMENT WITH INDICATION AND TRIP FACILITIES

Any trip conditions shall be indicated on the alternator/generator controller to allow easy visual identification of fault conditions and those alarms, which are annotated with the word "TRIP" shall incorporate facilities, which shall be arranged to stop the diesel engine driven alternator set.

The conditions shall include a minimum of the following:-

- High engine temperature. [TRIP]
- Low oil pressure. [TRIP]
- Low cooling water level.
- Low fuel level. [ALARM AT 40% AND TRIP AT LEVEL RECOMMENDED BY OEM]
- Excess electrical load on alternator. [TRIP]
- Battery voltage low at starter motor cranking speed.
- Failure of supply to engine immersion element.
- Failure of supply to battery charger.
- Start system inhibited (excessive start attempts).
- Alternator output under voltage. [TRIP]
- Alternator output over voltage. [TRIP]
- Alternator output under frequency.
- Alternator output over frequency. [TRIP]
- Alternator temperature (with temperature display on control panel)
- Alternator over-temperature [TRIP]

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

The Contractor must run a suitable muli-core cable from the controller/change-over panel for the provision of the following signals to the on-site telemetry panel:

- Low fuel alarm
- Low fuel trip
- Generator run
- Generator trip

The termination of these signals into the telemetry panel will be the responsibility of the Employer.

GEN.11 PRIME- MOVER FOR THE GENERATOR SET

- The prime-mover shall be a diesel engine specifically designed for the purpose of driving an alternator.
- 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. Turbo- charged 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.

GEN.11.1 ENGINE

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.
- 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.
- 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.

GEN.11.2 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 exhaust outlet shall be 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.

GEN.11.3 STARTING AND STOPPING

The engine 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 engine 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-energised 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.

GEN.11.4 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 battery box must be fitted with a pad-lockable bracket to guard against theft.

GEN.11.5 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 pre- determined high level, the charger shall be switched off, thus enabling the battery to discharge to a pre- determined 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 authorised 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.

GEN.11.6 COOLING SYSTEM

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 radiator and cooling system design shall be suitable for marine environments.

GEN.11.7 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.

GEN.11.8 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/traps.
- An indicating fuel level gauge.
- A low fuel level alarm giving an audible and visual signal on the MCB. A cancel device for the audible alarm is required.
- 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)

The fuel tank requirement is:

- The fuel tank shall be designed, constructed and installed in accordance with SANS 10131:2004. “The Storage and Handling of liquid Fuel, Part II – 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 litres 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 two hours of commissioning, which is over and above the fuel required to over-come the low-level fuel trip.

GEN.11.9 SPARE PARTS

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

GEN.12 CONTROL FOR THE GENERATOR

GEN.12.1 CONTROL PANEL WITHIN THE GENERATOR SWITCHBOARD

A "DeepSea Electronics 7420 MK II Auto/Mains (Utility) Failure Control Module" 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.

The distribution panel shall be suitably divided into two sections, one for "DeepSea Electronics 7420 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 Electronics 7420 or equivalent controller for the supervision and control, accessed and operated from the interior of the container.
- Emergency stop.
- Power and lighting distribution board with a suitable earth leakage unit.
- Battery charger.
- Monitoring System
- Spare cubicle.
- Immersion heater control equipment

Note: The Deepsea Electronics 7420 controller, or equivalent, shall be the master controller, mounted on the change-over panel door. The Deepsea Electronics 7420 controller, or quivalent, cannot be a secondary controller or slave to any other controller.

GEN.12.2 WEEKLY TEST CYCLE

A weekly test cycle must be set-up such that the generator unit must automatically start-up (off –load) every week at a specific date and time (to be advised by the Employer's Agent). If the generator is operational at the specific date and time then the test must be aborted.

GEN.13 CABLE TRAYS AND FASTENINGS

GEN.13.1 CABLE TRAYS

All cable trays unless otherwise specified shall be manufactured from 2 mm thick 304 stainless steel. Each length of cable tray shall be fixed to a continuous ladder system anchored to the walls or trenches.

Each cable tray joint and fixing position will consist of sections of 304 stainless steel "P1000 Trunking" (the full width of the tray), to space the back of the cable tray approximately 40mm from the structure. In instances where the cable tray system is required to run where obstructions occur e.g. beams, columns, pipes, etc., it shall be arranged to support the cable tray such that the back of the cable tray is spaced 40mm from the face of the obstructions. Anchor bolts shall be stainless steel and shall be not less than 8mm in diameter. Each fixing

position shall consist of a hole drilled into the galvanized steel structure, together with an 8mm tapped thread, to accommodate each fixing bolt.

The whole cable tray run shall be installed plumb and true to line.

GEN.13.2 CABLE FASTENINGS

Where cables are run on cable trays they shall be secured, as single cables, to the tray with PVC cable ties. The cable ties for each cable shall occur at approximately 400 mm centres along the cable length. Where cables are run adjacent to and parallel with each other on the tray the cable ties shall be staggered to ensure the spacing between cables does not exceed the thickness of one cable tie.

GEN.14 PLINTH FOR THE GENERATOR SET

An appropriately designed and sized concrete plinth slab is required for the Generator Set and shall be constructed in accordance with the generator OEM requirements.