

prasa cres

CORPORATE REAL ESTATE SOLUTIONS

TECHNICAL SPECIFICATION

Project Name: Procurement, Engineering, Supply, Install, Test and Commission including maintenance of 1000-KWp Photovoltaic solar rooftop at Durban Station.

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Amendment History

<i>Issue</i>	<i>Date</i>	<i>Author</i>	<i>Reason</i>

The site and building are owned by PRASA and has offices for PRASA personnel and tenants as indicated above.

The Contractor will be responsible for decommissioning, stripping existing electrical installations, supply, delivery, installation, testing, commissioning, and handing over in proper working condition of the complete upgrading of the new installation, as specified in detail in these documents. Also included in the scope is the supply of as-built drawings, operating and maintenance manuals and on-site training of the Employer's staff.

The Scope of Work shall include the supply of all necessary required Equipment and Contractor's Personnel to properly perform the Contractor's obligations under the Contract, including:

- a) Construction Site surveys (dimensional, layout, checking etc.);
- b) ensuring that the completed Works shall comply with the Codes and Standards and any applicable statutory requirements.
- c) selection of suitable Plant and Materials (where not already specified herein);
- d) offloading of Plant and Materials at Site.
- e) safety equipment (guards, notices, etc.
- f) construction, erection and the supervision of the Works.
- g) specialist installation and installation supervision.
- h) removal and disposal, as approved by the Employer, of all scrap and rubble generated by the Contractor within the Site to a demarcated area on the Site.

The Contractor must return all returnable documents on the attached specification of this document with the tender's returnable document.

The summary scope of work is as follows:

- Installation of solar plant system – 1000kWp with its ancillaries for full operation
- This system shall supply Durban Regional office.
- Solar panel to be installed in the Durban Station at 99-steps.
- Backup battery supply for the 1000kWp system.

- Installation of new backup generator sets
- installation of electrical and mechanical services
- installation of security system such as CCTV and access control
- installation of fence around rooftop

The detailed scope of work and specification document is represented below per discipline.

SECTION 2 – ARCHITECTURAL SCOPE AND SPECIFICATION

1.1. Scope of Work

The scope of work related to the architectural services is as follows:

- Removal of deteriorated roof waterproofing at 99 steps building, replace with new and apply finishing coating. Flood testing to be carried out thereafter
- Installation of fencing around rooftop parapet wall of 99 Steps
- Installation of fencing along control panel area

The reference code in the table below refers to the PRASA specifications document titled 'Blueprint 2022' which has been included as an Annexure to this document.

1.2. Roof Covering

Concrete slab to fall at 1°, Surface well prepared for receipt of waterproofing membrane touch fusion, finished with aluminium paint coating.

New roof and installation to comply with part 13, sabs 10400 laid as per Part L sabs 10 400 of the National Building Regulations.

1.3. WALLS

Where existing walls have been damaged during installation, Walls to be refurbished in accordance with SANS 10400-part B, Part L and Part T of the National Building Standards.

1.4. FLOORING

Prior to commencement of any excavations, all relevant studies to be carried out by specialist.

All concrete floors deemed to satisfy Sans 10400 Part J.

Specification
Floors
Screed concrete finish.
Walls
12mm one coat smooth plaster and painted with two coats Professional Superior Low Sheen (PEM 1000) or Luxurious Silk (D22) acrylic paint, colour to match existing.
12mm one coat smooth plaster and painted with two coats Professional Superior Low Sheen (PEM 1000) or Weather guard Ultrasmooth adhesion promoted (D62) acrylic paint, colour to match existing.
Roof
Concrete slab to fall at 1 °, One layer of SP4 waterproofing membrane finished off with two aluminium coating or similar approved.
Fence
Black High density security galvanised mesh fence with min 3.15mm horizontal wire diameter and 4mm vertical wire diameter. Panels: Appertures to be 76x12mm inner and min 3050mm wide panels to be reinforced with 4x 50mm V formation horizontal recessed bands. Height above the ground to be min 3000mm. All fixtures to be on the inside of the fence line. Panel to be fixed over 48-line wires with Double and single bolt clamps using Anti Vandal bolts. Posts to embedded into concrete and must have moisture proof caps for all posts. Pending on the security risk area; a) Razor mesh panels 600mm high b) Shark tooth spike rails and or c) 100mm Castle type spike rails can be installed on top of mesh. Posts to be 85mm width which includes Locking recess mechanism, posts to be sealed with UV stabilized polymer cap and post to be Hot Dipped galvanized. A 10 year underwritten Anti - Corrosion Gurantee life span to be provided. Product to comply with SANS 10244-2:2003 ISO 1461 hot dip galvanising. Anti - Burrow options: from 300 - 600mm Mesh extension shall be secured to to the panels underside for additional security and or a 200mm concrete sill shall be secured to the panel`s lower edge angle. Any concrete work to be certified by an engineer

Specification
General
Refer to PRASA station design blueprint annexure for accessories and supporting ironmongery.

Table 1: Architectural Specifications

SECTION 2 – STRUCTURAL SPECIFICATION

2. CONCRETE, FORMWORK AND REINFORCEMENT

This section covers the construction of all new reinforced concrete and associated concrete works requirements for the proposed construction of the ballast blocks, as directed by the Engineer.

2.1. PARTICULAR SPECIFICATIONS

The following specifications shall apply:

NB: All in situ concrete work (mass and reinforced) shall comply with SANS Specification 1200G ("8 Measurement and Payment" is not applicable) supplemented by the clauses in this section. Where SANS Specification 1200G and the clauses in this section are in conflict the clauses in this section shall take precedence.

In addition, the "Model Preambles for Trades" as recommended and published by the Association of South African Quantity Surveyors, 1999 Edition, shall be read in conjunction with and shall apply to all items in the Bill of Quantities not covered by the 'SANS Standardised Specifications' SANS 1200 Series.

Where the term "plain concrete" appears in SANS Specification 1200G it shall be read as "mass concrete".

- SANS 1200 G Concrete
- SANS 2001: CC1 Construction Works: Concrete Works (Structural)
- SANS 1083: 2006 Aggregates from natural sources
- SANS 10100-2:2000 The Structural use of concrete – Part 2: Materials and execution of work.
- SANS 50197-1:2000 Cement – composition, specifications and conformity criteria. Part 1: Common cements

- SANS 1491-1:2005 Portland cement extenders – Part 1 Ground granulated blast furnace slag.
- SANS 1491-2:2005 Portland cement extenders – Part 2 Fly ash.
- SANS 1491-3:2006 Portland cement extenders – Part 3 Condensed Silica Fume

2.2. CEMENT

Common cements, complying with SANS 50197-1 shall be used for all concrete work. On no account shall masonry cements be used for concrete work, even if the strength designations are the same as for common cements.

The Supervisor for test purposes may require samples of cement from anyone, or from every consignment. Cement in any consignment from which a sample may have been taken for testing shall not be used until it has been approved. Allowance must be made for possible delay in that tests may take 10 days to carry out.

Ballast blocks will be precast and delivered to site in a finished and cured condition.

2.3. WATERPROOFING

The existing waterproofing must be removed and replaced with a sika product or similar.

2.4. ALKALI REACTIVE CONCRETE

Alkali Reactive Aggregates shall not be used in this project. The equivalent Na₂O content of the concrete shall not exceed 2, 0 kg/m³ where % Na₂O equivalent = % Na₂O + (0,658 x %K₂O).

2.5. AGGREGATES

Fine and coarse aggregate shall comply with the relevant clauses of SANS 1083. No aggregate shall be delivered for use in the works until approval is given.

2.5.1. Sand (fine aggregate)

The fine aggregates shall comply with the requirements of SANS Specification 1083. Other aggregates may be approved if they have a satisfactory history and / or test results.

No aggregate may be used until it has been approved. Samples having a mass of 25kg (16.5 litres) of the proposed aggregate to be used may be required by the Supervisor for test purposes. Samples having a mass of 25kg shall be forwarded every 3 months during concreting work and if the source of supply is changed. Allowance must be made for possible delay in that the tests may take 14 days to carry out.

2.6. ADMIXTURES

Admixtures containing chlorides will not be permitted in reinforced concrete.

2.7. COVER BLOCKS

Cover blocks used to ensure the cover to reinforcement shall be made of cement mortar.

Cover blocks shall be dense and have a minimum 28 day crushing strength of 30 MPa and shall be cured in water for at least 14 days before being used.

Cover/spacer blocks made of plastic will not be permitted.

2.8. UNREINFORCED CONCRETE

Class A Concrete: Filling to cavity of hollow walls.

Unreinforced concrete cast against excavated surfaces: 15 MPa/19mm Concrete, Surface blinding under footings and bases.

2.9. REINFORCED CONCRETE

30 MPa/19mm Concrete:

2.10. BATCHING

All cementitious binders shall be batched by full sack or by mass batching with approved precision weighing equipment.

All aggregates shall be precisely measured by mass using approved precision weigh-batching equipment, unless otherwise permitted by the Project Manager.

Should any variation in the composition of the aggregate become apparent, the Project Manager shall be notified, and a further sample of aggregate submitted immediately for his approval.

2.11. GROUTING

A 25 MPa non-shrink cementitious grout: Bedding approximately 25mm thick under base plate including chamfered edges all round.

2.12. CURING COMPOUND

Unless otherwise directed by the Project Manager, the curing compound shall be:

- An approved trafficable, resin-based, white pigmented, membrane forming for slopes flatter than 1:1.
- An approved clear, aesthetically acceptable, membrane forming for all other concrete surfaces, including beam and slab soffits.

The curing compound shall comply with specification ASTM C309, except that the maximum permissible water loss in the test shall be 0, 40 kg/m².

Alternatively, the curing compound shall be acceptable if the treated concrete retains 90% or more of its mixing water when subject to the test set out in BS 8110 Part 1 – Chapter 6.6.

2.13. TOLERANCES

Deviations shall be within the limits listed in SANS 1200 G for degree of accuracy II unless otherwise specified.

FORMWORK

Smooth formwork (degree of accuracy i)

2.14. REINFORCEMENT

High tensile steel reinforcement to structural concrete work:

- In various diameters and lengths
- Mild steel reinforcement to structural concrete work
- In various diameters and lengths
- High tensile steel reinforcement to structural concrete work may be required

2.15. ALUMINIUM

Governing codes and standards

- EN 755 Extruded products
- EN 755-1 Technical conditions for inspection and delivery
- EN 755-2 Mechanical properties
- EN 755-9 Tolerances on other profiles/shapes
- EN 12020 Extruded precision profiles in alloys
- 6060 & 6063
- EN 515 Temper Designations
- EN 573-1 Numerical alloy designation system
- EN 573-2 Chemical symbol designation system
- EN 573-3 Chemical Compositions

All aluminium sections to be grade 304.

2.16. REQUIREMENTS

All structural aluminium alloy materials, fasteners and welding shall conform with the following requirements:

2.16.1. Preparation of Material

General

Fabrication and assembly operations for aluminium shall take into account the low weight of the structure and assemblies, the great flexibility of members, the dimensional changes due to temperature and the ease with which aluminium can be machined.

During erection the structure shall be securely bolted or fastened. Temporary bracing shall be used if necessary to ensure stability under all erection loads and conditions, including those due to erection equipment and its operation.

2.17. Storage and Transportation

Aluminium shall be stored in a cool dry place, clear of the ground. Contact with other metals and with materials such as cement and damp timber shall be avoided.

NOTE: This is to avoid possibility of superficial corrosion which may cause unsightly staining or marking. Surfaces shall be protected with strippable tapes, waxes or lacquers while danger of damage exists.

Aluminium construction parts shall be packed to avoid mechanical damage, abrasion and contact by agents liable to cause surface corrosion during transportation.

2.18. Marking Out

Fine scribing -lines shall not be used on critically stressed areas of thin metal, and where subsequent welding is involved, paint, chalk, graphite or other marking likely to contaminate shall not be used.

Due attention be given to the relatively high coefficient of expansion of aluminium in measuring, marking out and assembly, particularly when temperature ranges are large.

2.19. Cutting

Cutting shall be by machining, shearing or arc -cutting. Bandsaws and circular saws shall have a tooth form and pitch to suit the thickness of the material to be cut. Cut edges shall be smooth and free from burrs, distortions and other irregularities. Care shall be taken to avoid the use of tools contaminated by other metals, particularly copper or brass. Shearing shall be limited to material 6mm thick or less. Arc-welding shall be applied by a process shown by test to the engineer's satisfaction, to have no deleterious effect on the material. Flame cutting shall not be used, but it is possible to use water cutting.

Sheared or arc- cut edges shall be subsequently machined or filed smooth if used as edge preparation for welds in strength members.

2.20. Drilling Punching and Reaming

Holes shall be made by either drilling, or drilling followed by reaming. Punching can be used to a thickness of about 20mm except for 7xxx series alloys.

Holes for bolts, rivets, unless otherwise specified by the engineer, shall be of the sizes specified in Table 2.

Table 2

Type	materials	Diameter	Clearance on diameter mm	
Bolts close fitting	-	Any	≤ 0.15	
Bolts not close fitting	-	< 13	Reduced clearance	Normal clearance
		≥ 13	≤ 0.5	1
			≤ 1	2
Solid rivets	Aluminum	< 13		
	Steel or corrosion resisting steel	≥ 13	≤ 0.4	
			≤ 0.8	
HS Bolts All plies up to three, or outer two plies or greater than 3 plies	Steel or corrosion resisting steels	≤ 24	≤ 2	
		> 24	≤ 3	
HS Bolts above 3 plies. Inner plies	Steel or corrosion resisting steels	Any	≤ 3	
Special rivets and fasteners	All recommended by manufacturer			

Note 1: The clearance should not be increased on account of irregular or excess zinc coating on the bolts

2.21. Bolted Connection

2.21.1. Bolting

Where either the full area of the shank of the bolt, or the full bearing area of the shank of the bolt, is to be developed, the threaded portion of the bolt shall not extend within the thickness of the connected parts. In addition, the length of the bolt shall be such that at least one clear

thread shows above the nut after tightening, and at least one thread plus the thread run out is clear between the nut and the un-threaded shank of the bolt.

Washers shall be provided under all the bolt heads and nuts. Galvanised steel washers shall be used with steel bolts. washers of pure aluminium, or of the same material as the bolt or the member shall be used with corrosion resisting steel bolts.

Nuts shall be fully but not excessively tightened. Locking nuts shall be used as required.

The threads of aluminium and stainless-steel bolts shall be lubricated before assembly, if the joint will subsequently be disassembled.

2.22. Friction Grip Bolts

2.22.1. Surfaces in Contact

For joints between aluminium members, at the time of assembly, the contact surfaces shall be clean, free from burrs and defects which would prevent solid seating of the parts, and free from substances that would interfere with the development of friction between them.

When the aluminium surfaces are treated by grit blasting, the blasting shall provide a visually uniform coverage of the surface.

2.23. Assembly

If a joint is dismantled, it shall not be re-assembled unless the surface treatment of the interface has been re-applied.

2.24. Welding

2.24.1. General

Site work should be avoided if possible. It shall be done only where there is complete protection which simulates shop conditions.

Welding other than that specified on the drawing shall not be allowed without the prior written agreement of the engineer. Temporary welded attachments shall not be included unless specifically agreed with the engineer.

Dimensions shall have allowance for the effects of weld shrinkage. Welding sequences and heat input shall be balanced to avoid warping and distortion.

2.25. Welding Consumables

The filler wire shall be selected in accordance with prEN 1011-4:1995 taking into account the specific requirements of the joint or as specified by the engineer.

2.26. Welding Processes

Strength members shall be welded by either tungsten inert gas (TIG) or the metal inert-gas welding (MIG) process in accordance with EN288-1:1992 and EN 288-4:1992, taking account of special procedure requirements.

New and highly effective methods (laser, high energy MIG, friction stir welding...) can be used advantageously after approval tests.

2.27. Approval of Welding Procedure

Unless otherwise specified by the engineer, the precise course of action to be followed for each type of joint shall be documented as a welding procedure and approved by the engineer in accordance with EN288-1:1992, EN 288-4:1992 and prEN 288-13.

Where the production joint design or application is such that none of the test pieces can be regarded as representative.

2.28. Weld Quality and Inspection

2.29. General

The main requirements for control of weld quality are:

2.30. Procedure Approval

Welder approval

Non-destructive examination of production welds immediately before and after welding and testing of production control test pieces after welding

Quality Levels

The extent of the inspection of the inspection and inspection methods and the magnitude and level of acceptance of imperfections are both dependent on the quality level required for the weld. The quality level specified for each weld depends on the stressing requirements and shall be one of the following:

Minimum quality (Level D) may only be used where the engineer has indicated on the drawing those parts to be considered as requiring minimum quality

Note 1: the minimum quality will only apply where the actions under factored loading do not exceed one third of the factored resistance of the member or joint, e.g. Stiffness may dictate design. This will apply to both static and fatigue resistance.

Normal quality (Level C, EN 30042) shall be applied where the drawings do not specify any other quality level requirement. Absence of indication of quality requirement shall be taken to be normal quality level.

Note 2: The normal quality level will normally apply where the action under factored loading exceeds one-third of the factored resistance of the member or joint, and where the required class for fatigue does not exceed 20.

Fatigue quality (level B EN 30042) shall be applied where the engineer has indicated on the drawings the detail or details requiring an appropriate fatigue quality level by means of “Fat” level numbers and an arrow indicating the direction of stress fluctuation

Note 3: The fatigue quality level will normally apply where the required level for fatigue exceeds 20 (see prENV 1992-2,) There are 5 possible fatigue qualities depending on the type of joint and the degree of stress fluctuation (required level). They are referred to as Fat 25, 31, 39 49, 62.

Fatigue level B will be applicable to all joints

2.31. Fabricated Parts

All fabricated parts shall be properly fitted during assembly to result in properly aligned equipment having a neat appearance. Fabrications of load bearing members shall have no abrupt changes in cross section and regions of severe stress concentration. All sharp corners accessible by personnel during erection or operation shall be ground, rounded, or removed by other methods. Burrs, welding spatter and stubs of welding wire shall be removed.

2.32. Submission Of Shop Drawings

The Contractor shall submit shop drawings of the solar structure based on the architectural concept design and final structural designs by the Contractors Structural Professional engineer / protectional technologist. Structural shall comply with all relevant SANS and international standards.

SECTION 4 – ELECTRICAL ENGINEERING

1. INTRODUCTION

The site has an existing substation of 11kV medium voltage panel for various buildings and site, with multi transformers. The substation is called Parcel substation. The substation has transformers ranging from 1MVA, 1,6MVA and 2MVA. The supply for Durban station has a MV ring feed.

The scope focuses on the Durban Regional office. Regional office is feed from Parcel Main low voltage distribution board. This specific site has no backup generator; therefore, a new generator set shall be installed under this contract.

The available area, existing 99-steps rooftop is 9 203m².

The clients intend to install 1000kWp solar plant for Durban station, 99-steps rooftop.

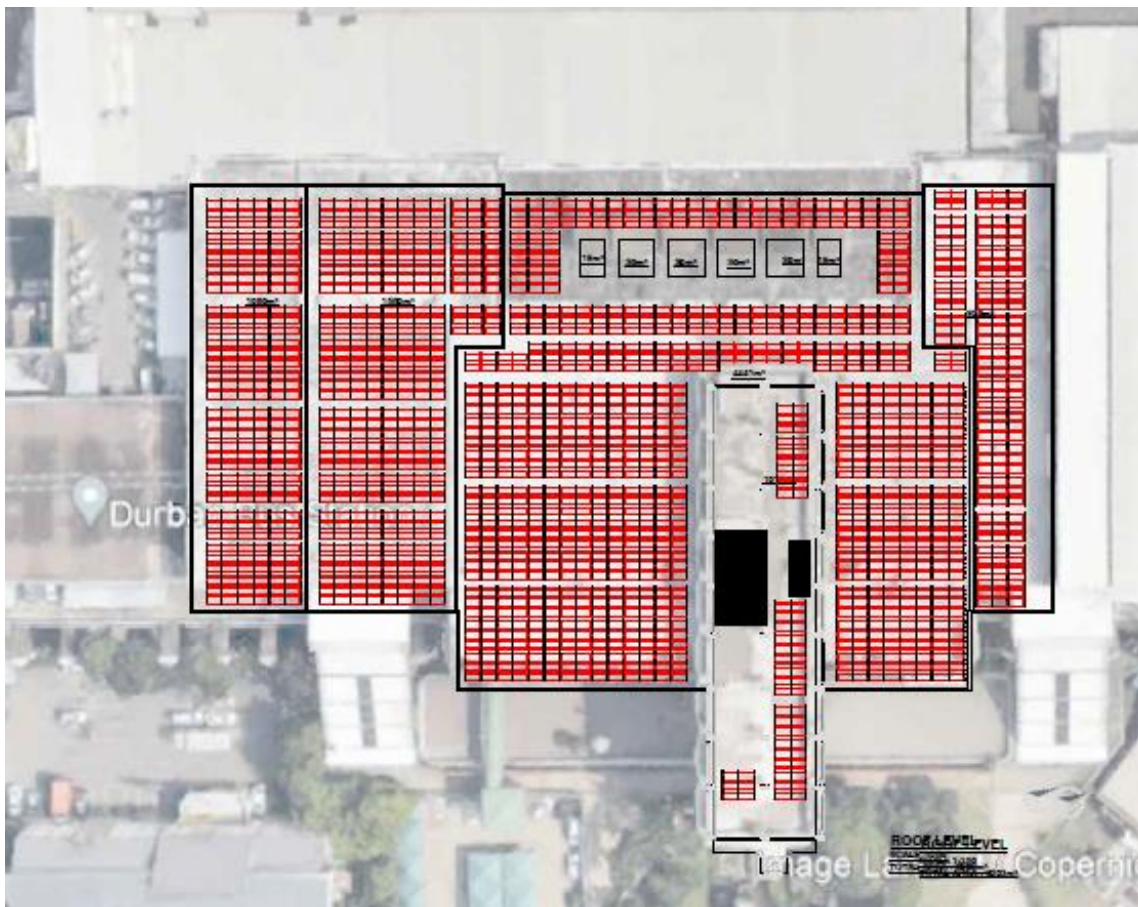


Figure 2: Solar panel at 99-steps concrete roof

The Contractor must return all returnable documents on the attached specification of this document with the tender's returnable document.

2. LOW VOLTAGE SCOPE

Scope of Work

The scope of work is to provide photovoltaic solar plant for the Duran station, upgrade and or carry out refurbishment where applicable. The solar plant shall be integrated with the existing electrical services. The scope includes assessing site to understand the site, confirm and firm up the scope of work. The described scope below includes work for other disciplines for the electrical contractor to understand the entire scope of work for this project as the lead Contractor. The detailed scope of work for other disciplines is also discussed under disciplines sections.

The scope of work consists of:

- Installation of photo voltaic solar plant system – 1000kWp with required and relevant equipment
- The installation of load loggers.
- Supply, delivery and installation of a new diesel generator set of 1250kVA (prime), 400VAC.
- Upgrading of building electrical installations such as lighting and control devices where applicable (small power)
- Installation of new security system such as CCTV and access control and its ancillaries
- Provision of software as indicated on the bill of quantities and this document such as energy management systems
- A 36-months maintenance contract after the installation.

The electrical work includes, but is not restricted to the following:

- Strip all existing electrical installation, wireways, old cable rack and redundant cables and hand them to PRASA and certain rubble is for disposal at Contractors cost.
- Isolation, disconnect and make safe, remove existing circuiting feeding regional office from Parcel substation LV room.
- Supply, delivery, installation, connection, testing and commissioning of the new photo voltaic solar plant 1000kW system complete with it associate and required equipment and ancillaries.
- The supply, delivery, installation, connections and testing of any material and equipment associated with the electrical supply connections to the buildings equipment's.
- Supply, delivery, installation, connection, and testing photo voltaic solar plant system as per these specifications
- Supply, delivery, installation, connection, and testing two off emergency backup generators set as per these specifications.
- The supply, testing and inspection at the manufacturer's premises, installation, connection, testing and commissioning of new distribution boards and switchgears.
- Supply, delivery, installation and connection of all power and lighting, distribution, cabling, conductors i.e., socket outlets, light switches, isolators, etc.
- Supply, installation and connection of all circuit wire ways, cable trays, cable ladders, conduit, draw and outlet boxes and sleeves as per the drawings.
- This includes the installation of a lightning protection system as per the drawings. A suitably certified Contractor shall install the lightning protection system, and all earthing points shall be tested, and the results recorded. All test results shall be submitted to the Project Manager in the form of a test report/certificate. Payment for this portion of the project cannot be made until the Project Manager has accepted the results of the tests.
- Supply, delivery, installation and connection of all circuit wiring, cables, and conductors.
- Provide labelling on distribution boards and equipment and cover plates as per specification.

- Supply, delivery, installation, and connection of all luminaries as per specification
- Connection of electrical power to all mechanical equipment and systems
- Supply, installation, connection, and testing of an earthing system entire installation including LV distribution boards providing clean earth for instrumentation.
- Excavations for all cable trenches, compaction, backfill and making good of existing surfaces.
- Co-ordination with PRASA (where applicable) and Municipality / supply authority representatives when required etc.
- Testing of all new installations in accordance with the latest requirements of SANS 10142, the Electrical Contracting Board of South Africa and the issue of a certificate of compliance test report for the electrical installation in the buildings
- Any other work deemed necessary by the Project Manager for the completion of the project.

3. MAIN DISTRIBUTION BOARDS / MAIN ELECTRICAL PANELS

3.1. GENERAL

The electrical panels shall be suitable for the coastal environment and prevailing climatic conditions on site and equipment shall be designed and manufactured in accordance with SANS 1973/60439. The equipment shall conform to SANS 60947 Parts 1 -7 and shall be suitable for operation on supply voltages of 230/400 Volt at 50 Hz, AC. Reference must be made to the schematic/line diagrams, as well as to the following specific requirements.

The main distribution boards in the substations shall be of the free standing, floor mounted, multi-tiered, with individual main MCCB/Isolator for each motor starter, with front and back access, suitable for top busbars entries and bottom and top exit cable. The schematic drawings show the specific requirements applicable to each assembly.

The assembly shall be constructed of and manufactured from 3CR12 or stainless-steel grade 316 or as per single line diagram.

The minimum thickness of 2mm thick electrical panel.

The metal enclosures, internal panels and all equipment support frames shall be manufactured from the same type of plate stated above.

The degree of protection shall not be less than IP54 in accordance with SANS 1222 and capable of withstanding the temperature, humidity, and coastal conditions. The assembly shall be fully vermin proofed.

A hot dipped galvanised steel base frame with predrilled holes for fixing the electrical panels to the floor shall be provided and removable lifting eyes with blanking off plugs shall be provided for lifting heavy assemblies. The panel shall be suitably braced to ensure rigidity. The method of preparing plate-work, priming and painting shall be in accordance with the standard painting specification.

The electrical panels are to be fully assembled in the manufacturer's factory for final acceptance tests. Where broken down for transportation to site, the electrical panels will be provided with all items required for re-assembly. Provision must be made for future extension at either side of the panels. All holes provided for such extension to be suitably plugged or covered.

The overall outside dimensions of the assembly shall be suitable for easy handling of the switchgear as indicated on the drawings.

All hinged front panels shall be fitted with stainless steel or heavy-duty rustproof hinges of an approved manufacture with a 180° movement and shall be secured in the closed position by means of locking devices of approved quality. Hinged front panels in excess of 450mm height shall be secured at both the top and bottom. Lockable catches are required on all hinged front panels. All hinged front panels are to be fitted with earth straps.

Covers, other than the hinged type, shall be provided with chromium plated handles to facilitate removal. Removable covers shall be secured in position by means of patent screw locking devices approved by Engineer. All removable covers and hinged front covers shall have a neoprene or rubber gasket to ensure that the required IP rating of the panel is achieved.

All the equipment shall be mounted behind the hinged front panels and neat machine punched openings shall be provided for the purpose of operating handles etc. The drawings will detail the instruments required which will be flush mounted. The positions of instruments shall be such that the glass cannot be broken by other equipment when the hinged front panels are in the fully open position.

Cut outs which are provided for future equipment and instruments shall be neatly blanked off by means of removable dummy frames. Back plates shall be provided in all spare cubicles for the specified future starters.

To avoid damage to paintwork, screws, bolts, door lock, etc. must not be in direct contact with painted surfaces.

The Engineer shall approve the manufacturer's detailed working / shop drawings of the assembly before any fabrication commences. Any other construction or type of assembly proposed as an alternative to that specified must have the approval of Engineer in writing. The drawings will detail all dimensions of busbars, connections, electrical component make, type and rating. Positions and layout of busbars, earth bars and gland plates will be shown in front and side elevation drawings.

3.2. PAINT SPECIFICATION

All metal used for the fabrication of the board shall be painted, i.e. internally and externally. Baked enamel, electro statically applied powder coating or similar proven methods, other than standard enamel paint applied by brush, shall be used.

In general, the following standard colours shall be used, but the final colours are to be confirmed with PRASA and the Engineer.

- Non-essential sections Electric orange
- Essential sections Signal red.
- Uninterrupted power (UPS) Purple.
- Instrumentation and control Blue.

3.3. EDGES

Care shall be taken to ensure that all edges and corners are properly covered, after all burrs and sharp edges have been removed.

3.4. SURFACE PREPARATION

Surface preparation shall comply with SANS 10064. Prior to painting, all metal parts shall be thoroughly cleaned of rust, mill scale, grease, and foreign matter to a continuous metallic finish. Sand or shot blasting or acid pickling and washing shall be employed for this purpose.

The corrosion inhibiting process shall be suitable for the environmental conditions to be encountered on site and full details shall be provided at the time of tendering. Details of the chemical process employed, and the method of application shall also be provided at the time of tendering.

3.5. FINISH ON STAINLESS STEEL

One (1) coat of suitable etch primer (15 microns). Apply epoxy polyester powder coat (60 microns final thickness). Steel shall be correctly pickled and passivated prior to being painted. Pickling and passivation shall be undertaken after basic manufacture of the Enclosure is complete.

3.6. BUSBARS

All busbars shall be manufactured from solid high conductivity copper and shall comply with the requirements laid down in SANS 1195. The completed busbar system shall be a standard modular system and shall have been tested to SANS approval and a certificate shall be made available confirming the full busbar technical description, current rating, and fault rating together with full details of the test results. Busbars shall be designed to withstand a test voltage of 2.5kV AC for one minute.

The busbar assembly shall be rated in accordance with the specified ultimate projected fault level, which will be not less than the short-circuit stresses limited by the protective device(s) on the supply side of the busbars, as well as the specified continuous full load current, with a current density not exceeding 1,60 Amps per mm². The busbars shall withstand a fault current under test conditions of the specified fault level for 1 second. If a fault level is not specified, the busbars shall be tested at 20 times rated current for 1 second.

The fault current during tests shall be:

- between all three-phases
- any two phases
- neutral and the adjacent phase, and
- earth conductor and the nearest phase conductor.

The busbars shall be continuously rated for the specified current with a maximum temperature rise of 40°C relative to a peak ambient temperature of 40°C giving a maximum peak busbar temperature of 80°C.

Busbars shall be mounted in the top section of the assembly and shall be rigidly supported by means of approved insulated busbar clamps (at intervals not exceeding 500mm) to prevent damage resulting from the specified short circuit conditions.

The busbars shall run along the entire length of the assembly up to 76mm from either end. The phase busbars shall be identified in the phase colours red, white and blue.

The busbars shall be arranged horizontally with the longer side of the cross-sections in the vertical plane and one behind the other in the horizontal plane. The minimum clearance between live conductors and live conductors and earth shall be 40mm.

3.7. EARTH BUSBAR

A solid copper earth bar shall be provided inside each assembly at the back and along the entire length, at a height of approximately 500mm above floor level, or 200 mm above the gland plates. A bar is to be provided at the top of the assembly where top entries exist and this shall be solidly connected to the bottom earth bar.

The bar will be supported on robust spacers and will have a minimum clearance of 40mm to the sheet steel panel.

The earth bar shall have same size as the phase busbars and shall be drilled with the requisite number of holes for the individual connection of all cable ECC and other earth conductors.

The earth bar, busbar joints and cable terminations must not be insulated.

Stainless steel bolts and lock washers shall be provided through the earth bar at each earthing position and at least 5 additional holes will be provided for future connections, each being fitted with nuts and bolts as above.

The earthing positions shall be evenly spaced along the length of the earth bar and the bar must be clearly identified as the earth.

3.8. NEUTRAL BUSBARS

Neutral busbars in 3-phase, 4 wire supplies shall have a cross-section of the same area and size as of the phase busbars. Where single-phase circuits (e.g., lighting, and general power circuits) are protected by single-phase circuit breakers or fuses, all neutral conductors shall be connected to a separate neutral busbar mounted in a suitable position. The cross-section of the busbar shall be at same as phase busbars and the busbar shall be long enough for the lug of each conductor to be bolted separately to the busbar. Only one neutral conductor is allowed per nut and bolt combination.

A separate neutral bar shall be provided for each earth leakage unit provided on the switchboard.

3.9. BUSBAR DROPPERS

All busbar droppers must be suitably supported (maximum spacing @ 500mm centres) and braced to suit the specified and/or projected short circuit conditions. They should be fully insulated and screened against accidental contact.

The droppers to the supply side of a single functional unit, as well as the components included in this unit, may be rated on the basis of the reduced short-circuit stresses occurring on the load side of the short-circuit protective device in this unit provided that these conductors are arranged such that under normal operating conditions an internal short-circuit between phases and/or between phases and earth is only a remote possibility, for example by being provided with adequate insulation or shrouding.

Particular attention shall be paid to the provision of adequate facilities for making off the main power supply cables. Attention must be paid to the vermin proofing of single core cabling.

Bunched cable connections will not be accepted between busbars and outgoing power circuit breakers, fuses or isolators.

3.10. BUSBAR CONNECTIONS

All connections and extensions to busbars shall be effected by means of stainless steel nuts, bolts and washers or cadmium plated, high tensile steel bolts and nuts which shall also be provided for future extensions. The minimum diameter of any hole will be 10 mm.

In exceptional cases a relaxation of SANS 1973 may be permitted to allow the drilling of holes, in which case the cross-sectional area as measured is to be reduced by the area of the holes.

3.11. EQUIPMENT

Unless otherwise stated on the drawings the latest version of the following minimum specifications shall be assumed for equipment to be installed in the switchboards:

SANS 60947 relates specifically to equipment for use at voltages up to 1000V AC.

All contactors and/or starters shall be protected with suitable back-up current limiting circuit breakers to protect the equipment against abnormally high currents or short circuits developing in the system.

The manufacturer will be required to ensure the correct co-ordination between circuit breakers, contactors, and overload relays to comply fully with SANS 60947 Part 4, in order to achieve 'Type 2' co-ordination.

Unless otherwise stated, contactors and/or starters shall be rated for 10 million operations for making and breaking no-load currents to category AC3 as laid down in SANS 60158. Note that SANS 60947 requires equipment and wiring to be suitable for 7.2 x full load current for Direct-On-Line starters.

Each switchboard shall be provided with a means to isolate the incoming supply. This may be achieved using an isolator, circuit breaker (fixed or draw-out), rated to make against the full system fault at the point and break the full load current. The incoming supply section containing switchgear, protection equipment, controls and instrumentation shall form a clearly labelled, self-contained unit behind one or more hinged panels. The operating handle of the isolator, circuit-breaker or fuse switch controlling the incoming supply shall protrude through

the panel and shall be interlocked to ensure that the panel can only be opened when the supply is off.

Equipment that cannot be flush mounted on the panel, shall be mounted on a suitable metal chassis and shall protrude through a close-fitting cutout in the panel. All protection relays contained in enclosed units with glass fronts shall be flush mounted on the hinged panels, contactors, thermal overload relays, etc. shall be mounted on a chassis behind the panel.

Access to the various starters shall be possible without isolation of the entire MCC, but the hinged front panels corresponding to each compartment shall be inter-locked with a local isolator in order that any compartment must be isolated before access to the equipment can be obtained. A mechanical device shall be incorporated in each isolation in the off position to provide a locking out facility during maintenance periods.

All over current reset buttons (22mm diameter) shall be mounted on the front panel enabling operators to reset the unit without having to open the panel.

Timers and relays controlling a starter shall be mounted in the compartment with the starter. All timers and relays must be clearly labelled with the identity given on the schematic diagrams.

Equipment to be supplied under this contract must be identical in all respects and it shall be possible to interchange such equipment should it become necessary.

All material and equipment must be suitable for 400/230V-supply voltage, 50 Hz supply frequency and must be approved by the Engineer. In addition, all equipment shall be designed, manufactured and tested in accordance with the relevant IEC Standard Specification.

3.12. DERATING OF EQUIPMENT

Full cognisance must be taken of manufacturers derating tables for equipment located in enclosures and the rating of that equipment must be increased accordingly. In all such cases labels must be provided on the front of the associated cubicle stating the maximum permitted circuit loading.

3.13. CABLE TERMINATIONS

Due to the continuing miniaturisation of equipment, difficulties can be experienced in terminating power cables onto equipment terminals, particularly where more than one cable has to be terminated. The manufacturer shall ensure that suitably designed and rigidly braced copper stubs are extended from such terminals to facilitate the termination of all cables. Flash barriers must be used between the phase terminals of circuit breaker equipment.

3.14. INSTRUMENTATION

All instruments shall be of a matching flush pattern. The single line diagram will indicate the ratio of CTs where required. The instruments shall be suitable for the environment in which they are installed. All instruments shall withstand a test voltage of 2kV for 1 minute and the terminals of all instruments mounted on hinged panels shall be shrouded.

Electrical panel shall be provided with digital meter to measure voltages, amperes, kWh, Hz, etc. the meter shall be able to measure each motor power consumption.

3.15. PROTECTIVE DEVICES AND PROTECTION SETTINGS

The switchgear shall be provided with the specified protection and auxiliary relays, which must be of a modular pattern, readily accessible, replaceable, and extensible.

The thermal overload releases and instantaneous magnetic short circuit trips are to be adjustable over the trip ranges as specified by Engineer.

The Contractor must allow to grade, set and test the protection devices for the main switch, bus section switches and each motor circuit.

3.16. PUSH BUTTONS AND INDICATING LIGHTS

These shall be 22mm diameter unless otherwise specified and shall be suitable for the environment conditions. Emergency Stop pushbuttons shall be 40mm diameter "Twist to Release"

Indicator lamps may only be of the Cluster LED types. Where LEDs are specified as indicators on main supply voltages, a suitable current limiting capacitor and reverse voltage protection diode must be used. For low AC or D.C. voltages ($\pm 24V$) a current limiting resistor will suffice.

3.17. SITE TESTS

After completion of erection, cabling and field wiring, the Contractor shall set all overloads, protection devices etc. and shall again carry out a full functional test to prove the correct operation of the entire electrical panel, including the simulation of all remote devices. A signed compliance certificate by the Contractor's accredited person for the electrical panel and its installation shall be handed over to Engineer on Completion.

The tests shall be witnessed by the Engineer.

3.18. WORKMANSHIP GUARANTEE

A 12-month guarantee shall cover the sheet metal enclosures and all the equipment installed therein against faulty workmanship and materials. The guarantee period shall begin from the date the electrical panels are completely installed and accepted by Engineer.

3.19. SUB-DISTRIBUTION BOARDS

3.19.1. General

Sub-Distribution board shall comply with the requirements of the standard specifications of these documents or shown on the drawings. All sub-distribution boards must be dustproof with an IP54 rating and 1,6mm stainless steel and/or as per drawings specification. Floor standing distribution boards shall have sheet of 2,0mm (minimum) stainless steel. They must have a proxy finish.

Distribution boards are to be manufactured by an approved switchboard manufacture and to have a SABS approved manufacturer circuit breakers and/or isolators (as per drawing) and lightning/surge arrestor. All DB's to have surge arrestors as per drawings. A thirty percent (30%) space must be included on all DB's.

Drawings of all distribution by the manufacturer shall be submitted by the Contractor to the Engineer for approval before commencement of manufacture of distribution boards. After construction all DB must be inspected by the Engineer before installation.

3.20. Installation of Distribution Boards

Distribution boards shall be installed in the positions as shown on the respective drawings. The Contractor shall ensure that the distribution boards with the necessary conduits, sleeves, and channels as required are placed in position and mounted when required, and he shall ensure that all equipment is installed in the correct positions. It must be emphasised that no chasing will be allowed in walls built with face-bricks on the side in which distribution boards and ancillary equipment are installed. In all such cases the Contractor shall place his equipment in its proper place for the building contractor to build.

The costs of any additional work caused by late, incorrect or defective positioning of equipment and/or material by the Contractor, shall be recovered from him.

The Contractor shall, while material and/or equipment forming part of the electrical installation are/is being built in and have a competent representative present to ensure that no unnecessary stress is placed on the material that will influence subsequent installation of equipment. Care shall be taken that all equipment of the board fit properly in their respective position without distortion which can lead to a poor installation and appearance. All bolts, clamps and fasteners shall be examined and properly tightened.

The Contractor shall ensure that all circuit breakers and other equipment can be changed and replaced if and when required.

All support props and struts, packing pieces and material used by the board manufacturer to prevent damage during transit, shall be removed by the Contractor. The Contractor shall examine all boards and ensure that all equipment shown on the appropriate relevant drawings has been supplied and fitted.

Any conspicuous damage like scratches or chafe marks to paint work, shall be touched up with the same colour paint as supplied by the board supplier.

The mounting height of all distributions measured to the top of the edge of the board shall be 2 000 mm above finished floor level, unless otherwise specified or the position and

circumstances dictate differently. The Contractor shall ensure that cables sleeves and provision for the entry of cables to distribution boards as shown on drawings are done properly and neatly.

All DB must have surge arrestors as specified on the drawing.

Exposed cables above or below the surface distribution board must be covered with a metal cover of the same colour as the DB.

All distribution boards shall have mechanical barrier which will separate supply from normal supply /generator supply from the solar system supply.

3.21. EARTHING

Earthing shall be done in accordance with the requirements of the standard specifications and those of the Supply Authority.

Earth system neutral and all non-current carrying metal parts of electrical equipment, conduit, cable racks, etc.

Earth metal parts of distribution boards, switch boxes, conduit, wash-hand basins, working surfaces, cable armouring and electrical equipment.

A separate isolated earth-bar shall be fitted in each distribution board for the dedicated computer socket outlets. These earth-bars shall be earthed with an insulated earth conductor to a separate earth spike from the main earth. The computer earth spike shall be inter-linked outside the building to an earth conductor, to the main earth spike of the building.

Additional Equipment

Install three phase lightning arrestors in the Distribution boards as per drawing.

3.22. LABELS

All distribution boards shall be marked as follows:

- Name and number of distribution board and Fault level rating of distribution board, example “DB - G, 5kA”;
- Origin of supply, and size of all cables, example “Supply from main DB - 25 mm² x 4c

- All circuit breakers shall have its current rating clearly indicated on the handle, or on the panel adjacent to the switchgear.
- All circuit breakers shall be properly labelled as to its service, as indicated on the drawings.

3.23. COLOUR CODING AND LABELLING OF THE DISTRIBUTION BOARD

The distribution board must be white in colour, with the following specification:

- Non-essential DB colour to be white with white colour face plate. The label will have black engraved letters on white ivorene label. Ivorene label super-glue or pop riveted to face plate or frame. Distribution board number as per drawing, e.g. DB-G. Content of internal label on face plate – DB number indication of a feeder source, size of a feeder cable, fault level rating of a distribution board and phase rotation direction. The label of a DB will be 6 mm label on face plate to be 3 mm. labelling of cables – all incoming and outgoing cables shall be labelled with ivorene labels indicating the size of the cable.
- Essential DB colour to be white with red colour face plate for sub-distribution boards.
- Essential DB colour to be electric orange with red colour face plate for main-distribution board.
- The label will have black engraved letters on red ivorene label. Ivorene label super-glue or pop riveted to face plate or frame. Distribution board number as per drawing, e.g. DB-E/G. Content of internal label on face plate – DB number indication of a feeder source, size of a feeder cable, fault level rating of a distribution board and phase rotation direction. The label of a DB will be 6 mm label on face plate to be 3 mm. labelling of cables – all incoming and outgoing cables shall be labelled with ivorene labels indicating the size of the cable.
- Uninterrupted Power Supply / Solar system boards - DB colour to be white with blue colour face plate. The label will have black engraved letters on white ivorene label. Ivorene label super-glue or pop riveted to face plate or frame. Distribution board number as per drawing, e.g. DB-U/G. Content of internal label on face plate – DB number indication of a feeder source, size of a feeder cable, fault level rating of a distribution board and phase rotation direction. The label of a DB will be 6 mm label on

face plate to be 3 mm. labelling of cables – all incoming and outgoing cables shall be labelled with ivorene labels indicating the size of the cable.

- All distribution boards shall have mechanical barrier separating non-essential and essential sections of the electrical panel.

All Essential and UPS distribution boards, kiosks and low-tension switchboards shall be equipped with LED indicators connected to the incoming supply and labelled alternative supply.

POWER SOURCE	NORMAL	ESSENTIAL	UPS
Colour of Electrical Panel	Distribution Boards in buildings White or Beige Outdoor Kiosks, and Low Tension Switchboards Electric Orange	Distribution Boards in buildings White or Beige Outdoor Kiosks, and Low Tension Switchboards/ main LV room Electric Orange	Distribution Boards in buildings White or Beige Outdoor Kiosks, and Low Tension Switchboards/ main LV room Electric Orange
Colour of Plate	Distribution Boards in buildings White or Beige Outdoor Kiosks, and Low Tension Switchboards Electric Orange	Distribution Boards in buildings Red Outdoor Kiosks, and Low Tension Switchboards Red	Distribution Boards in buildings Blue Outdoor Kiosks, and Low Tension Switchboards Blue
Label of plate	Black engraved letters on white Ivorene label. Ivorene label	White engraved letters on red Ivorene label. Ivorene label	White engraved letters on blue Ivorene label. Ivorene label

POWER SOURCE	NORMAL	ESSENTIAL	UPS
	super-glued or pop riveted to face plate or frame.	super-glued or pop riveted to face plate or frame.	super-glued or pop riveted to face plate or frame
Contents on external Label	Distribution Board Number as per example DB A	Distribution Board Number as per example DB/E-A / DB/E – 1	Distribution Board Number as per example DBAU / DB/U – 1
Contents of internal label of face plate	Distribution Board Number, Indication of Feeder Source, Size of Feeder Cable, Fault Level Rating of Distribution board, Phase rotation direction	Distribution Board Number, Indication of Feeder Source, Size of Feeder Cable, Fault Level Rating of Distribution board, Phase rotation direction	Distribution Board Number, Indication of Feeder Source, Size of Feeder Cable, Fault Level Rating of Distribution board, Phase rotation direction
Letter size	Label of Distribution Board : 6 mm Label on Face Plate: 3 mm	Label of Distribution Board : 6 mm Label on Face Plate: 3 mm	Label of Distribution Board : 6 mm Label on Face Plate: 3 mm
Labelling of cables	All incoming and outgoing cables shall be labelled with Ivorene labels indicating the size of the cable.	All incoming and outgoing cables shall be labelled with Ivorene labels indicating the size of the cable.	All incoming and outgoing cables shall be labelled with Ivorene labels indicating the size of the cable.

3.23.1. Balancing Of Load and Phases

In multiphase distribution boards, all single phase circuits shall be equally distributed over all three phases so as to balance the electrical load as far as possible.

Each type of sub-circuit shall separately be balanced over all three phases as far as possible.

3.23.2. Provision for Future Equipment

Where space is required for future switchgear, the panel shall be correctly punched for such future switchgear.

Approved blank covers must be provided.

3.24. EARTHING

Earthing shall be done in accordance with the requirements of these documents and those of the Supply Authority.

Earth system neutral and all non-current carrying metal parts of electrical equipment, conduit, cable racks, etc.

Earth metal parts of distribution boards, switch covers, conduit, wash-hand basins, working surfaces, cable armouring and electrical equipment.

The current carrying capacity of earth conductors shall in general be not less than 50 % of that of the largest conductor, which is protected, except that earth conductors smaller than 2,5 mm squared may not be used.

All luminaires shall be earthed to an earth conductor.

A specialist and approved lightning & earthing protection contractor will be appointed by the Contractor. A provisional amount for this work has been allowed for in the tender summary. The lightning protection system shall comply with the latest relevant requirements of the specification:

SANS 10313: Protection of structures against lightning.

3.25. CONDUIT AND FITTINGS

3.25.1. Flush In Walls, Floors and Concealed In Roof Spaces

Conduit fittings and their installation shall comply with these documents. All conduits shall be concealed by laying in concrete, chasing in walls or running in ceiling/roof spaces. All chase work and making good thereof shall form part of this contract.

Contractor is to install PVC conduits in all electrical installation. Conduits jointing to be done with couplings or approved jointing accessories for conduit jointing and contractor is to use glue to make sure that the jointing or connection of conduits is permanently fixed.

All conduits shall be painted and match the wall after installation where applicable.

3.26. COVERPLATES

Switched socket outlets and switches are mounted in hot deep galvanised wall outlet boxes and for blank cover plates they shall be white.

All cover plates shall be PVC and white in colour with 3mm engraved lettering indicating distribution board and circuit number.

Colour coding is to be done as per SANS standard, namely: -

- Normal /Non-essential Supply: white,
- Emergency/Essential Supply: signal red
- UPS supply: blue

3.27. CABLE SLEEVES

All cable sleeves inside the building and on the site across roads and under hardened surfaces shall be supplied and installed by the Contractor and shall form part of his contract.

Cable sleeves shall be made from PVC and shall be at least Class 34, unless otherwise specified and shall be installed at all entrances to building, road and street crossings and such other entrances to building, road and street crossings and such other places as may be specified elsewhere in these documents or shown on the drawings. Sleeves used at

entrances to building shall be sealed at both ends after the cable has been installed. During installation and until final sealing is done, the sleeves shall be kept clean of debris and blockage by temporary plugs. Final sealing shall be done with a weak cement mixture. Sleeves for future use shall be likewise sealed.

The sizes and number of cable sleeves are indicated on the drawings.

Where the diameter of cable sleeves is such that it cannot be hidden behind a plastered slot in the wall, an acceptable and suitable cover shall be provided and screwed over the cable slot.

The Contractor shall ensure that the correct sizes, number, and length of sleeves are supplied and installed so that the cables can be pulled-through and installed.

3.28. ARRANGEMENT OF CIRCUITS

The arrangements of the various circuits are indicated on the drawings, together with the required protection (switchgear), control and the type and number of wiring (conductor or cable) of each circuit.

All protection shall be done with moulded case circuit breakers (MCCB's) from a SABS approved manufacturer.

No mixing of different types, ratings and manufacture of switchgear shall be allowed.

The Contractor shall check and make sure that the conductors as given for the various circuits, comply with the requirements of the standard specifications of these documents, as well as those of the SANS Code of Practice, SANS 10142-1 as amended.

The Contractor shall ensure that all circuits are connected such that the load is equally balanced over all three phases.

3.28.1. Isolators, Circuit Breakers, Earth Leakage Relays and Surge Arrestor

Isolating switches, circuit breakers and earth leakage units shall comply with the relevant requirements and shall be of the SABS approved manufacture (commercial/industrial circuit

breakers and switch disconnectors), or as may be specified elsewhere in these documents or shown on the drawings. The circuit breakers must be hydraulic magnet type.

3.29. SWITCHED SOCKET OUTLETS

Switched socket outlets (S.S.O) shall be 250V 16A 3 round pin, 3-pin and 2pin and dedicated switched socket outlet shall be 250V 16A 2 round pin and chamfered and shall be of approved manufacture and shall bear a SABS mark. The position of the sockets out will be 300 mm above floor finishing level (AFFL) or/and as per drawing. Sockets outlets with waterproof housing must be provided and must be installed as shown on the drawings be the same height of 300mm AFFL, or as specified on the drawing.

Labelling on the cover plate is to be engraved or with pop riveted to cover plate with black letters. Content on label shall be the distribution board number and circuit number feeding socket outlet, e.g. DBA/PD1/1. Each socket outlet on a circuit shall be labelled.

All s.s.o shall be wired with 4,0mm² conductors that is red, white, or blue for live circuits, black conductors for neutral and green for earth.

Dedicated switched socket outlet shall not be linked with earth leakage.

Cover plates for s.s.o shall be white plate with white or red toggle or blue plate as indicated on the drawing.

Cover plate for dedicated s.s.o shall be white with red toggle and chamfered earth, or blue plate as indicated on the drawing.

POWER SOURCE	NORMAL	ESSENTIAL	UPS	DEDICATED This socket outlet shall be used for computer equipment only and shall not be on earth leakage units.
Cover Plate	White	White	White	Red

POWER SOURCE	NORMAL	ESSENTIAL	UPS	DEDICATED This socket outlet shall be used for computer equipment only and shall not be on earth leakage units.
Colour				
Switch / toggle Colour	White	Red	Blue	Red
Label Type	Black letters on white Ivorene label or Black engraved letters on cover plate. Ivorene label glued with super glue or pop riveted to cover plate.	White letters on red Ivorene label or Red engraved letters on cover plate. Ivorene label glued with super glue or pop riveted to cover plate.	White letters on blue Ivorene label or Blue engraved letters on cover plate. Ivorene label glued with super glue or pop riveted to cover plate.	Black letters on white Ivorene label or Black engraved letters on cover plate. Ivorene label glued with super glue or pop riveted to cover plate.
Contents On Label	Distribution Board Number and Circuit number feeding the socket outlet as per example DBA/ P1/1	Distribution Board Number and Circuit number feeding the socket outlet as per example DB/E-A/ P1/1	Distribution Board Number and Circuit number feeding the socket outlet as per example DB/U – A / P1/1	Distribution Board Number and Circuit number feeding the socket outlet as per example DB-A/ PD1/1

POWER SOURCE	NORMAL	ESSENTIAL	UPS	DEDICATED This socket outlet shall be used for computer equipment only and shall not be on earth leakage units.
	Each socket outlet on a circuit shall be labelled.	Each socket outlet on a circuit shall be labelled.	Each socket outlet on a circuit shall be labelled.	Each socket outlet on a circuit shall be labelled.
Letter Size	3 mm	3 mm	3 mm	3 mm
Earth Pin	Round	Round	Round	Chamfered
Female Socket	White	White	White	Red

3.30. LIGHT SWITCHES

Switches shall comply with the requirements of these documents, shall have a rating of not less than 16A 240V and shall be suitable to break the load which is typical of LED luminaries. Light switches shall be of approved manufacture and shall bear a SABS mark. The position of the light switch must be 1 200 mm above floor finishing level (AFFL) or/and as per drawing. Light switches with waterproof housing must be provided and must be installed as shown on the drawings.

Light switch cover plates are to be provided with an engraved label or pop riveted to cover plate with black letters. Content on label shall be the distribution board number and circuit number feeding light switch, e.g. DBA/L1/1. Each light switch on a circuit shall be labelled. All switch covers must be metal steel.

All lighting circuit shall be wired with 2,5mm² conductors that is red, white or blue for live circuits, black conductors for neutral and green for earth.

Where applicable, lighting circuit shall be wired or connected with 2,5mm²-2core PVC/SWA/PVC Ecc copper cable. This shall be shown on the drawing.

POWER SOURCE	NORMAL	ESSENTIAL (Gen set)	UPS
Cover Plate Colour	White	White	White
Switch / toggle Colour	White	Red	Blue
Label Type	Black letters on white Ivorene label or Black engraved letters on cover plate. Ivorene label glued with super glue or pop riveted to cover plate.	White letters on red Ivorene label or Red engraved letters on cover plate. Ivorene label glued with super glue or pop riveted to cover plate.	White letters on blue Ivorene label or Blue engraved letters on cover plate. Ivorene label glued with super glue or pop riveted to cover plate.
Contents On Label	Distribution Board Number and Circuit number feeding the socket outlet as per example. DBA/ P1/1	Distribution Board Number and Circuit number feeding the switch as per example. DB/E-A / L1 Each socket outlet on a circuit shall be labelled.	Distribution Board Number and Circuit number feeding the switch as per example. DB/U – A / L1 Each socket outlet on a circuit shall be labelled.

POWER SOURCE	NORMAL	ESSENTIAL (Gen set)	UPS
	Each socket outlet on a circuit shall be labelled.		
Letter Size	3 mm	3 mm	3 mm

3.31. ISOLATORS

All welding/industrial isolators shall be 5 pin, 400V, 3-phase, neutral, earth and shall be weatherproof to IP65 standards. Other isolator (surface and or recessed) are 3-pole / 400V (32A, 60A, 100A); 1-pole (20A, 32A), etc. Colour to be as per the table below.

Isolators shall be connected with 16mm²-4core PVC/SWA/PVC ECC copper Cable or as per single line diagram.

All final connections shall comply with the requirements of SANS 10142-1.

Isolators shall IP65 weatherproof surface mounted isolators wall-mounted at ± 1 300 m AFFL or as indicated on the drawing.

POWER SOURCE	NORMAL	ESSENTIAL (Gen set)	UPS
Cover Plate Colour	White	White	White
Switch / toggle Colour	White	Red	Blue
Label Type	Black letters on white Ivorene label or Black	White letters on red Ivorene label or	White letters on blue Ivorene label or

POWER SOURCE	NORMAL	ESSENTIAL (Gen set)	UPS
	engraved letters on cover plate. Ivorene label glued with super glue or pop riveted to cover plate.	Red engraved letters on cover plate. Ivorene label glued with super glue or pop riveted to cover plate.	Blue engraved letters on cover plate. Ivorene label glued with super glue or pop riveted to cover plate.
Contents On Label	Distribution Board Number and Circuit number feeding the socket outlet as per example. DBA/ P1/1 Each socket outlet on a circuit shall be labelled.	Distribution Board Number and Circuit number feeding the switch as per example. DB/E-G/ S1 Each socket outlet on a circuit shall be labelled.	Distribution Board Number and Circuit number feeding the switch as per example. DB/U – G / S1 Each socket outlet on a circuit shall be labelled.
Letter Size	3 mm	3 mm	3 mm
Comments	n/a	Where red switches are not obtainable the illuminated type red switch may be used or a white switch may be used but the switch shall be tagged with a non-removable red sticker.	Where blue switches are not obtainable the illuminated type blue switch may be used or a white switch may be used but the switch shall be tagged with a non-removable blue sticker.

3.32. DESIGN DRAWINGS

The design drawings generally show the scope and extent of the proposed work and shall not be held as showing every minute detail of the work to be executed.

The position of power points, switches and light points that may be influenced by built-in furniture must be established on site, prior to these items being built in.

3.33. LOW VOLTAGE CABLE

The sizes and routes of low voltage cables are indicated on the drawings and in these documents.

Low voltage cables shall be PVC/SWA/PVC ECC type with copper conductors which shall comply with the requirements of SANS 1507 in those of the standard specifications, in all respects.

Cables shall bear the SABS mark. The supply, installation, termination, and jointing of cables shall comply with SANS 10198 and with the requirements of these documents. No jointing will be allowed in cables unless authorised by the Engineer.

3.33.1. Earth Conductors

Earthing shall comply with the requirements of the Supply Authority and SANS 10142-1 as amended.

3.34. CABLE GLANDS

All cable glands shall be of the SABS approved IP 65 rated and shall conform to SANS.

3.35. MARKING

The Contractor shall mark & label of all substation equipment. Supply and install laminated single line schematic diagram of the LV reticulation and state the feeder. Labelling with ID codes of all LV & control cable ends at substation. Supply and install new OHS Act signage & fire & resuscitation notices on MV and metering/LV rooms of substation.

Cables shall be labelled at all terminations with suitable and approved labels (stainless steel Dymo-tape or Irvine white ivorene label written in black) indicating:

- i) Origin and Destination; (e.g. from Meter room to DB - C)
- ii) Cable size and no. of cores; (e.g. 16 mm²-4-core)
- iii) Conductor type. (e.g. PVC/SWA/PVC Copper ECC cable)

3.36. CABLE ROUTES

The final cable routes shall be determined on site before installation commences. Concrete cable markers shall be installed along the cable routes where applicable.

3.37. CABLE TRAYS AND RACKS

All cable wireways, channels, trucking, ladders and trays shall be SABS manufacture and shall be hot deep galvanised steel finish.

All cable wireways, trunking, channels, trays, etc. shall be neatly and properly fixed, suspended, clamped or supported with hot deep galvanised steel finish mechanical support accessories specially engineered and manufactured as per detail specifications of the manufacturer.

All cable trays/racks/ladders exposed to view shall be provided with galvanised steel finish galvanised steel in-fill plates to prevent cables being visible from the bottom.

The Contractor shall note the minimum mounting height requirements of all ducting and wire ways.

Allowance must be made for the installation of a new heavy hot deep galvanised cable ladder that will support the cables as specified. This shall include all fixing materials, risers, bends and splice kits.

Description

Duty	:	Heavy
Material	:	hot deep galvanised
Span	:	6m with loading of 144 kg/m
Side rail	:	100mm high
Cross rung	:	150mm, 300mm,
Cable ladder width	:	As required + 20% spare capacity

3.38. LUMINAIRES

3.38.1. General

Luminaires which comply with the requirements of the standard and detail specifications of these documents shall be supplied and installed in accordance with these documents and/or drawings. The tender rates shall be for the type specified and if alternatives are offered it shall be under a covering letter submitted with the tender documents. The onus will be on the Contractor to prove that the alternatives are in all respects equal or better to the types specified by means of a supplying SABS approved photometric data.

Luminaire positions indicated on drawings are diagrammatic, and all positions, spacing, etc. must be determined in accordance with drawing.

3.38.2. Fixing Of Luminaires

Luminaires shall be installed in the position(s) indicated on the drawings. Final positions shall be determined by the engineer when in doubt.

3.38.3. Supply and Installation of Luminaires

The contractor shall allow for ordering, receiving, packing out, storing, mounting/fixing and final connections, of all the luminaires indicated on the drawings, in his tender sum.

No luminaires shall be ordered prior to the Engineer's official written approval.

3.38.4. Damage to Luminaires

All luminaires damaged by the contractor or his staff before first delivery shall be replaced with new luminaires at his own cost.

3.38.5. SANS Specification

Luminaires shall comply with the relevant SANS specification where such specification exists and shall carry the SANS mark of approval.

Where a SANS specification does not exist for complete luminaires, the accessories and control gear shall be SANS approved and carry the SANS mark of approval.

3.38.6. Photo-Electric Daylight Sensitive Switch

Exterior lighting shall be controlled by a photo-electric cell mounted against the exterior of the building with the unit positioned so that the extraneous light shall not affect its operation.

The unit shall comprise a photocell, thermal actuator and change-over switch, rated at not less than ten amperes (20A). The cover of the unit shall be manufactured from a tough, destruction resistant material for protection against tampering. The cover shall have good weather proofing properties, be ultraviolet resistant and shall not deteriorate when exposed to sunlight for prolonged periods. Switch contacts shall be silver plated and shall be capable of breaking the load associated with fluorescent lamp luminaires. Contact rating shall be not less than 10 A.

The operational level shall be factory preset for "ON" at a light level of approximately 54 LUX and "OFF" at approximately 108 LUX. Voltage variations shall not materially affect the operational levels.


A time delay of not less than 30 seconds shall be provided to prevent the unit from functioning due to lightning or other short period changes in illumination.

The unit shall be effectively safeguarded against surges by means of a suitable surge protector which shall preferably form an integral part of the unit.


Bypass switches shall be provided for exterior lights controlled via photocells so that testing and maintenance can be done at any time.

External lighting shall be controlled via a photocell mounted on a wall.

3.38.7. Schedule and Specification of Luminaires

TYPE	DESCRIPTION	TYPE
A5	<p>Surface mounted IP65 die-cast aluminium body luminaire +/-4440lm (30W) LED. Correlated colour temperature (CCT): Neutral white light (4000K) – 40W/ +/-4440lm. (+/- 10% tolerance of 4440-lumen may be acceptable upon Engineers approval), Operating hours / Lifetime LED 60 000 minimum.</p> <p>Must have a 10kA/10kV surge protection minimum. Impact resistance and Diffuser protection – IK08 minimum.</p> <p>The luminaire must consist of a high-impact polycarbonate with a robust clear polycarbonate diffuser and is designed to operate LEDs of 30W / +/-4440 lumen, 4000k. The luminaire must bear the standard code SANS 60598-2-1 safety mark. The body and diffuser must be designed in such a way to prevent collection of dust and moisture on the accessible surface of the body, thus also preventing any grip of the luminaire. The luminaire must be designed to allow entry of surface conduits via 20mm conduit or and 2,5mm 3 core cable threaded entries at both ends, as well as a 25mm hole in the centre of the back of the body. A silicone sponge gasket ensures reliable IP 65 rating. The</p>	

TYPE	DESCRIPTION	TYPE
	<p>one-piece, injection-moulded polycarbonate diffuser must be vandal resistant. It must be secured to the body by six stainless steel Allen head screws. The removable gear tray must be manufactured from stainless steel, powder coated white to optimise luminaire efficiency. All control gear components are mounted on the gear tray. The gear tray can be removed by loosening four Allen head screws in keyhole slots, which allow the gear tray to be relieved into a suspended position, ensuring ease of maintenance. All control gear components are removable and bear the relevant SABS mark. All screws, bolts and metal parts must be stainless steel or non-corrosive material. Mains connections are by means of a suitable screw terminal block with a wire clamping contact. The luminaire must have an electronic temperature monitoring prevents overheating of LEDs and power supply. Power factor $\geq 0,95$.</p> <p>Uniform luminance with low glare due to prismatic diffuser design. Long service life: over 60 000 hours (L70B10). No ingress of dust and moisture into the LED and controller compartment - IP 65</p> <p>The fitting shall be tested and comply with the requirements of SANS IEC 60598:1</p> <p>Must have a 5-years warrantee.</p>	
A6	Same specification and requirements as type A5 above but shall have a back-up battery to operate for 1 hour.	

TYPE	DESCRIPTION	TYPE
C6	<p>LED streetlight +/- 10 000lumen (80W) (+/- 10% tolerance of 10 000-lumen may be acceptable upon Engineers approval), (4000K) with aluminium body, IP66. +/- 10 000 lumen, Wattage may differ from supplier to supplier. LED lifetime of 100 000hrs and Driver lifetime 100 000-hours.</p> <p>Must have a 10kA/10kV surge protection minimum. High-impact polycarbonate and Diffuser protection – IK10 minimum.</p> <p>Contractor to allow for PRASA selective colour – Blue colour – to be confirm on luminaire approval. The fitting to include sensor, for dimming at night and activated by the motion or movement.</p> <p>The luminaire shall consist of an LED engine, power supply and spigot compartment. This should allow the easy installation of the LED engine by means of a hinging action onto a spigot base casting, with incorporated levelling device. It shall be secured by stainless steel latches and an access screw. The LED engine, consisting of the LED light source and the power supply, to be easily replaced or upgraded. Both compartments shall be rated IP 65. Electronic temperature monitoring prevents overheating of LEDs and power supply, positioned directly next to LEDs (ThermiX®). The power supply shall be automatically disengaged when opening the luminaire. The luminaire housing must be manufactured of marine grade aluminium. These shall be installed on a hot dipped galvanised steel pole. Contractor to make allowance for pole mounting. The LED lifetime of 100 000hrs (LED lifetime and Driver), (L90B10).</p>	

TYPE	DESCRIPTION	TYPE
	Must have a 5-years warrantee.	

NB: All luminaires must have a 1,5mm² cabtyre cable / conductor which is 1,5m long and must have 3-pin socket. The contractor shall install an unplugged socket for each internal luminaire on the trunking. All light luminaires / fittings must bear SANS approval.

3.38.8. Three-Phase Energy Logger

Energy Analyzer, Electrical Network Analyzer, Power Quality Analyzer, Energy Meter – Including Analysis Templates. This is a meter and log a building's energy for a period of time e.g. an hour, a week, or one month to get all the data you need.

This handheld three-phase power quality analyser uses external Rogowski (or similar) coils and voltage-sensing clamps. The flexible coils shall be easy to install. The coils can easily be opened and closed, so no need to disconnect any wires. The voltage-sensing clamps can easily be clamped on, so no need to switch off power. The meter shall easily be installed without any power interruptions.

3.39. EARTHING AND LIGHTNING PROTECTION

3.39.1. Earthing

The entire installation shall be properly and effectively earthed as prescribed in the Wiring Regulations and to the requirements of the relevant supply authority.

The plant earthing system and main earth bus bar shall be tested for 10 Ohm. If the amount does not reach additional earthing equipment shall be installed by the Contractor. Earthing and bonding of the new transformer shall consist of 70mm² copper earth wire and 16mm diameter stainless steel core copper coated earth rods.

The earthing installation shall be integrated with the instrumentation system earth and all other services.

The Contractor, however, will be responsible for the equipotential bonding of installed equipment, e.g. transformers, mechanical equipment, pumps, electrical equipment, cable ladders etc.

The connections for the 70mm² multi-stranded conductors shall be based on M10, high tensile, stainless bolts and nuts or equivalent. The minimum size bolts permitted for connections below 70mm², i.e. 16mm², shall be M8.

The Contractor shall provide these as well as the 70mm² green/yellow insulated conductor from the main earth loop.

The main cable support system as provided by the Contractor may also be used to support these conductors in the most economical route.

Under no circumstances shall any connection points, bolts, screws, etc., used for earthing be utilised for any other purpose.

It will be the responsibility of the Contractor to supply and fit earth terminals or clamps on Goods and Materials that must be earthed where these are not provided. Unless earth conductors are connected to proper terminals, the end shall be tinned and lugged. Earth conductors for individual circuits branching from the ring main shall be connected to the common earth conductor by means of exothermic welds. Insulation tape shall be used to cover all exposed metal, and a PVC cable tie strapped over the tape ends to prevent unwrapping. The common earth shall not be broken.

Earth conductors shall be connected to the earth rod by means of Exothermic Welds. Insulation tape shall be used to cover all exposed metal, and a PVC cable tie strapped over the tape ends to prevent unwrapping.

All rods shall be threaded at either end so that extensions can be added to where deep driven installations are required. All connections shall be taped or waterproofed to ensure that corrosion does not affect the joint during the life of the installation.

The rods shall be supplied complete with a driving bolt for protecting the ends of the coupling whilst being driven into the ground.

3.40. EARTHING & BONDING

The Contractor is to ensure that all earthing and bonding is carried out in accordance with SANS 10142, PRASA standard specifications and the local authority's requirements. The earthing installation is to be carried out by a specialist.

The Contractor should note that as this installation is a Class II Division 2, all metal parts, and equipment are to be earthed and bonded to eliminate static build up. An earth mat is to be installed and the Contractor shall allow for a survey by a specialist and installation of it according to the relevant SANS code. The Contractor shall submit all test results to the Project Manager.

The Contractor shall install an earth point on all motors and metal structures in the PRASA buildings and or where applicable.

A schedule of the work shall be carried out by an Earthing Specialist.

Earthing shall be provided for the LV installation equipment.

The earthing shall be carried out by a specialist and comply with SANS 61024 Parts 1 and 2.

3.41. LIGHTNING PROTECTION TESTING AND COMMISSIONING

The entire installation shall be tested and commissioned in the presence of the Engineer. On completion and handover "As Built" drawing and test results (COC) shall be handed over to the Engineer. The drawings shall depict the location on the earth rods and mats and their respective readings.

3.42. DRAWINGS

The Contractor produces the detailed layout design and individual wiring diagrams for each starter / panel in AutoCAD format fully in compliance with the Project Manager's requirements. All drawings are to be submitted for approval prior to the start of manufacture.

In addition, the Contractor submits all cable pulling schedules, termination schedules as well as lightning protection and earthing system designs, for approval. Any installation or manufacture of equipment prior to the approval of drawings is entirely at the Contractor's own

risk. Similarly, the cable numbering systems, plant ID numbers and tag numbers will be in accordance with the Employer's requirements.

3.43. PHOTOVOLTAIC SOLAR SYSTEM

a) General

The contractor shall provide the detail design, manufacture, supply, delivery, installation, testing and commissioning of the photovoltaic (PV) solar system as specified.

This shall be a photovoltaic solar system (PV system) and shall generally comprise of solar inverters, inverter-chargers, lithium-ion batteries, solar modules, isolating and protection equipment, associated cabling, and a monitoring system. The System must be digital enable and shall be monitored and integrated with Building Management System (BMS).

The Photovoltaic Solar plant must be capable of generating approximately 1250 kVA / approximately 1000kWp, 3-phase, 400VAC at 50Hz. The system shall be linked with backup generator set as indicated on the drawings.

The summary scope is not limited to the following:

- Assessment of the site
- Verify design and produce detailed designs/shop drawings approved solar panels.
- Detailed Construction drawings of the PV system
- Co-ordination with Engineer and client for approval and acceptance of design drawings
- Supply, delivery, installation, test, and commissioning of the PV solar system
- A 12-month Free Maintenance after hand over
- A 36-month Contract for maintenance, service of the solar system and generator
- Contractor shall issue a list of equipment with prices to be used for any replacement of the generally problematic equipment.

b) Solar Plant - Technical Specification

Photovoltaic (PV) Capability

The PV capacity of 1000 KWP (One Thousand kilowatt) system. The DC capacity is the sum of nominal power of all modules (defined at STC) to be installed.

Photovoltaic (PV) Module

- The solar panel minimum wattage shall be 650W.
- Supply and install the PV Modules to achieve the specified levels of performance for the required design life of 25 years under the prevailing site environmental conditions to be determined.
- PV Modules technology is either of crystalline silicon (c-Si) type. All PV modules supplied for the Plant are of the same type, size and from a single manufacturer.
- The panel shall be off Grade-A. A certification from the manufacture / supplier shall be submitted before delivery of solar panels on site.
- The module manufacturer complies with followings.
 - Has been producing PV modules commercially for last five years,
 - Has an experience in minimum of 5 MWp cumulative capacities in PV installation.
 - Produce a Tier 1 solar panels
- The PV modules minimum guarantees from the manufacturer are.
 - Power Output Warranty: maximum power output degradation of 10% and 20% of rated peak power respectively for 10 years and 25 years operational period.
 - Linear Degradation: first year degradation not more than 3.0% and linear degradation from second year and onwards not more than 0.75% per year.
 - Workmanship guarantee: Product guarantee against manufacturing defects for a minimum of 10 years.
 - Positive tolerance: rated power output tolerance must be positive e.g. 0/+5%.

- The module rated peak power (defined at STC condition) is used to determine the peak power of the Plant. The peak power is the sum of the manufacturer's name plate data sheets for each individual module.
- The flash test data from manufacturer (measurement according to IEC 60904 part I) for each module to be installed in the project. The sum of power in flash test data is equal to or higher than peak power of the Plant.
- All modules to have valid industry standard certifications; IEC 61215 and IEC 61730, issued by reputable testing institutions according to IEC.
- The module arrangements to be decided to minimize the losses due to mismatching. Proper sorting method and only modules from the same set is used in in the same string.
- All transportation, storage, handling, and installation of the modules to be in accordance with the specifications from the manufacturer, as to not to void the module manufacturer's warranty.

Solar Panels
Minimum Requirements. Must be the same or higher
Peak power (Pmax): 650W or higher
Mono-crystalline type
Efficiency - 20% minimum
Open Circuit Voltage (Voc): 45.9V
Max Power Voltage (Vmp): 41.77V
Short Circuit Current (Isc): 18.57A
Max Power Current (Imp) : 15.57A
Power Selection: 0 ~+ 5W
Power tolerance - +/-5 W

Solar Panels	
Minimum Requirements. Must be the same or higher	
IEC 61215-1/1-11-2;2016 and IEC 6173D-1/2;2016	
Safety class based on IEC 61140: Class II	
Maximum System voltage: 1000V or higher	
Maximum Over current protection Rating: 25A	
Power Production tolerance: +_3%	
Open circuit voltage Tolerance: +_2%	
Short Circuit Current tolerance: +_4%	
Fire performance - Class C as per IEC 61730	
Front cover - 3.2 mm tempered glass	
Frame - Anodized aluminium alloy, crossbar enhanced	
Application class – A	
Junction box - IP68, 3 bypass diodes.	
Temperature Co-efficient = -0.37 % (Pmax), -0.29 % (VOC) and 0.05 % (ISC)	
Operating temperature - 40 to +85 degrees Celsius	

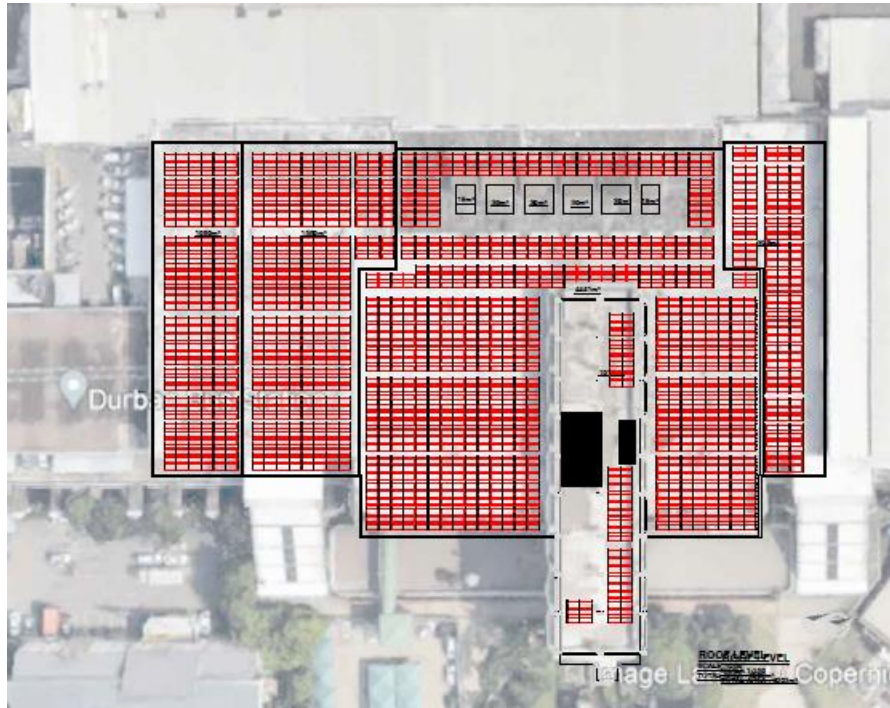


Figure 3: Solar Panels at 99-Steps Rooftop Durban Station

DC Combiner box

- The DC combiner boxes are designed for use for external condition with a design lifetime of 25 years.
- The combiner box includes string fuse for each string. The fuse rating is sized according to the requirement from module and inverter manufacturer.
- The DC combiner box includes lightning current and overvoltage surge arrestor.
- The DC combiner box includes array on-load disconnect switch, which is accessible without opening the combiner box. This switch allows for isolating array connected to box for maintenance and emergency purpose and is lockable.
- The combiner boxes are equipped with sun shields were exposed to direct sunlight. To prevent overheating inside the boxes, reduced terminal occupancy is considered. The place of installation location must be easily accessible and offer a secure base for working on the device.

- The cable labelling and single line diagram of connections inside the combiner box is kept on each combiner box.
- The combiner box shall be minimum IP65.

Inverters and inverter-charger

- Selects Inverters with proven track records in terms of performance and operation.
- Provide an inverter arrangement that gives overall optimal energy yield over the life of the Project, considering the site conditions and the proposed module layouts.
- All inverters installed are of same type, size and from a single manufacturer.
- Inverters selected for the installation to conform to the following specifications.
 - Inverter is selected with respect to local climatic and environmental condition and is equipped to operate in high temperature region,
 - The inverter power is not derated for the temperature range between -10°C and +40°C.
- Inverters selected for the installation has a minimum of 5 years product guarantee against manufacturing defects.
- Inverters can log performance parameters (input power, output power). The data storage management process and stores the operating data of the inverter.
- The inverter manufacturer's warranties for the site-specific environment and installation type to be confirmed.
- The inverters comply with all relevant national and international certificate labels and suitable of installation in South Africa.
- All transportation, storage, handling, and installation of the inverters are in accordance with the specifications from the manufacturer, as to not to void the inverter manufacturer's warranty.
- The solar inverters shall be of 250KWp.
- The Inverter-charger shall be of 500KWp.

The solar inverters shall be installed on the load side of the inverter-chargers and must comply with the following:

Provision of 250KWp required inverters to meet the minimum specification.

INVERTERS		
Item No.	Description	Minimum Requirements
1	AC (Grid-connected)	
1,1	Apparent power	275kVA
1,2	Rated power	250kW
	Grid voltage	380VAC - 400VAC
1,3	Rated voltage	400V
1,4	Rated current	361A per Inverter
1,5	Voltage range	360V - 440V
1,6	Rated frequency	50/60Hz
1,7	Frequency range	45~55/55~65Hz
1,8	THDI	<3%
1,9	PF	0.8lagging - 0.8leading
1,10	AC connection	Three phase 4-wire + protective earth
1,11	AC input	275kVA
1,12	Adjustable grid code selection	Yes
1,13	Transformer less topology	Yes
1,14	DC/AC output converter	True three-phase bridge topology
1,15	AC connection type	Aluminium and copper up to 240mm ²
1,16	Anti-islanding protection	Yes
1,17	Efficiency	98,40%
1,18	Night consumption	< 0.6 W
1,19	Wireless remote monitoring	Yes, with Wi-Fi logger card
1,20	User interface	4 x LED & web interface
2	DC (Battery and PV)	
2,1	Max. PV open-circuit voltage	1000V DC
2,2	Max. PV power	250kWp

INVERTERS		
Item No.	Description	Minimum Requirements
2,3	PV MPPT voltage range	480V - 8050V DC
2,4	Number of independent MPPT	Minimum 6 per inverter
2,5	DC input pairs per MPPT	4
2,6	DC switch rating per MPPT	50A or higher
2,7	Max DC input power	17500kW per MPPT
2,8	Battery voltage range at Max. charge power	500V - 600V
2,9	Battery voltage range	352-600V
2,10	Max. charge power	275kW
2,11	Max. discharge power	250kW
2,12	Max. charge current	550A
2,13	Max. discharge current	550A
2,14	Reverse polarity protection	Yes
2,15	Lifetime free online monitoring	Yes
2,16	DC input individual current monitor	Yes (individual string current monitoring)
3	General Information	
3,1	Protection degree	IP54
3,2	Noise emission	<65dB(A)@1m
3,3	Operating temperature	-25 °C~+60 °C
3,4	Cooling	Forced air
3,5	Relative humidity	0-95% non-condensing
3,6	Maximum operating altitude	2000 m without derating
3,7	Dimension (W/H/D)	1200/1900/800mm
3,8	Weight	1025kg
3,9	Build-in transformer	Yes
3,10	Transfer between on/off grid	Automatic≤10ms
3,11	Standby consumption	<30W
3,12	Detachable wiring box	Yes
3,13	Relative humidity	0 to 100 % condensing
3,14	Cooling	Forced air
3,15	Input and output surge protection	Yes, pluggable Type 2, monitored

INVERTERS		
Item No.	Description	Minimum Requirements
3,16	Photovoltaic array isolation control	as per IEC 62109
3,17	Safety standard	IEC 62109-1 & 2
4	Communication	
4,1	Display	Touch screen
4,2	Communication	RS485/CAN or similar

AC combiner panel

AC combiner panels will have individual incoming circuit breakers for each solar inverter. The incoming circuit breakers shall have isolation behaviour and be suitably selected to allow spare capacity when compared to the solar inverter output as well as being correctly selected to protect the AC cable.

The AC combiner panel shall be fitted with busbars to combine the incoming AC circuits before entering the main output AC circuit breaker. The busbars shall be rated at 1.6 A/ mm² and be suitably supported for the site-specific prospective fault current (short-circuit current).

Neutral and earth bars will be of the same rating as the phase busbars. All busbars and wiring shall be adequately rated and suitably supported. The minimum busbar fault current rating shall be 10 kA.

The main output AC circuit breaker shall have isolation behaviour. Suitable busbar extensions shall be fitted to the circuit breaker for easy termination / connection of the outgoing AC cabling.

The AC combiner panel shall be fitted with a power meter on the main output AC circuit breaker that measure current, voltage, power factor, kVA, kW, kVAr as well as maximum values.

Solar modules and installation

Solar modules must be the mono-crystalline type and comply with the following:

- Maximum system voltage : 1000 V
- Efficiency : 20% minimum
- Fire performance : Class C as per IEC 61730
- Tier rating : 1
- Application class : A
- Power tolerance : +/- 5 W
- Cell arrangement : 144
- Front cover : 3.2 mm tempered glass
- Frame : Anodized aluminium alloy, crossbar enhanced
- Junction box : IP68, 3 bypass diodes.
- Cable : 4 or 6 mm²
- Connector : T4 series
- Temperature Co-efficient : -0.37 % (Pmax), -0.29 % (VOC) and 0.05 % (ISC)
- Operating temperature : -40 to +85 degrees Celsius

All panels must be tested individually, and certificates issued to guarantee the objective plant performance of 1000kWp.

Bidders must provide solar panel that are same or higher of the above specification. This is linked and depends on the proposed structure and required supply.

The solar modules shall be installed on a suitable mounting system. The mounting system shall be certified and have appropriate installation instructions. Weather conditions must be

considered when the mounting system is designed to match the installation site's weather conditions.

Solar modules must be installed in neatly arranged rows with consideration for cleaning, servicing, and maintenance. For this reason, access paths must be included in the design. A maximum linear string must have an access path every 50m. The design must be submitted for approval to the engineer prior to ordering and installation of any equipment.

Where appropriate, permanent safety lines or anchors for temporary safety line must be included in the design and the Contractors offer.

Inverter-Charger

Three phase inverter-chargers must comply with the following:

- Inverter size : 500kW / as per designs
- Parallel operation possibility : Yes
- Power control : Yes
- Remote monitoring : Yes
- Remote control : Yes
- Remote configuration : Yes (with configurable access levels)
- AC Input voltage range : 360V to 440V
- AC Input frequency : 45Hz to 65Hz
- DC Input voltage range : 600V to 900V
- DC Charge current : 722A
- Safety standard : IEC 62109-1/2
- Efficiency : 98.5 %
- IP rating : 20

- Anti-islanding : Yes
- Overload capacity : 110% for 10min / 120% for 1min
- Cooling : Forced air
- Maximum altitude : 6000m
- Interface : Touch screen HMI

Cabling

- The installation of power and control cables and execution of associated work is in accordance with relevant SANS Standards and cables are SABS approved.
- All cables in the Plant are fastened adequately to avoid swinging and tension and durable mounted in such a way as to protect them from rodent attack, weathering and UV radiation.
- All cables are uniquely numbered (permanent labelling) to facilitate later traceability & fault location. Circuits and cables are planned and installed to ensure accessibility and ease of maintenance.
- Electrical conductors are selected with an insulation level applicable to the system voltage for which they are used and capacities suitable for the load being served. The type of cable used is determined by individual circuit requirements and individual equipment manufacturer's recommendations. Current carrying conductors are either copper or aluminium.

DC Connectors

- Modules connectors and DC cables connectors are compatible and from the same manufacturer throughout the project.
- To use cables with connectors which are contact-proof and designed to avoid corrosion.

DC cabling and installation shall comply with the following:

- DC cable standard : IEC 62930
- Installation standard : IEC 60364-4
- DC voltage rating : 1000 V
- Cable size : 4 or 6 mm²
- Connectors : T4
- Junction boxes : IP65, UV and weatherproof
- Cable installation: on roof : Below solar modules allowed.
- Cable installation: from solar modules to DC isolators: Galvanized conduit
- Cable installation : Earth- and short-circuit proof.
- Cable installation : UV and weatherproof
- Parallel strings : Fused on positive and negative
poles with PV rated DC fuses.
- Field array enclosures : Must include surge protection and
fuse protection of strings.
- Earthing : Galvanized conduits to be bonded
with earth strapping
- Earthing : All solar modules to have
individual earth wires to structure
- Earthing : Mounting structure to be earthed
with minimum 16 mm² wire

All connections and extensions to be done with T4 connectors. No joining or extending of solar cable to be done with terminals or strip connectors.

Lithium-Ion Battery and container equipment

A containerised fully enclosed stackable lithium iron phosphate batteries will be installed. A potential for future expansion for added batteries to accommodate Solar plant expansion (30% spare space) at Durban Stations. As charging and discharging voltages and currents are critical to batteries these must be considered in the selection of the battery. The battery backup time to be sized for 2-hours full load for a 1000kW plant.

The battery shall be Lithium-Ion (LiFe) that operates for minimum 10 000 cycles, 80% Depth of Discharge (DoD), and or 5500 cycles at 50% DoD and minimum of 10-years lifespan. The maximum load duration shall be 5 minutes per 30-minute cycle, 2 x maximum overload to handle for 2 seconds. The fly leads minimum to be 1800mm long, power cable Red – positive, black – negative.

Each PCS with 500kWh rated capacity (maximum power 600kW) 400 Vac (1600 x 1050 x 2050 (W x D x H, mm)) including transformer and static switch. Including DC/DC cabinet with 10 MPPT modules and an EMS (with HMI screen with remote control and platform) (600 x 720 x 2050 (W x D x H, mm)). BESS of 1290kW (scalable) All included in a 20ft (6.096m) IP54 grade container with forced air cooling, transfer switches, smoke alarm and firefighting, auxiliary power supply, lighting and UPS and DC confluence controller and distribution cabinet. UN3536 certified.

Other key points:

- 24/7 monitoring – locally and remotely
- Onsite commissioning
- Local field service technicians
- Local & live training by the OEM
- 10-year warranty on battery and inverter
- PRASA energy department seeks to also conduct a “FAT” Factory acceptance Test during building and stacking of containerized battery banks.

The battery shall comply with the following:

Nominal voltage - 2-Hour's backup supply for a 1000KWp solar plant, (1000 kWp battery storage capacity, 80% DOD)

- Nominal voltage : 512-800V (to suit inverter-charger)
- Charge / Discharge current : to meet recharge design criteria.
- Cooling fan : No
- Enclosure : Heavy duty custom made; powder coated
- External interface : CAN Bus
- Protection : Circuit breaker with shunt
- Remote tripping over CAN Bus : Yes
- Manual reset : Yes
- Cell under- & over voltage protection : Yes
- Built-in temperature protection : Yes
- Minimum SOC control : Yes
- Human machine interface : Yes, with 0-100% state of charge indication
- Wi-Fi remote monitoring : Yes
- Warranty : minimum +10 years / 10 000 cycles, 80% DoD
- Service life : >20 years at low cycle
- Mounting : Floor standing

The following shall form part of the battery equipment.

- **Control interface** - RJ45 Socket x 2 – CAN Bus for Interfacing with Compatible Inverters and System Controllers, connection of parallel batteries.
- **Protection** - Shunt Trip Circuit Breaker sized to suit max current, can be tripped by BMS if critical fault, manual reset. Includes overcurrent, cell under and over voltage, temperature, weak cell detection, minimum SOC control.
- **Human Interface** - State of Charge Display (0 to 100%), Error light, Error Reset Button, Serial RS232 Plug for Programming (note the Lite 80/56 has a CAN port for programming and not a serial port), Wi-Fi remote monitoring.
- **Warranty** - 10 years or 10 000 cycles for average 80% DoD, and max 90% DoD
- **Service Life** - >16 years (>10 000 cycles) expected life at 80% DoD (1), >20 years (>5 500 cycles) at 50% DoD.
- **Essential Accessories** – These shall be required for battery connection to the PC - Lite 5/4 up to Lite 60/42 - Serial RS232 to USB adapter (must be the brand supplied by same supply that supplies the batteries). Adapter as per the battery supplier (must be the brand supplier that supplies the batteries and shall be supplied with battery). CAN Bus Termination Resistor (as per the battery supplier) – one required per battery, must be the brand supplied by same supply that supplies the batteries) and must be included with the battery package.

Lithium-Ion Battery	
Description	Requirements
Battery Size	2 -Hour's backup supply for a 1000kWp solar plant, (1000 kWp battery storage capacity, 80% DOD)
Nominal voltage	512-800V
Enclosure	Containerised PRASA branded as per PM, Heavy duty custom made; powder coated

Lithium-Ion Battery	
Description	Requirements
External interface	CAN Bus
Protection	Circuit breaker with shunt
Remote tripping over CAN Bus	Yes
Manual reset	Yes
Cell under- & over voltage protection	Yes
Built-in temperature protection	Yes
Minimum SOC control	Yes
Human machine interface	Yes, with 0-100% state of charge indication
Wi-Fi remote monitoring	Yes
Warranty / Lifetime	Minimum + 10 years / 10 000 cycles at 50% DoD or 5 500 cycles at 50% DoD
Mounting	Floor standing = Containerised

- This site shall provide the batteries and inverters installed in a container, as indicated below.

Earthing

- Earthing system for the PV Plant that eliminates the risk to personnel or animals of electric shock under normal operating conditions as well as fault conditions.

Furthermore, the earthing system ensures the functionality of electrical protection equipment during electrical faults.

- The designs of the earthing system in accordance with Solar PV industry best practice and in compliance with SANS 10200:1985 and SANS 10292:2001.

q) Site Acceptance Test (SAT)

The Contractor will have a dedicated test sheet for testing the system that must be completed during the SAT. This test sheet shall include voltage measurements (AC and DC), current measurements (AC and DC) and frequency. The readings must be recorded and signed off by a trade-tested electrician.

The SAT shall include a full battery test that include discharge and re-charge cycles.

Prior to the SAT all labelling will be fitted indicating the function and isolation points as specified.

r) Drawings

The Contractor shall submit drawings / information for approval prior to placing orders on suppliers / delivery to site:

- a) Inverter-charger details
- b) Solar inverter
- c) Battery details
- d) DC combiner details
- e) DC isolation with surge protection details
- f) AC input and output isolator details
- g) Equipment lists.
- h) Solar module layout

- i) DC cabling details
- j) Solar module details
- k) Mounting system details
- l) Design details showing voltage and power calculations.
- m) Detailed Design report
- n) Design confirmation using dedicated solar design software.
- o) AC tie-in
- p) AC and DC wiring schematic
- q) Recommended spare parts.

s) Operating and Maintenance Manuals

The contractor shall supply three complete, comprehensive sets of operating and maintenance manuals containing all design and drawing information as listed above.

The above manuals are to be handed to the Employer's authorised representative on completion of the site acceptance test.

t) Warranty – Minimum Requirements

All the equipment's shall carry a minimum of warranty period as indicated below or as detailed on each related specifications document of each equipment. The contractor shall be responsible and shall fix, repair, service and or maintain the equipment within the first 12 months period after the hand over to the client.

- General workmanship : 12 months

- Electrical equipment and material (AC and DC) : 12 months
- Solar modules : 25-year product
- : 10-year performance
- Inverter-charger : 10 years
- Inverters : 12 months
- Lithium iron phosphate battery : 10 years / 10 000 cycles
- Transformers : 12 months
- Electrical Panels (MV and LV panels) : 12 months

The Contractor shall provide the warranties above on the system for the indicated periods, starting from the date of hand-over. During the warranty periods, the Contractor shall repair any defective material, equipment or workmanship (excepting proven, wilful or accidental damage, or reasonable wear and tear). These shall be made good with all possible speed at the Contractors expense and to the satisfaction of the Project Manager / Engineer.

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

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

The Project Manager / Employer reserves the right to demand replacement or making good by the Contractor at his / her own expense of any part of the contract which is shown to have

any latent defects or not to have complied with the specification, notwithstanding that such work has been taken over or that the guarantee period has expired.

Should any specified materials or equipment in the Contractor's opinion be of inferior quality, or be unsuitably employed, rated or loaded, the Contractor shall prior to the submission of his quotation advise the Employer accordingly. His / Her failure to do so shall mean that he / she guarantees the work including all materials or equipment as specified.

u) Co-ordination

Due to the nature of the installation, a fixed sequence of operation is required to properly install the complete PV system. The work shall be closely scheduled in order not to delay the entire project.

The Contractor shall be responsible for all the requirements and execution of the other trades and shall examine the plant and specification covering each of these sections.

v) Drawings

The Contractor shall issue design drawing for acceptance by the Project Manager/Engineer. Once the designs have been accepted, the Contractor shall issue detailed construction drawings and list of material in a form of bill of quantities.

The drawings must be signed off by the respective discipline ECSA professional registered engineer or ECSA professional registered technologist.

w) Schedule of Information / Compliance Document

(Returnable Document)

The Contractor must sign and return the compliance document. Failure to do so will automatically lead to disqualification of the submitted quotations.

** The Contractor to indicate Yes or No to confirm compliance to specification **

Description	Response (Yes / No)
Solar modules	
Mounting system	
DC cabling and installation	
AC cabling and installation	
Inverter-charger	
Solar inverter(s)	
Lithium iron phosphate battery	
Bypass facility	
DC isolation with pluggable and monitored surge protection	
DC current monitoring on solar inverter(s)	
AC input isolation with surge protection	
AC output isolation with surge protection	
AC output isolation with Type B RCD	
By-pass switch included	
Monitoring system	
Battery recharge less than two hours	
Design requirements	
ECSA accredited / registered (Pr Eng / Pr Tech Eng) sign off	
Health & Safety file allowed for	
Site acceptance testing allow for	
Customer hand-over and training allow for	
Anti-islanding NRS and SANS approved	
Guarantee	

x) Test Certificates and Inspections

After completion of the works and before first delivery is taken, a full test will be carried out on the installation for a period of sufficient duration to determine the satisfactory working thereof. During this period the installation will be inspected, and the Contractor shall make good, to the satisfaction of the Engineer, any defects which may arise.

The Contractor shall provide all instruments and equipment required for testing and any water, power and fuel required for the commissioning and testing of the installation at completion.

y) Guarantee and Maintenance

The Contractor shall guarantee the complete plant for a period of twelve (12) months after the first delivery has taken place.

If during this period the plant is not in working order, or not working satisfactorily owing to faulty material, design or workmanship, the Contractor will be notified, and immediate steps shall be taken by him to rectify the defects and/or replace the affected parts on site at his own expense.

The Contractor shall maintain the plant in good working condition for the full twelve months period to the final delivery of the installation. However, should the Contractor fail to hand over the plant in good working order on the expiry of the specified twelve months, the Contractor shall be responsible for further monthly maintenance until final delivery is taken.

z) Materials and Workmanship

The work throughout shall be executed to the highest standards and to the entire satisfaction of the Engineer who shall interpret the meaning of the Contract Document and shall have the authority to reject any work and materials, which, in his judgement, are not in full accordance therewith. All condemned material and workmanship shall be replaced or rectified as directed and approved by the Project Manager / Engineer.

All work shall be executed in a first-class manner by qualified tradesman.

The Contractor shall warrant that the materials and workmanship shall be of the highest grade, that the equipment shall be installed in a practical and first-class manner in accordance with the best practices and ready and complete for full operation. It is specifically intended that all material or labour which is usually provided as part of such equipment as is called for and which is necessary for its proper completion and operation shall be provided without additional cost whether or not shown or described in the Contract Document.

The Contractor shall thoroughly acquaint himself / herself with the work involved and shall verify on site all measurements necessary for proper installation work. The Contractor shall also be prepared to promptly furnish any information relating to his own work as may be necessary for the proper installation work and shall co-operate with and co-ordinate the work of others as may be applicable.

- All components and their respective adjustment, which do not form part of the equipment installation work but influence the optimum and safe operation of the equipment shall be considered to form part of and shall be included in the *Contractor's* scope of works.
- All control equipment and serviceable items shall be installed and positioned such that they will be accessible and maintainable.
- The Contractor shall make sure that all safety regulations and measures are applied and enforced during the installation and guarantee periods to ensure the safety of the public and the User Client.
- Wherever applicable the material is to comply with the relevant South African Bureau of Standards specifications, or the International standards, where no SABS specifications exist.
- Material wherever possible, must be of South African manufacture.

aa) Spare Parts List

Tenderers shall complete the following schedule, listing and pricing all plant parts which are likely to require replacement and giving the Tenderers recommendation as to the stocks of

spares that should be held by the owner. Unless otherwise stated prices shall be deemed to be inclusive of VAT and shall hold good for the duration of the Contract.

PLANT ITEM	SPARE PART DESCRIPTION	RECOMMENDED STOCKS	PRICE EACH DELIVERED TO WORKS
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			

PLANT ITEM	SPARE PART DESCRIPTION	RECOMMENDED STOCKS	PRICE EACH DELIVERED TO WORKS
18			
19			
20			

SIGNATURE: _____ DATE:

ab) The Maintenance and Inspection check list

The following are the requirements for maintenance and inspection for the solar plant. The list is not limited to the items below.

Inspection checklist

1. Photovoltaic modules (Solar panels)
 - Inspect modules for damage.
 - Address array shading issues.
 - Adjust array tilt for optimal sun exposure.
2. Balance of System
 - Check screw connections for tightness.
 - Inspect and clean all electrical equipment.
 - Inspect array mounting system for any issues, fix if not aligned.
3. Mounting systems
 - Ensure proper functioning of the solar panel mounting system.
 - Check for cracks or damage.
4. Combiner box
 - Verify the tightness of electric connections.
 - Inspect for any signs of damage or wear.
5. Solar charge controllers
 - Check the functioning of solar charge controllers.

- Inspect for any visible damage.
- Batteries for Solar Electric Systems:
- Load-test batteries to assess performance.
- Inspect battery enclosure for any issues.
- Inspect battery terminals and connections.
- Clean battery terminal points

6. Solar inverters

- Inspect the interior cabinet for dust or debris.
- Verify proper functioning of the inverter.
- Check for any signs of damage.

7. DC and AC disconnects

- Inspect and ensure proper functioning of disconnects.

8. Additional checks

- Check the fan functioning within the system.
- Inspect the array for any damage or wear.
- Address any visible cracks or structural issues.

A report shall be produced and submitted every quarter for the duration of the maintenance period.

Contractor shall be available on a call-out, to respond within or less than 2-hours on a call out to attend to any issued related to the solar plant, this forms part of the 36-months contract.

4.3.4 GENERATOR PLANT SPECIFICATION

The Standard for Uniformity in Construction Procurement published in terms of the Construction Industry Development Board (CIDB) Act, 2000 (Act no. 38 of 2000) / latest document, the Standardized Construction Procurement Documents for Engineering and Construction Works as issued by the CIDB and any other relevant documentation pertaining thereto must be studied and all principles in this regard must be applied to all procurement documentation, practices and procedures.

The Contractor, under this contract, shall supply, install, and commission a new diesel emergency generating plant to provide emergency power to PRASA Durban station. The list is as follows:

- 1x1250kVA, 400V diesel generator sets - containerised, 3CR12 housing and base
- The generator set must include sound attenuator

The generator must be suitable for coastal environments.

It is a specific requirement of this enquiry that the successful contractor must have permanent premises situated in a suitable geographic location in order to provide a standby response of two hours maximum to the respective train station as per the bill of quantities.

Tenderers are to note that typical basic standard offers by their suppliers will not be acceptable. All offers must be fully in accordance with the specifications in these tender documents inclusive of all extra items specified.

The scope of work is to procure, manufacture, supply, store, assemble, deliver, install, test and commission, guarantee and maintain for first 12 months a new (as indicated on the Bill of quantities of the station), 230VAC/ 400VAC, 50 Hz emergency generator for the respective train station as indicated on the Bill of Quantities, which will enable the plant to provide a reliable system of emergency power should the normal mains power supply fail at the respective train station as per the bill of quantities. The generator shall have a guarantee of

12 months or 1200 hours, whichever comes first from the hand over date. During that first 12 months contractor shall provide free spare parts caused by contractor's quality of product. Contractor shall carry out service 4 times during the year as per the scheduled attached on annexure of the document.

The complete diesel generator installation shall comply with the requirements of the PRASA General Technical Specification for emergency generator plant and the additional requirements in this section of the document.

The generator contractor will be responsible for the complete diesel generator installation and associated equipment and power and communication cabling between the generator set and the AMF panel, the set is to include the metal clad insulation of the complete exhaust pipe and silencer system within the enclosure and the supply, oil resistant hose pipes and a funnel. The fuel line from the fuel tank must be fitted with a fuse link operated shut-off valve. Fuse link to be mounted above the plant in the event of a fire. The drain from the radiator and oil sump must be extended to outside the base frame. **The exhaust pipe must discharge outside the building** and be fitted with a mesh at the end to prevent entry of small birds.

It is the generator contractor's responsibility to ensure that the container manufacturer / supplier provides adequate ventilation within the enclosure for the efficient operation of the plant at full load condition.

Adequate electrical protective devices must be provided to shut the engine down before any permanent damage can result to the generator equipment. Refer to 'Alarm and Protection Equipment' clause in the General Technical Specification. The following equipment must also be provided:

A low level cut out probe in the diesel day tank to prevent the engine running dry, in addition to the low-level alarm probe.

A low-level cut-out probe near the top of the radiator to provide engine cut-out in the event of low coolant or a water leak.

In general, the essential outgoing circuits will be the:

The supply to the kiosk / electrical board on the essential side of the electrical board.

The electrical contractor shall provide the cabling and connections from the PRASA electrical panel to the generator changeover, to the generator and back to the essential electrical panel.

Part of this contract is to provide:

A 12-month guarantee of all new diesel generator plant from the date of hand over to the employer.

A daytime emergency calls out service with a response time of 2 hours during the first year.

A three-monthly maintenance inspection including a 30 minute on-load run test and checking the battery charging system and replacing the fuel filters.

A full annual service of the generator plant and replacement of the battery at the end of the 12-month guarantee period.

Additional 36 Months Contract Entails the following:

- Two major services annually
- Two minor services annually
- Replace batteries every 12 months/1200hours whichever comes first.

Guarantee

A guarantee period of 12 months shall apply to all new plant and equipment supplied and installed under this contract. The guarantee period shall commence from the practical completion date.

For details refer to the clause Guarantee in the General Technical Specification.

Maintenance

Maintenance of the specified systems, services and / or parts of equipment and infrastructure shall all be referred to as "Maintenance of an Installation". Maintenance of all completed installations shall ensure reliable functioning and optimum service life thereof. Maintenance

responsibilities for each installation including all units and components as specified shall commence after practical completion of the installation and shall leave the Contractor with a functional installation to maintain and guarantee for 12 months.

Maintenance of an installation shall be performed in accordance with the Technical Specifications, the Operating and Maintenance Manuals (where applicable) and the Maintenance Control Plan.

Drawings

Final position of the generator set is indicated on the drawing. Further details shall be discussed on site by the generator specialist and the engineer.

Engine Instruments

Refer to clause Panel Equipment in the General Technical Specification for equipment to be provided.

Battery Charging System

This shall include the engine alternator and regulator (12V or 24V system). Battery specification to suit manufacturer.

Electrical Reticulation

Electrical reticulation work under this contract will involve the installation of the new AMF panel and interconnecting of the power and control cabling and earthing between the generator set, alternator and the AMF panel. Also included under this scope of work is the separate earthing to ground of the generator set and the AMF panel. An emergency stop button shall be fitted on the outside of the enclosure. Wiring between this stop button and the AMF panel shall be undertaken by the generator contractor.

The electrical contractor will install and terminate the out-going cables from the AMF panel to the PRASA electrical board and / or as per drawings.

Cabling between the alternator and the AMF panel shall be suitably rated for the full load rating of the alternator and shall be suitably supported on stainless steel Gr316L cable tray.

All new electrical installation work shall comply with the SANS 10142-1 as amended.

After completion of the work, a compliance certificate for the new electrical installation work for the generator and AMF panel shall be issued to the Engineer.

AMF Panel

The diesel engine must be started automatically when the mains power fails.

The AMF panel must be mounted on the base frame of the engine or alternatively mounted at the end of the set and be visible through a window in the enclosure door.

A correct protective 1800A (adjustable to 1600A) circuit breaker for the respective size of the generator (the generator supplier or contractor must consult with the Engineer for the correct circuit breaker to be installed if uncertain) 1800A, four pole, with 10/15 kA MCCB shall be provided as the main switch for the incoming supply from the Four pole supply source. A separate main generator circuit breaker rated for the FLC of the alternator, to protect the alternator against short circuit and overload is to be mounted in the AMF panel. The electrical / mechanical change over switch / contactors shall be mounted in the AMF panel. A by-pass switch for maintenance is also to be provided.

In addition, there shall be a cable to the main distribution board to an essential supply side to feed essential busbar which shall have circuit breakers feeding other distribution boards. Refer to the single line diagram for detailed drawing.

The AMF panel shall be fully equipped (including battery charger) and wired as detailed in the standard specification. An approved generator controller unit shall be used.

In addition to the power cabling a 2,5 mm² 7 core armoured (control) cable and a 4 mm² 4 core armoured cable (for battery charger) will be required. The AMF panel shall also incorporate a red alarm indicator with audible electronic siren and reset button which must be clearly visible through the window in the door. A remote panel to be provided under this scope

of works shall consist of a red indicator lamp for a general generator alarm (labelled GENERATOR ALARM)

The remote panel is to be handed over to the Project Manager and or client.

Fuel / Water Separator

The diesel generator set shall be provided with an approved fuel separator/filter unit.

The fuel filter unit and replacement filters are available suitable supplier.

Tenderers shall allow for the separator / filter to be installed in the fuel line from the tank to the diesel engine. The unit shall be positioned above the engine drip tray. The separator shall be manufactured to the following specifications.

The filter cartridge must be changed every 3 months even if the diesel engine does not run. Tenderers must allow for the cost of replacing the cartridges in their service rates.

Technical Specification

The diesel / water separators:

- Shall be manufactured from die-cast aluminium.
- Shall be Robust Double Epoxy powder coated.
- Shall have a 10-micron filter cartridge with mechanical shut off, for overwhelming by water.
- Shall have a flow rate of ± 4 litres per minute minimum.
- Shall have an Inlet / Outlet port.
- All parts shall be corrosion resistant, and float shall be solid.
- Approximate measurement of unit shall be, Height - ± 325 mm, Width - ± 99 mm, Depth ± 125 mm.
- Shall be 4 Bar pressure tested.

- Shall have a \pm 300 millilitre per minute water dump – differential head pressure dumping.
- Shall have a 2mm dump valve aperture.

Operation

- No visual inspections i.e. automatic water dumping.
- No electrical circuits required.
- Complete water separation.

Fuel

Fuel supplied and used in the diesel engine shall be commercially obtainable automotive diesel fuel to SANS 342.

The new generator set shall be provided with a full tank of diesel fuel. The fuel shall be pumped into the day tank for use during testing and commissioning.

Annual Service

At the end of the guarantee period a full annual service shall be undertaken in accordance with the following table. Should this service schedule not include all the requirements deemed necessary by the manufacturers of the relevant generator sets, then the contractor is to ensure that the omitted schedule maintenance items are included and that the annual service is in accordance with the manufacturer specifications.

Should the engine use for less than 1200 hours in the twelve-month period, the schedule below must be used:

The preventive maintenance operations must be applied at the interval (hours or months) which occurs first.

To ensure consistency in tendering, tenderers shall allow in the priced bill of quantities for 3 inspections and the replacement of filters and a full annual service at the end of the guarantee period.

A = 3 Monthly inspection / service and initial training of operators

B = Every 400 hours or 12 months

A	B	Operation
●	●	Check the amount of coolant
●	●	Check the level of the lubricating oil
●	●	Check the restriction indicators for the air filters and, when necessary, renew the filter elements.
●	●	Start and run the engine with 30% load (minimum), until normal temperature of operation is reached. Engine must run for a minimum of 1 hour.
●	●	Drain the water / sediment from the primary fuel filter.
	●	Check the condition and the tension of all drive belts.
	●	Check the specific gravity and the pH value of the coolant.
	●	Renew the lubricating Oil
	●	Renew the canisters of the lubricating oil filter
	●	Renew the canister of the main fuel filter
	●	Clean the primary fuel filter
	●	Ensure that the mounting nuts for the turbochargers are tightened securely.
	●	Check the timing of the fuel injection pump
	●	Check that the drive coupling bolts of the fuel injection pump are tightened to 120Nm (88lbf ft)
	●	Ensure that the fuel injectors are checked and corrected or renewed, if necessary *

A	B	Operation
	●	Ensure that the tappet clearances are checked and adjusted, if necessary *

In addition to the operations listed above, the following must be included in the 12 month annual service.

- Drain and flush the coolant system and renew the coolant mixture.
- The operation of the turbochargers be checked and repaired if necessary by a competent person.
- Check that the air charge cooler and the radiator are clean and free from debris
- The operation of the alternator be checked and repaired if necessary by a competent person.
- Check the battery charging system and adjust the charging rate if necessary.
- Install a new heavy-duty battery each 12 month interval.

Quarterly Maintenance Inspections

A quarterly maintenance inspection is required every 3 months throughout the guarantee period for the plant providing emergency power. A quarterly maintenance schedule is attached which must be photocopied and completed by the service Contractor. The engine must be started by simulating a mains failure and run for at least 30 minutes.

The price for the quarterly inspections shall include all necessary costs such as travelling, labour, tools, cleaning materials, replacing fuel filter cartridges etc. Contractors are advised to assess the rising costs and price these services accordingly, as these costs are fixed and no additional escalation on rates will be permitted.

Monthly Maintenance Services – first 12 months after installation and 36 months.

A monthly maintenance service will be required for the generator set. A free maintenance for the 12 months shall be provided. Thereafter, a 36-month maintenance.

Emergency Call Outs

Should a breakdown occur during the 12-month free maintenance period, the contractor is expected to visit site within two hours of receiving written notification from PRASA Agent. Any faulty electrical or mechanical equipment shall be replaced at the contractor's cost under the guarantee.

Reimbursement (including travelling) will not be made for call outs to faults on new equipment installed under guarantee unless it can be proven wilful damage or negligence by the Employer's operating staff.

Servicing

All parts and components shall be approved and in accordance with the manufacturer's spare parts' list. Generic or similar parts not approved by the manufacturer of the plant may not be used.

Documentation

General Technical Specification: INSTRUCTION MANUALS. The same clause also specifies the requirement for wall mounted drawings in plant rooms, which are to be provided for in the enclosure of the new generator set.

Four copies of an A4 size hard covered spiral binder with 12 coloured plastic fly sheets suitable to contain the following information shall be provided for the new generator and handed to the Engineer:

- 1) Cover page with title of contract and file numbers
- 2) Contractors details – name, address, contact names and phone/cell numbers
- 3) Consultants details as above
- 4) Hand over certificates – compliance forms, practical completion forms
- 5) AMF panel routine test certificates from supplier – refer SANS 1973 and a schedule of all controller programmed settings
- 6) Site instructions

- 7) Technical data sheets with supplier's names and model numbers – radiator level probes, battery charger unit, generator controller, plug-in relay types and replaceable filter cartridges.
- 8) As built drawings of AMF panel and genset
- 9) Operating and maintenance manuals
- 10) List of all consumables with make and type number – oil, filters etc.

Logbook

An A4 size hard covered service logbook on a chain shall be provided in a metal envelope or chain the book so it will not get lost. The logbook shall be chained to the inside of the enclosure. The logbook is to be filled in each time anyone opens the doors to the enclosure after the set is commissioned. A full detail of servicing and repairs is to be recorded in the book with the run hour reading.

Cleaning / Clearing

Cleaning during maintenance service refers to the high-pressure hosing of the engine. Removal and disposal of any oil or diesel in the drip tray.

All mechanical and electrical equipment must be cleaned of dust and oil. The electrical switchboard must be blown out of dust with an air blower.

Clearing refers to the removal of all unauthorised items stored within the canopy to ensure fire safety and compliance with the OHS Act. The enclosure may not be used as a storeroom.

Signage

Mandatory signs to SABS shall be installed inside the enclosure – first aid, resuscitation, fire, etc. All other signage shall be approved by the PRASA Agent (Consultant) before purchasing.

A sign as indicated in clause 11 of the General Technical Specification must be installed inside the enclosure at the electrical indication/control panel.

In addition to the mandatory OHS signs, a plastic laminated schedule shall be mounted inside the enclosure with the contractor's name and contact details together with the name of the PRASA service/maintenance manager and his/her contact details.

A plastic laminated schematic wiring diagram of the electrical control system must also be mounted inside the electrical enclosure.

Two signs shall be installed outside on the door. One at high level with the words "GENERATOR PLANT" and the other with the words "UNAUTHORISED ACCESS NOT PERMITTED"

The generator set plant and the control panel shall also be provided with a unique alpha numeric label identifying the plant for the PRASA e.g. PRASA – 005.

All signs must be fixed with non-corrodible screws.

Commissioning

The diesel generator set and AMF panel is to be tested in the supplier's workshop prior to dispatching to site. Tests in the workshop shall include a load test with a dummy load, equivalent to the full output of the particular alternator and in the presence of the PRASA Agent (Consultant). Temperature rise tests shall also be taken within the enclosure during the load tests.

Training

The contractor shall ensure that the relevant PRASA personnel (at least two persons) are fully versed with the operation, starting procedure and monthly maintenance requirements of the generator sets. The names **and signatures** of the trained officials indicated on the handover certificate shall be forwarded to PRASA Agent (Project Manager / Engineer).

Electrical Competent Person & Identification

The Contractor must have in his permanent employ a person deemed to be electrically competent. Such a person must be in possession of a valid and current certificate certifying he/she is an Installation Electrician. This person will accept a permit to work on behalf of the Contractor associated with system outages. It is a requirement that the above person be

resident on the site whenever installation work is being carried out. Work on site shall at all times be supervised by a designated responsible person appointed in writing in terms of the OHS Act No. 85 of 1993.

Whilst on site all staff and labourers employed by the generator contractor shall wear distinctively marked clothing bearing the name of the mechanical contractors or his identification logo.

Visits to Site

Tenderers are advised to visit the site and acquaint themselves with the existing installation, working, site and access conditions. A compulsory site visit will be held as per the details noted in the Tender Notice.

No claims whatsoever shall be entertained due to lack of knowledge of the site conditions.

Indemnity

In carrying out his obligation as the Mandatory to the Employer for this Contract in terms of Section 37(2) of the Occupational Health & Safety Act No. 85 of 1993, the Contractor ensures that he complies with the Act when providing the Works or using plant, materials or equipment. The *Contractor* indemnifies the Employer and the Engineer and their representatives against loss and damage to property, death of, or injury to, a person and claims, proceedings, compensation and costs arising from the Contractor's transgression of the Act, except to the extent that the Employer caused the transgression.

QUALITY CONTROL

The Contractor shall specify to what standards the equipment will be Manufactured e.g. ISO, EN, IEC, CENELEC.

The Contractor shall supply all necessary compliance certificates, handover documents, drawings.

4.3.5 GENERAL TECHNICAL SPECIFICATION

GENERAL

This is a typical standard specification that covers the supply, delivery, complete installation and testing on site in full working order and the guarantee of new diesel generator plant as detailed below.

Brochures with full technical particulars, performance curves and illustrations of the equipment offered must be submitted with the tender. Contractors may quote their standard equipment, complying as close as possible with the specification, but any deviations from the specifications must be fully detailed.

The schedules following this specification must be completed by the Contractor in all respects.

The Employer reserves the right to accept any portion of any tender and does not bind itself to accept the lowest or any offer.

REQUIREMENTS

The diesel engine alternator set shall be robust in construction, of the heavy duty, industrial engine type with speed not exceeding 1500 RPM and shall comply with SANS 8528. The set shall be fully automatic, i.e. it shall start when any one phase of the main supply fails, and shall shut down when the normal supply is re-established. The set shall be capable of delivering the specific output continuously under the site conditions, without overheating. Maximum ambient temperature can be assumed to be 40° C and the maximum ambient humidity at lowest temperature to be 80 %. The altitude is between below 1 m above sea level. The engine shall be capable of delivering 110% of the specified output for one hour in any period of 12 hours consecutive running, in accordance with BS 5514.

Full particulars, including detailed descriptions, illustrations and curves, with engine performance (output of engine against speed for both intermittent and continuous operation) and fuel consumption curves shall be submitted with the tender.

This shall be an open set frame, the engine and alternator shall be mounted as a complete set on a common steel base, which shall incorporate anti-vibration dampers. The set must be placed on a level concrete floor. A drip tray, large enough to catch a drip from any part of the engine and water discharged from the fuel / water separator filter, must be fitted under the engine. All diesel engines must be fitted with a charging alternator for charging the battery.

VOLTAGE AND OUTPUT

The required generator set is 1x1250kVA, 400VAC containerised diesel sets.

The output shall be rated to suit the specified, kVA, power factor and voltage ratings as shown on the specification schedule. The engine size shall not exceed the specified ratings by more than 25%. Contractor to complete the attached schedule and return it with the BOQ for evaluation.

DIESEL ENGINE

Diesel engines shall be manufactured in accordance with BS 5514. The engine must be of the solid injection, compression ignition type, running at a speed not exceeding 1500 r.p.m. The engine must be amply rated for the required electrical output of the set, when running under the specified site conditions. **The engine shall be de-rated for the site conditions.** Unless otherwise indicated, the starting period from either automatic or manual switching-on until the taking over by the generating set, in one step of a load equal to the specified site electrical output shall not exceed **15 seconds**. This must be guaranteed by the Tenderer. 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. Water cooled engines shall be fitted with immersion heaters. Turbo charged engines will only be accepted if the Tenderer submits a written guarantee that the engine can deliver full load within the specified period. Emissions from the exhaust shall be kept to a minimum and shall be given at the time of tender.

A remote drain for draining the sump oil and water from the radiator must be extended to the outside of the base frame.

Battery

The set must be supplied with a fully charged **heavy duty, industrial**, maintenance free lead-acid/calcium type battery, complete with the necessary electrolyte. Batteries shall be of the

DELTEC or as approved by the Engineer and shall not be less than 120 Ah rating. The battery will be of sufficient capacity to provide ample starting torque for the engine, which could require up to six consecutive starts. However, the battery capacity shall not be less than that recommended by the diesel plant manufacturer.

The battery shall be mounted on a painted non corrodible, battery shelf secured to the base frame. Rubber insertion shall be installed at the bottom of the shelf. The terminals of the battery shall be sprayed red and green with a terminal spray protector.

Where plant is installed indoors within a plant room, a complete set of distilled water bottles, funnel, hydrometer, etc. will be provided in a glass case fixed on to the plant room wall to maintain and test the battery.

Cooling

Air cooled or water-cooled engines shall be acceptable. To prevent excessive running temperatures on water cooled engines, an engine-mounted, tropicalised, pressurised radiator with blower-type fan shall be provided to maintain safe operation at 43°C ambient temperature. The radiator shall be designed for an ambient air temperature of 50° C. Total air flow restriction to and from the radiator shall not exceed 0,12 kPa. The Contractor shall provide duct work with flexible connecting section between radiator and discharge louvre frame. Radiators must be dosed with anti-freeze and a suitable corrosion inhibitor. A low-level probe shall be mounted near the top of the radiator to alarm with visual indicator and shut-down the plant. Should the radiator be too narrow to accommodate the probe, then the probe shall be installed in an enclosed cylinder with extension pipe fixed to the radiator. The probe shall be of the Electromech AC DC Dynamics LS 103-3 or similar make.

An audible alarm and visual trip system shall be provided on the control panel to indicate that excessive temperatures have been reached.

Lubrication

The main bearings and other important moving parts in the engine shall be lubricated by a forced feed system. An audible alarm and visual trip system shall be provided on the A.M.F. panel to operate the stop solenoid in the event of low oil pressure.

Fuel Tank

The generator shall have its own diesel tank that shall run for 12-hours at full load.

All fuel pipes shall be hot dip galvanised with appropriate bends to provide an expansion facility and flexible connections with armoured covering for vibration isolation at the engine. Copper shall only be used from the primary filter to the engine pump.

Fuel / Water Separator

A fuel / water separator unit with automatic water dump feature shall be installed in the fuel line from the tank to the diesel engine and shall be mounted above the engine drip tray. The unit shall be of the Duvalco Mk3 DSF type with 10-micron filter cartridge and have a flow rate of +/- 4 litres/min or similar.

Governor

The speed of the engine shall be controlled accurately by a mechanical governor complying with class A1 to BS 5514 such that when full load is suddenly switched off the temporary increase in speed will not exceed 10% above 1500 rpm. The permanent speed variation shall not exceed 2½% of the nominal engine speed. Manual adjustment must be provided on the engine to adjust the normal speed setting.

Engines delivering an output **(as indicated on the BoQ) KVA** shall be provided with an electronic governor where the engine is electronic.

Flywheel

A suitable flywheel must be fitted that is large enough to prevent any visible flicker in the lights. The cyclic irregularity of the set must be within the limits specified in BS 5514. The fly wheel must be covered/enclosed.

Silencer and Exhaust System

The complete exhaust system shall be made of stainless steel.

A residential exhaust silencer (to 65 dB (A)), muffler companion flanges, and flexible stainless steel (suitable for coastal conditions) bellows-type exhaust fitting properly sized shall be

furnished and installed according to the manufacturer's recommendation. The generator set should be sound attenuated to achieve an ambient sound level 79dB(A) at 7 metres from the plant. The exhaust pipe shall be secured by flanges both sides of the wall of the plant room at the point of exit and shall extend 0,5m above the room gutters and must be fitted with a weather flap. Exhaust pipes through canopy walls must be flanged where it penetrates the canopy wall to permit ease of removal of the canopy. The exhaust pipe must be flexibly connected to the engine to take up vibrations transmitted from the engine. The exhaust pipe and silencer must be lagged inside the generator room to reduce heat and noise transmission.

The silencer shall be mounted so that its weight is not supported by the engine nor will exhaust system growth, due to thermal expansion, be imposed on the engine penetration. Exhaust pipe size shall be sufficient to ensure that exhaust back pressure does not exceed the maximum limitations specified by the engine manufacturer.

The muffler and all indoor exhaust piping shall be lagged by the installing Contractor to maintain a surface temperature not to exceed 150°F (65.5°C). The insulation shall be installed so that it does not interfere with the functioning of the flexible exhaust fitting. Insulation between the manifold and silencer shall be double 25mm layers of FIBREFAX and the silencer and piping to the outer wall insulated using 50mm thick wire backed INSULWOOL of at least 80kg density. The insulation shall be cladded under tension and riveted with 3mm stainless steel rivets. The cladding shall be 0,7 mm thick 430 stainless steel.

The generator shall be supplied and include a sound attenuator.

Alternator

Alternators shall be manufactured in accordance with BS 5000. Unless otherwise specified, the alternator shall be of the self-excited brushless type enclosed in a ventilated drip-proof housing, and must be capable of supplying the specified kVA continuously with a temperature rise not exceeding the limits laid down in BS 5000 for rotor and stator windings having 'Class H' insulation.

The alternator shall be capable of delivering an output of 110% of the specified output, for 1 hour in any period of 12 hours consecutive running.

The alternator windings will be suitably impregnated and tropicalised to withstand the specified climatic conditions. Alternators shall be of the low harmonic type. An alternator heater will not

be required. Contractors are to list the number of similar installations operating in similar climatic conditions.

Regulation

Since the alternator set could be installed in an area where maintenance staffs are not readily available it is essential to offer regulating equipment which is simple and robust in construction. Complicated equipment requiring specialised knowledge will not be considered.

The alternator shall be self-regulated and the voltage regulation limits shall not exceed $\pm 1\%$ of the nominal specified voltage, under all load conditions and at the specified power factor, while the engine speed “droop” variations between no load and full load shall not exceed $4\frac{1}{2}\%$.

Performance

The excitation system shall be designed to promote rapid voltage recovery following the sudden application of full load. The voltage shall recover to within $2\frac{1}{2}\%$ of the steady state within 300 milli-seconds following the application of full load and the transient voltage dip shall not exceed 15%.

Coupling

The engine and alternator must be directly coupled with a high class quality flexible coupling which is designed to cope with the most severe torque changes, due to instantaneous load changes in the alternator from no load to full load. The flexible coupling shall be of the HOLSET type or equal and similar.

Computer Power Supply

The Contractor shall ensure that the output has low harmonic distortion and voltage regulation of less than 4%.

Automatic Mains Failure Panel

The panel will incorporate all of the specified control and protection equipment required to operate and protect the alternator. Control units must be supported by GSM and have modem support with auto-call function for e-mail or SMS sending. It is important that the equipment used in the control panel has a history of use in RSA and that parts are readily available off the shelf.

The visual and audible alarms, battery-charging unit and mains failure sensing relays will also be incorporated in the panel. All instruments are to be flush mounted.

Where solid-state equipment is used for control circuits etc, these shall be of the printed circuit board design, which can be easily unplugged and replaced with standard replacement cards in the event of failure, testing etc. Spares of these PCB cards etc must be available at all times from the supplier of the emergency equipment.

The Project Manager / Engineer must approve the panel manufacturer's detailed working drawings of the assembly before any fabrication commences. Any other construction or type of assembly proposed as an alternative to that specified must have the approval of the Project Manager / Engineer in writing. The drawings will detail all dimensions of busbars, connections, electrical component make, type and rating.

Positions and layout of busbars, earth bars and gland plates will be shown in front and side elevation drawings.

All panel and equipment shall to be designed in accordance with SABS IEC 60439-1 and SANS 1973-1-2 and shall be suitable for operation on supply voltages of 230/400 Volts, 50 Hz, AC.

Panels designed for plant within plant rooms shall generally be of a floor standing cubicle type assembly, suitable for top and bottom cable entries. Schematic drawings will show the specific requirements applicable to each assembly.

Panels designed for plant shall be mounted on the base frame of the plant and provided with vibration isolation from the generator set.

The entire assembly shall be of strong and rigid construction with suitable folded 3CR12 stainless steel frame work, totally enclosed by means of removable 3CR12 stainless steel covers and hinged 3CR12 stainless steel doors where required. The entire assembly shall be manufactured from 3CR12 sheeting of a minimum 2mm thick.

The overall outside dimensions of the assembly shall be suitable for easy handling of the switchgear as indicated on the drawings. The height of the assembly shall generally not exceed 2 100mm above floor level.

All removable covers shall be secured in position by means of patent screw locking devices approved by the Project Manager / Engineer. All panels shall be suitably braced to ensure rigidity.

Identification labels in accordance with the specification will be screwed to the front of each door on the panel. The label will describe the purpose of the equipment contained within each compartment.

All hinges and door handles shall be of the bolted-on type and shall be manufactured from non-ferrous materials or stainless steel, suitably finished and treated against corrosion by an electro-plating process. All hinges are to be of the lift-off type and samples shall be submitted to the Project Manager/Engineer for approval.

Hinges and door locks shall be of approved SABS quality to ensure satisfactory operation and a pleasant appearance, and where possible the lock and door catch shall consist of one combination unit.

Door latching and de-latching operations shall be smooth and quick, whilst ensuring proper compression of the sealing gaskets.

The repeated opening and closing of the hinged doors and the operations of the door locks and catches shall not cause chipping or scratching of the painted surfaces or any other blemishes to the finished panels.

Each lock shall have two keys, and where more than one locked panel is specified the locks shall be in one master series. All keys, plus one master key, shall be handed to PRASA for which a receipt shall be obtained. One master key shall in addition, be handed to the PRASA representative (Consultant).

All keys submitted by the Contractor shall be suitably tagged with the panel designation and location.

Bolts, nuts and washers used throughout the panel shall be of stainless steel with the exception of busbar bolts, nuts and lock-washers which shall be of stainless high tensile steel or high tensile phosphor bronze material.

All screws, bolts, door locks, etc must not be in direct contact with painted surfaces, to avoid sticking or damage to the paintwork.

The 3CR12 panel shall be epoxy powder coated Red (Colour VEP 2002).

This inside of the cabinet door shall be fitted with a suitable holder for the schematic control diagrams, schedules of equipment of the method of operation specification.

All busbars shall comply with the requirements laid down in SANS 1195. The completed busbar system shall be a standard modular system and shall have been tested to SABS approval and a certificate shall be made available confirming the full busbar technical description, current rating and fault rating together with full details of the test results. Busbars shall be rigidly supported by means of approved insulated busbar clamps to prevent damage resulting from the specified short circuit conditions.

Solid high conductivity copper busbars shall be rigidly mounted in the top section of the switch panel. The busbars must be rated for the continuous full load current, as stated, at a current density not exceeding 1,60 Amps per mm².

If a relaxation of SANS 1973 is agreed to permit the drilling of holes, the cross-sectional area as measured is to be reduced by the area of the holes.

The busbars shall run along the entire length of the assembly up to 76mm from either end, and the incoming collector bars shall be fitted directly below the main circuit breaker or incoming HRC fuse unit.

Sufficient space must be allowed for the connection of all the incoming cables as specified. All busbars shall be identified in the phase colours red, white and blue.

The busbars shall be arranged horizontally with the longer side of the cross-sections in the vertical plane and one behind the other in the horizontal plane at 90mm centres.

All connections and extensions to busbars shall be effected by means of high tensile phosphor bronze nuts, bolts and washers or cadmium plated, high tensile steel bolts and nuts which

shall also be provided for future extensions. The minimum diameter of any hole will be 10 mm.

A solid copper earth bar shall be provided inside each assembly at the back and along the entire length, at a height of approximately 500mm above floor level, or 200 mm above the gland plates. A bar is to be provided at the top of the assembly where top entries exist and this shall be solidly connected to the bottom earth bar.

The bar will be supported on robust spacers and will have a minimum clearance of 40mm to the sheet steel panel.

The earth bar shall have a cross-section of not less than 40mm X 6mm and shall be drilled with the requisite number of holes for the individual connection of all cable ECC and other earth conductors.

High tensile phosphor bronze or cadmium plated nuts, bolts and lock washers shall be provided through the earth bar at each earthing position and at least 5 additional holes will be provided for future connections, each being fitted with nuts and bolts as above.

The earthing positions shall be evenly spaced along the length of the earth bar and the bar must be clearly identified as the earth.

Alternator Protection

Small alternators shall be protected by a triple pole MCB or air circuit breaker with instantaneous short circuit trips and adjustable thermal overload protection of the correct characteristics which shall be provided on the front of the panel. The settings of this unit will ensure that the alternator is adequately protected against all short circuit conditions. Alternatively, on small alternators, fuse protection may be used in conjunction with a phase failure monitor.

Larger alternators shall be protected by an adjustable electronic circuit breaker.

Parallel Operation

Should parallel operation with other sets or any supply network be specified, it must be possible to synchronise such machines without creating any undue shock or fluctuating conditions.

Alarm and Protection Equipment

Alarm relays with re-set push buttons are required to give visible and audible alarm signals to protect the plant by shutting it down before any permanent damage results. The visual indication will remain uncanceled until the problem causing the trip has been returned to normal.

The protection required will be:

- Overload
- Temperature High
- Low Oil Pressure
- Over Speed
- Under speed
- Start Failure
- Low Water Level
- In addition, one DIESEL FUEL LOW level alarm and indication as well as one BATTERY/CHARGER FAILURE alarm and indication must be provided which does not trip the engine. Provision must be made for both these items to be remotely alarmed.
- FUEL TANK EMPTY – to trip the engine before the fuel runs out completely so as to avoid bleeding the engine on refuelling. The lights and associated push buttons will be engraved accordingly.

One common hooter (Klaxon type SY2/725) and red flashing light is required to be mounted on the outside wall of the plant room with the alarm cancel button mounted on the control panel. The alarm system must be supplied from the starting battery.

Provision is also to be made for remote alarm indication and remote cancellation in the charge office.

A remote alarm panel shall be supplied and installed in the charge office with a connecting 2,5mm² 4 core pvc/swa/pvc cable from the generator control panel. The remote alarm panel shall incorporate a mains on and generator on and not in auto indicators, a low fuel, low battery, start fail, and genset fault indicators and relays as well as an electronic sounder (with low sound level) and a silence button. The silence button shall not switch off the pilot lights – pilot lights can only be switched off when the fault has been cleared at the generator panel.

Start and Stop Delay Timers

Where connected to a rural supply system with auto-reclosing protection, an adjustable timer (0-180 sec) will be fitted to prevent starting as a result of transient faults. The engine control system is also to be fitted with an adjustable timer (0-3 minutes and set on 1 minute) which will keep the engine running on load for a pre-set time after the mains power has been restored to normal. An additional timer (0-10 minutes and set on 8 minutes) will keep the engine operating on no load for its 'run-down' period. It shall be possible for the set to take load again without adverse effects.

Operation Selector

A four-position selector switch is to be provided on the AMF panel to select the mode of operation, which could be – 'Auto', 'Manual', 'Test' and 'Off'.

With the selector in the 'Auto' position, the set is to automatically start and stop, according to the mains supply condition.

In the 'Test' position the engine shall be capable of being manually started and stopped without the alternator picking up any electrical load, to ensure that starting equipment, battery etc. are in operational condition. This routine will be repeated every week and a logbook recording this fact must be provided in the plant room.

With the selector in the 'Manual' position, the set must pick up the electrical load when started but it must not be possible for this supply to be paralleled with authorities supply. A change over relay/contactors is therefore to be provided in the main distribution board.

In the 'Off' position the set shall be completely isolated and cannot be started manually or automatically. This setting will be used for maintenance of the machine only.

Battery Charging

The AMF panel is to include a fully automatic battery-charging unit to keep the battery at its optimum condition at all times. The preferred charger unit is the LAVATO model BCE or equal and approved. The system shall ensure that the batteries are not overcharged by being permanently connected to the charging system. The charging current must reduce to 30% when the battery voltage is above 50%. The charging circuit must be able to inhibit:

A short circuit at the battery charger terminals

Inverse battery polarity

Low battery charge ($< 0.2 U_c$)

The output current of the charger shall not be less than 3 amps at 12 volts.

An alarm relay output will be required.

Fuse protection must be provided on the input supply and on the battery output.

An ammeter and voltmeter suitably scaled to indicate the trickle charging supply will be flush mounted in the front panel. The voltmeter will operate by depressing a spring loaded push button and will not remain in the circuit continuously.

Panel Equipment

The following items of equipment will be fitted to the panel:

- One flush mounted 72mm x 72mm PCI voltmeter scaled to the specified voltage to read all phase-neutral voltages.
- One 7 way voltmeter selector switch to suit item 7.7.1 above.
- One 72mm x 72mm frequency meter showing alternator frequency.
- One run hour meter with cyclometer counter showing the actual running hours of the engine.
- 3 - 2 amp HRC fuses for the voltmeter circuit, including spare fuses.

- 3 - 72mm x 72mm maximum demand indicating ammeters scaled to the specified maximum load current, complete with current transformer, to indicate the current in each phase of the alternator.
- One phase rotation indicator.
- One suitable rated main isolating switch to isolate the complete board.
- One adjustable type triple pole MCB or air circuit breaker rated to protect the alternator.
- One four-position selector switch as specified.
- One emergency stop push button behind a hinged cover.
- Two push buttons (green and red) marked 'Start' and 'Stop' for test operation.
- One complete battery charger with instrumentation to be operated from the mains supply.
- One alternator charge indicator with 30-amp deflection.
- One start-delay timer.
- One stop-delay timer.
- Relays and reset push buttons for engine protection with spare lamps.
- One lube oil pressure gauge and relay with shutdown for low pressure.
- One low fuel level relay device and spare lamps.
- One fuel tank empty cutout relay and spare lamps.
- One low water level relay device and spare lamps.
- One battery/charger relay device and spare lamps
- One 12 Volt DC. Hooter/alarm with protection fuses, cancellation button, etc and terminals for the operation of a remote alarm.
- One push button for manual start operation.
- One set of terminals and all interconnecting wiring including earth connections.
- One on-load by-pass switch in separate cubicle as specified.

- One spring-reserve seasonal time switch or photocell.
- Surge arrestors for all 3 phases and the neutral.
- Any other equipment necessary for the correct and safe operation of the installation.

Marking

All instruments, lights, push buttons etc are to be provided and will be marked with Trafolyte engraved labels, screwed to the panel. The lettering shall be 6mm high. All labels will be in English and any other Official Language as directed by the PRASA representative (Consultant).

All engine instruments shall have clear markings on the faceplates, indicating the normal operating zone(s). Maximum and minimum allowable values/limits and danger zone(s).

The base frame or other suitable location shall be marked with the recommended oil type to be used in the engine.

Change Over System

The main switchboard shall be divided into two sections for 'mains supply' and 'mains/emergency generator supply'. Two specified three pole contactors rated for AC3 operation, or two motorised circuit breakers shall be incorporated in the switchboard to facilitate the automatic changeover of supplies, but they shall be electrically and mechanically interlocked to prevent the generator from running in parallel with the mains supply.

An engraved plastic danger notice is to be prominently fixed on the switchboard stating that "This switchboard can be automatically energised from the emergency generating set."

By-pass Switch

The main switchboard must be equipped with a manually operated on-load by-pass switch, which shall connect the incoming mains to the automatic control gear or directly to the outgoing feeder. In the latter position, the automatic control gear, including the main contractors, shall

be isolated for maintenance purposes. A triple pole on-load isolator is to be provided to isolate the mains. It shall not be possible to start the engine except with the selector switch in the “Test” position.

It is required that this by-pass switch and mains isolator be mounted away from the automatic control gear in a separate compartment either on one side or in the lower portion of the switchboard and that the switches are operated from the front of the cubicle.

Earthing & Lightning Protection System

The system shall comply with the relevant requirements of the following specifications.

- SANS 10313 : Protection of structures against lightning
- SANS 10199 : Design and installation of earth electrodes
- SANS 1063 : Earth Rods and Couplers

Only SABS approved earth rods and couplers bearing the SABS mark must be used.

Earthing

The neutral of the system and the alternator must be solidly earthed. The Contractor shall provide a 500 x 50 x 6mm thick copper bar fixed to the plant room wall on two insulators rated at 500V. The earth mat shall consist of 70mm² bare standard copper conductor and 4 or more 1500mm long x 16mm diameter earth spikes to achieve a maximum resistance of 10 OHMS. The earth mat shall be spaced 4 metres from the plant room. Two 70mm² insulated copper conductors shall connect the diagonal ends of the earth mat and earth bar within the plant room.

Lightning Protection

Aluminium roof conductor shall be installed on the roof and bonded to a down conductor and then connected to the 1500mm long earth spike via 70mm² insulated copper conductor. Bi-

Metallic connectors are to be made at all aluminium and copper connections. The lightning protection and earthing system shall be bonded to ensure that they are at the same potential

Suitable surge arresters must be installed on each phase and the neutral in the AMF control panel and connected to the earth bar.

Warning Notices

A non-corrodible and non-deteriorating engraved warning notice will be wall mounted in a conspicuous position reading:

“Danger: This engine will start without notice. Turn selector switch to ‘Off’ position before working on plant. (Do not forget to reset)”.

In addition all statutory notices required by the Occupational Health and Safety Act No. 85 of 1993, for the handling and generation of electrical equipment.

Inspection And Testing

Because of the number of Contracts and the need for the project to function as a co-ordinated whole, particular emphasis will be paid to testing. No test will be recognised unless it is documented in a previously agreed format. The test procedure shall ensure that every combination of switches and events is tested for correct functioning and each such combination is recorded in a test sheet and checked off.

No plant or equipment may be energised until testing is complete and the results accepted by the Project Manager/Engineer.

The Contractor shall supply all test equipment and consumables.

The Contractor shall conduct tests at the following stages. The Project Manager/Engineer shall be advised of the tests one week in advance of the test dates.

- a) At manufacturer's work before equipment is released to site.
- b) During installation where testing is necessary

- c) Before final connections are made
- d) After installation is complete

After the tests are complete the Contractor shall compile and submit a report to the Representative/Agent (Consultant). After submission of the test report the Representative/Agent (Consultant) may call for all or some of the tests to be repeated in his presence. Should any test be unsatisfactory at this time the Representative/Agent (Consultant) reserves the right to have his reasonable abortive costs deducted from the contract sum.

Inspections during Manufacture

The Project Manager/Engineer shall have access at all reasonable times to any works where materials are being manufactured for the purpose to the contract and shall be at liberty to inspect the manufacture at any stage and to witness the carrying out of the specified tests. Every reasonable facility and assistance shall be provided by the Contractor and/or his supplier for the purpose of such inspection by the Representative/Agent (Consultant) or his representative. The Representative/Agent's (Consultant) may reject at any stage of manufacture any material which does not comply with the specification or such modifications thereof as have been agreed by the Representative/Agent (Consultant).

Factory Testing

It shall be the responsibility of the Contractor to carry out such factory tests as are practicable to ensure that all plant, equipment and components supplied under this Contract comply fully with the relevant specifications and can function as intended. Dummy load tests of the alternators full rated output shall be carried out in the suppliers workshops prior to the plant being despatched to site.

Inspection on Arrival at Site

On delivery direct to the erection position or to the storage area, the plant and equipment shall be inspected by the Project Manager/Engineer and the Contractor or his agent. The Project Manager/Engineer shall be at liberty to carry out any tests he may deem fit before acceptance.

Payment for delivery to site shall not be made until the relevant items of plant and equipment have been inspected and accepted by the Project Manager/Engineer.

Repairs to Damage

Damage or defects of any kind, which become apparent on inspection or delivery, shall be repaired by the supplier of such items to the satisfaction of the Representative/Agent (Consultant) immediately upon detection. Where damage is such that, in the opinion of the Representative/Agent (Consultant), satisfactory repairs are not practicable, the damaged articles shall be replaced at no cost to the Department which shall accept no responsibility for any loss or damage which may be suffered as a result of delays in obtaining the necessary replacements.

Testing After Installation

On completion of the installation of all plant and equipment the Contractor will be required to make appropriate arrangements and supply any instruments or apparatus etc. necessary for the testing of all plant and equipment supplied by the Contractor. Testing shall be in the presence of the Representative/Agent's (Consultant's) representative in order to demonstrate compliance with the requirements or the specification.

All load resistance equipment and instruments including fuel oil will be provided by the Contractor and test reports in duplicate for both series of tests will be submitted to the Representative/Agent (Consultant) within 7 days of such tests.

Site tests must include function tests of all operating systems and protection devices.

Insulation Testing

Before starting the generator set after installation, test the insulation resistance of the alternator windings. The automatic voltage regulator (AVR) must be disconnected and the rotating diodes either shorted out with temporary links or disconnected. Any control wiring must also be disconnected.

A 500 volt Megger or similar instrument should be used. Disconnect any earthing conductor connected between neutral and earth and megger an output terminal to earth. The insulation

resistance should exceed 5 megger ohm to earth. Should the insulation resistance be less than 5 megger ohm, the winding must be dried out.

COMMISSIONING

Commissioning shall proceed in accordance with a previously agreed procedure which shall be documented and which shall form the basis of the commissioning report.

During commissioning the operating parameters of each piece of equipment and each device shall be established and recorded at no-load, average and full load conditions.

The final set of points of all adjustable devices shall be recorded.

The Contractor will be required to make appropriate arrangements, and supply the necessary instruments and apparatus, etc., for the testing of all plant and equipment, in the presence of the Representative/Agent's (Consultant's) representative in order to demonstrate compliance with the requirements of the specification.

The Project Manager/Engineer may require valid calibration certificates to be submitted to cover any meters, gauges, or other instruments used in the tests and may, if considered necessary, arrange for the use of additional meters or other instruments in order to establish the degree of accuracy of the tests.

The Contractor shall be responsible for performing all tests on completion and shall provide the services of an approved Commissioning Project Manager / Engineer and all necessary skilled and unskilled labour, as well as the required tools and test equipment. The Project Manager / Engineer shall approve the procedure for carrying out the tests on completion and shall witness all tests and shall approve any adjustments or modifications necessary to achieve satisfactory operation.

The Project Manager / Engineer shall also witness and approve the tests for demonstrating the plants ability to meet the specified duty. Should the Contractor fail to provide the necessary staff to undertake the tests on completion timeously or efficiently, the Project Manager / Engineer may, in order to meet the programme for start-up, make arrangements to have the outstanding duties undertaken by others for the Contractor's account.

Load Balancing

It is important to ensure that a balanced load is presented to the generator set. If loading in one phase is substantially higher than the other phases, it will cause overheating in the alternator windings, imbalance in the phase to phase output voltage and possible damage to the sensitive 3 phase equipment connected to the system. Ensure that no individual phase current exceeds the current rating of the generator set. For connection to an existing distribution system, it may be necessary to reorganise the distribution system to ensure these loading factors are met.

SAFETY PRECAUTIONS

Protection of Persons and Plant

Due cognisance shall be taken of the need to provide adequate protection of persons and plant, from accidents arising or likely to arise from whatever source. To this end, all units of plant which may possibly be subject to damage or become a source of danger to human life either in itself or by virtue of its operation shall be adequately protected as laid down in the Occupational Health and Safety Act No. 85 of 1993.

Appointment of Responsible Person

- The Contractor shall cause all work to be carried out under the general supervision of a responsible person appointed by the Contractor in writing in accordance with the provisions of the General Safety Regulation R.11. Supervision of any work; made in terms of the Occupational Health and Safety Act No. 85 of 1993.
- A copy of the letter of appointment and of the appointee's written acceptance thereof, shall be lodged with the Representative/Agent (Consultant).
- Work on site shall not commence until the documents referred to in sub-clause (b) have been received by the Representative/Agent (Consultant).
- Due cognisance shall be taken by the Contractor of Regulation 5 "Work in Confined Spaces", of the O.H.S.A. Regulations and further to this no clearance certificates shall be given by this Department.

Precautions shall be taken to avoid safety and health hazards to workmen. The Contractor shall be responsible for supplying protective clothing etc. for use of the workmen.

DEFECTS LIABILITY PERIOD

The Contractor shall be responsible for the initial routine maintenance and provision of all lubricants, etc., until such time as the plant and equipment is capable of fulfilling its specified operational duties.

Once the plant and equipment has been successfully commissioned and accepted, the Contractor's staff will undertake the routine maintenance of the plant and equipment for a period of 12 months in accordance with operating procedures and routine maintenance requirements to be furnished by the Contractor prior to acceptance.

The Defects Liability Period shall commence concurrent with the guarantee period.

All cos of servicing and maintenance during this period is to be included in the tender price.

Under the agreement the Contractor will arrange for qualified maintenance staff to visit the plant once every three months and shall, in the presence of the Officer –in-Charge:

- Enter into the log book the date of the visit, the tests carried out, adjustments made and any further notes concerning the condition of the plant and its operation. Also log the hour meter reading.
- Lubricate, grease all moving parts and check and clean all items of equipment as specified in the quarterly maintenance schedule addendum "A" and in accordance with the manufacturer's instructions. Replace all fuel filter cartridges.
- The plant to be tested for automatic starting by simulating a mains failure, and run on maximum possible load for at least half an hour. During this test all mechanical and electrical equipment will be checked for correct operation. All trip alarms and change over relays will be tested for correct operation. All necessary adjustments will be made and recorded in the log book.

Should the Contractor find **any** item which may require replacing due to fair wear and tear or any item which has become unserviceable for the same reason, he will immediately report this matter and submit a quotation in writing to the Representative/Agent (Consultant), detailing the cost of such repair.

The Contractor will advise when it becomes necessary to decarbonise the engine and will indicate the cost of this service.

After the expiry of the 12 month guarantee/defects liability period the Contractor will be required to maintain the generator sets and associated equipment for a further 2-year period.

GUARANTEE

The Contractor shall guarantee all plant, equipment and fittings supplied by him and installed under this contract for a period of **twelve months**. The guarantee shall include any latent defects in the plant, equipment, fittings and installation thereof and any labour or other costs inherent in repairing any defects and ensuring that the plant, equipment and fittings remain free of defects and in good working order to the satisfaction of the Representative/Agent (Consultant).

This guarantee shall not be applicable to existing plant and equipment previously installed by others.

Fair wear and tear shall not be considered as requiring any action by the Contractor under the requirements of the contractual guarantee.

Inspection of the plant shall be made by the Contractor in the presence of the Representative/Agent (Consultant), at suitable intervals, to confirm that the plant is operating in a satisfactory manner.

Provision, as required, shall be made in the contract rates, or elsewhere, for any additional costs incurred in providing this contractual guarantee.

TRAINING AND INSTRUCTION

On completion of the installation on site, the Contractor will be required to instruct the Staff member-in-Charge in the safe and satisfactory operation of the plant and will ensure that he/she is fully conversant with the equipment.

INSTRUCTION MANUALS

Three (3) copies of the operating and maintenance manuals shall be provided on delivery of the plant and equipment. These shall come in the form of plastic covered ring files with the following information indelibly printed on their covers.

OPERATING AND MAINTENANCE INSTRUCTIONS FOR THE
GENERATOR SET AT
PRASA

SUPPLIED BY

(Name, address, email, telephone and fax number of Contractor).

Each page, pamphlet, booklet, diagram, drawing etc. shall be separately bound into the manuals in a clear plastic pocket. Each pocket shall be numbered and indexed.

The first page of each set of manuals shall be an index which shall include a list of the numbers and descriptions of all drawings and pamphlets included in the set and also a list of the Representative/Agent (Consultant)'s drawings relating to the relevant sections of the Contract.

The instructions shall include the following:

- a. A list of spares, tools and testing equipment supplied under the Contract.
- b. A list of spare parts and testing equipment which are not supplied under the Contract but which may be required for future major overhaul and/or testing of electrical plant and equipment.
- c. For (a) and (b) above for spares, tools and testing equipment the Suppliers' names, addresses, telephone numbers, fax numbers and costs must be listed.
- d. List of "Name Plate Data" giving full particulars of serial numbers and other descriptive data pertaining to the plant and equipment installed.
- e. List of points requiring lubrication, stating for each point the type and grade of lubricant recommended and full details as to quantity, timing and renewing of lubrication. Before typing the manuals, the Contractor shall contact the Representative/Agent (Consultant) to obtain the

name and brand of lubricants generally in use by the Representative/Agent (Consultant) and, wherever possible, suitable grades of lubricant of that particular brand shall be nominated by the Contractor in the manuals.

- f. Particulars of bearings, contacts and other moving parts with instructions relating to any special attention which may be required.
- g. Precautions to be taken in starting, running and stopping the plant or equipment by remote or manual control.
- h. Routine tests which the Contractor/Supplier(s) would suggest be carried out.

All information mentioned above shall be cross-referenced to the drawings.

Additionally the manuals shall provide the following information which shall also be cross-referenced to the drawings:

- All technical and other information, in English, concerning the equipment.
- Equipment layout drawings.
- Power single line diagrams.
- Control schematic diagrams.
- Narrative description of the control circuit operation.
- Fault finding routines.
- Routine maintenance instructions, procedures and frequencies.
- Equipment and component specification sheets.
- List of equipment and components including manufacturer, catalogue number and suppliers address, fax and telephone numbers.
- Instrument data sheets
- Cable block diagram
- Cable schedules
- Termination schedules

- Issue a certificate of compliance for electrical installations signed off by a currently registered Installation Electrician.

Copies of all computer generated drawings compatible with Autocad version 2015 shall be submitted to the PRASA on a USB.

Further one (1) set of drawings relevant to a particular generator and a hard covered A4 size log book shall be placed in a weatherproof glass fibre enclosure adjacent to the generator. This enclosure shall be electric orange in colour, be sized to accommodate drawings folded to A4 format, be labelled “Electrical Drawings” and shall have provision for fitting a standard padlock.

SAFETY ARRANGEMENTS AND PROCEDURAL COMPLIANCE WITH THE OCCUPATIONAL HEALTH AND SAFETY ACT (ACT 85 OF 1993) AND APPLICABLE REGULATIONS.

- The Contractor shall accept his obligation to complying fully with the Act and applicable Regulations and with PRASA safety requirements.
- The Contractor shall provide a written Health and Safety plan, the file shall be approved before starting with the work
- The Contractor shall keep a safety file at all times.
- The Contractor shall keep a site diary and instruction book.
- The Contractor shall attend PRASA safety induction training before starting with the work.

ENVIRONMENTAL RESPONSIBILITY.

- The Contractor shall separate hazardous or non-hazardous waste and where practical, waste for recycling prior to disposing thereof.

- The Contractor also undertakes to minimize the amount of waste generated or released, whether it is hazardous or non-hazardous waste, as far as possible to reduce the impact on the Environment.

The Contractor undertakes to dispose of waste generated, albeit hazardous or non-hazardous waste in a responsible manner and submit proof of all disposal documents to the Project Manager / Engineer.

ADDENDUM "A"

**GENERATOR : 3 MONTHLY MAINTENANCE
(STANDBY PLANTS)**

ITEMS CHECKED TO BE TICKED OFF

[1]	CHECK AND TOP UP WHERE NECESSARY (SPECIFY TOTAL QUANTITY). EXCESS OF 10 LITRES WILL BE REIMBURSED	YES	NO	[5]	VISUAL INSPECTION OF ELECTRICAL APPARATUS	YES	NO
A	CRANKCASE OIL (QTY)			A	LV CABLES IN ORDER		
B	INJECTOR BOX OIL (QTY)			B	LV CABLE TERMINATIONS IN ORDER		
C	RADIATOR			C	ALL LV SWITCHGEAR COVERS & PANELS INTACT		
				D	ALL SWITCHGEAR INTACT		
[2]	CHECK FUNCTION ADJUST, TIGHTEN AND LUBRICATE (WHERE NECESSARY)			E	SWITCHES / CIRCUIT BREAKERS IN "ON" POSITION		
A	FUEL PUMP TIMING			F	ARE CIRCUIT LEGENDS AVAILABLE?		
B	PUMP DRIVE			G	ARE CIRCUIT LEGENDS COMPLETE?		
C	OIL FEED PUMP			H	ARE CIRCUIT BREAKERS PROPERLY LABELLED?		
D	EXCESS FUEL DEVICE			I	TIME SWITCHES / SET ACCORDINGLY?		
E	GOVERNOR			J	ARE INDICATING PANEL LIGHTS WORKING? IF NOT INDICATE QUANTITY REPLACED		
F	TURBO CHARGER			K	CHECK SELECTOR SWITCH IN ALL POSITIONS		
G	HEAT EXCHANGER			L	CHECK ALARM ENGINE SHUTDOWN FUNCTION ON :		
H	FAN BEARINGS				LOW FUEL WARNING		
I	DYNAMO BEARINGS				START FAILURE		
J	STOP SOLENOID			M	CHECK ALARM ENGINE SHUTDOWN FUNCTION ON :		
K	HAND / ELECTRIC DAY TANK PUMP				HIGH TEMPERATURE		
L	LUBRICATING OIL FILTER ELEMENT				LOW OIL PRESSURE		
					OVER-SPEED		
[3]	CHECK CONDITION, TIGHTEN (WHERE NECESSARY)			N	TEST PLANT FOR 30 MIN ON FULL LOAD		
A	RADIATOR CORE			O	CHECK AND RECORD THE METER READINGS		
B	RADIATOR HOSES				3PH..... PH1.....V PH2.....V PH3.....V		
C	RADIATOR PRESSURE CAP / VALVE			 A A A		
D	WATER HEATER ELEMENT & THERMOSTAT			P	RESET ALL MAXIMUM DEMAND AMMETERS		
E	VEE BELTS						
F	ENGINE MOUNTING			[6]	CLEANING		
G	ENGINE / ALTERNATOR COUPLING			A	CLEAN AIR CLEANER DRY ELEMENT & BATH		
H	EXHAUST SILENCER & PIPES			B	CLEAN FINS AND OIL COOLER		
I	DAY TANK CONDENSATE			C	CLEAN ENGINE		
				D	CLEAN DRIP TRAYS (WHERE FITTED)		
[4]	CHECK FOR LEAKS & TIGHTEN (WHERE NECESSARY)			E	CLEAN DAY TANK AND GAUGE GLASS		
A	DRAIN PLUG						
B	OIL LINES AND SEALS			[7]	DUST AND CLEAN		
C	FUEL LINES AND SEALS			A	DOORS AND FRAMES		
D	INJECTOR SEALS			B	WINDOW PANES AND FRAMES		
E	ALL PACKING SEALS			C	WINDOW GUARDS		
				D	WINDOW CILLS		
				E	WALLS AND CEILINGS		
				F	CABLE DUCTS		
				G	LV SWITCHGEAR		
				H	LV DISTRIBUTION BOARD / CONTROL PANEL		

TECHNICAL SPECIFICATION – Durban Station, KwaZulu - Natal

[1]	CHECK AND TOP UP WHERE NECESSARY (SPECIFY TOTAL QUANTITY). EXCESS OF 10 LITRES WILL BE REIMBURSED	YES	NO	[5]	VISUAL INSPECTION OF ELECTRICAL APPARATUS	YES	NO
[8]	INSPECTION & ATTENDANCE TO SUNDRY ITEMS	YES	NO	[10]	CLEAN AND OIL	YES	NO
A	CABLE DUCT COVERS TO BE IN POSITION			A	DOOR HINGES		
B	WARNING SIGNS IN POSITION ON OUTSIDE DOOR			B	DOOR LOCKS		
C	WARNING / FIRST AID SIGNS IN POSITION ON INSIDE OF PLANT ROOM						
D	FIRE EXTINGUISHER PRESENT AND SERVICABLE						
[9]	REPORT UNDER REMARKS THE CONDITION			[11]	CLEAN AND POLISH		
A	DOORS (HINGES, LOCKS, ETC.)			A	PLANT ROOM FLOORS		
B	WINDOWS INCLUDING GLASS, CILLS, ETC.						
C	YARD FENCING AND GATES (WHERE APPLICABLE)			[12]	REPLACE FUEL FILTER CARTRIDGE		
D	WALLS (ANY CRACKS?)			A	CHANGE FILTER CARTRIDGE - EVERY 3 MONTHS		
E	ROOFS (ANY LEAKS?)						

Contractors are to note that all maintenance to Nickel Cadmium Alkaline batteries, charging equipment and accessories are to be in accordance with the manufacturer's requirements. Any loss or damage to the equipment through negligence on the Contractor's part will be for his account.

[13]	BATTERIES AND CHARGERS	YES	NO	CELL NO	Volts	Specific Gravity (SG)	YES	NO
A	CLEAN BATTERY / CONTAINER / STAND AND TERMINALS WITH LUKE WARM WATER AND DRY OUT			1				
B	NEUTRALISE CORROSION WITH BICARBONATE OF SODA SOLUTION			2				
C	TOP UP ALL CELLS WITH DISTILLED WATER			3				
D	CHECK SPECIFIC GRAVITY OF ELECTROLYTE IN EACH CELL WITH HYDROMETER			4				
E	CLEAN ALL BATTERY TERMINALS AND SPRAY WITH RED AND GREEN TERMINAL PROTECTOR SPRAY			5				
F	CHECK FOR LOOSE CONNECTIONS AND TERMINALS, TIGHTEN WHERE NECESSARY			6				
G	Ensure that battery charger is set on trickle charge			7				
H	15 AMP / VOLTMETER ON CHARGER OPERATIONAL			8				
I	IS TEST BUTTON ON CHARGER OPERATIONAL?			9				
J	CHECK INDICATION LIGHTS ON CHARGER AND REPLACE IF NECESSARY. INDICATE QUANTITY REPLACED (QTY)			10				
				11				
				12				

REMARKS : If answer is "NO" on any of the previous items, state action taken by yourself or to be taken by the Department

SERVICED BY _____ PRINT NAME	MODEL & SERIAL NO OF SET _____
SIGNATURE _____	LOCATION OF SET _____
COMPANY NAME _____	RUN TIME DURING TEST _____
DATE _____	RUN HR METER READING _____ Min.

4.3.6 RETURNABLE

A) SCHEDULE OF RATES

Where rates are not included in the Schedules of Quantities, the following rates, which shall be inclusive of, profit, supervision, administration and transport charges, shall be used to assess the value of variations to the contract.

The *Project Manager* may, if he considers that the rates below are unreasonable, request their amendment prior to acceptance of the tender.

1. DIESEL ENGINE PLANT

Item	Description	Unit	Qty	Rate
1.1	Drain and flush and replace crankcase oil	Sum		
1.2	Drain and replace injector box oil	Sum		
1.3	Drain, flush and replace radiator water with anti - freeze	Sum		
1.4	Replace radiator pressure cap / valve	ea	1	
1.5	Replace vee belt	ea	1	
1.6	Replace oil feed pump	ea	1	
1.7	Replace dry air filter	ea	1	
1.8	Replace radiator hoses	ea	2	
1.9	Replace starter motor	ea	1	
1.10	Replace 24V/12V battery charging system - & ensure correct operation	Sum		
1.11	Battery service	Sum		

Item	Description	Unit	Qty	Rate
1.12	Replace 12V battery – heavy duty industrial type	ea	1	
1.13	Rate to supply and install diesel fuel	liter	1	
1.14	Replace Duvalco 10-micron fuel cartridge – in line	ea	1	
1.15	Replace Duvalco 5-micron fuel cartridge – bulk tank	ea	1	

Note: The Contractor shall supply any additional information that may not be included on the above list.

SCHEDULE OF EQUIPMENT

B) EMERGENCY GENERATOR SET

TO BE COMPLETED FOR NEW PLANT

1. ENGINE

- | | | | |
|-------|--|---|-----|
| 1.1. | Manufacturer's Name | : | |
| 1.2. | Country of Origin | : | |
| 1.3. | Model Number | : | |
| 1.4. | Continuous Sea Level Rating after allowing
for Ancillary Equipment | : | kW |
| 1.5. | Percentage Derating for Site Conditions in
accordance with BS 5514 | : | |
| | (a) For Altitude | : | |
| | (b) For Temperature | : | |
| | (c) For Humidity | : | |
| | (d) Total Derating | : | |
| 1.6. | Guaranteed Nett Output on Site | : | kW |
| 1.7. | Nominal Speed | : | RPM |
| 1.8. | Number of Cylinders | : | |
| 1.9. | Strokes per Working Cycle | : | |
| 1.10. | Swept Volume | : | |
| 1.11. | Fuel Consumption of the Complete
Generating Set on Site in kg/h/kW of | | |

Alternator output at:

- (a) Full Load :
- (b) 3/4 Load :
- (c) 1/2 Load :

NOTE: A tolerance of 5% shall be allowed above the stated values of fuel consumption.

1.12. Method of Cooling :

1.13. Type of Radiator if Water Cooled :

1.14. Method of Protection against
High Temperature :

1.15. Method of Protection against Low
Oil Pressure :

1.16. Minimum Time required for Assumption of
Full Load :

1.17. Are Performance Curves attached? :

1.18. Make of Fuel Pump :

1.19. Make of Fuel Filters :

2. Fuel Tank (Day Tank)

2.1. Capacity : litres

2.2. Overall Height of Tank : mm

2.3. Overall Width of Tank : mm

2.4. Overall Length of Tank : mm

3. Fuel Tank (Bulk Storage Tank)

3.1.	Capacity (litres)	:	N/A
3.2.	Overall Height of Tank (mm)	:	N/A
3.3.	Overall Width of Tank (mm)	:	N/A
3.4.	Overall Length of Tank (mm)	:	N/A

4. **Alternator**

4.1.	Manufacturer's Name	:	
4.2.	Country of Origin	:	
4.3.	Output Power (Full Load)	:	kVA
4.4.	Nominal Speed	:	rpm
4.5.	Type of Enclosure	:	
4.6.	Class of Insulation	:	
4.7.	Phase-Phase Voltage	:	
4.8.	Max. Full Load Current	:	
4.9.	Efficiency at specified P.F.		
	and		
	(a) Full Load	:	
	(b) 3/4 Load	:	
	(c) 1/2 Load	:	

5. **Automatic Mains Failure Panel**

5.1.	Manufacturer's Name	:	
5.2.	Country of Origin	:	

5.3. Type of Board :

5.4. Main Busbar Size :

5.5. Make of Volt, Amp and Frequency Meters :

5.6. Ratio of Current Transformers :

5.7. Make of Hour Meter :

5.8. Rupturing Capacity :

6. **Dimensions of Generator Set**

6.1. Overall Length : mm

6.2. Overall Width : mm

6.3. Overall, Height : mm

6.4. Overall, Weight : mm

6.5. Minimum Recommended Dimensions for

Generator Room:

Length : m

Width : m

Height : m

7. **Battery**

7.1. Maker's Name :

7.2. Type of Battery :

7.3. Voltage of Battery :

7.4. Number of Cells :

7.5. Capacity :

NOTE: Under no circumstances will the tenderer be permitted to deviate from the materials specified above unless agreed in writing, by the Project Manager, prior to award of tender.

DATE:

SIGNATURE OF:

SPARE PARTS LIST

Tenderers shall complete the following schedule, listing and pricing all plant parts which are likely to require regular replacement and giving the Tenderers recommendation as to the stocks of spares that should be held by the owner. Unless otherwise stated prices shall be deemed to be inclusive of VAT and shall hold good for the duration of the Contract.

PLANT ITEM	SPARE PART DESCRIPTION	RECOMMENDED STOCKS	PRICE EACH DELIVERED TO WORKS
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			

PLANT ITEM	SPARE PART DESCRIPTION	RECOMMENDED STOCKS	PRICE EACH DELIVERED TO WORKS
14			
15			
16			
17			
18			
19			
20			

SIGNATURE: _____

DATE:

3.44. ELECTRONICS AND SECURITY SYSTEM INSTALLATIONS

General

All electronics and telecommunications equipment supplied under this contract shall be designed to perform effectively under the full range of conditions of temperature, pressure and voltage regulation prevailing.

The equipment shall also be capable of withstanding the highly corrosive effects of a moist saline atmosphere. All enclosures of equipment and outdoor equipment shall have a minimum degree of protection of IP66 and all equipment shall be able to withstand the vibrations present on the structures.

Electronic Equipment

All equipment and fittings supplied and installed under this contract, shall be in accordance with the standard and project specifications of this document. All distribution boards and kiosks shall be manufactured as per SANS 1973. All electrical panels and equipment shall be designed and manufactured in accordance with SANS 1973/60439. The equipment shall conform to SANS 60947 Parts 1 -7, unless otherwise stated, and shall be suitable for operation on supply voltages of 230/400 Volts, plus neutral and earth, 50 Hz, AC.

SCOPE OF WORKS

The Contractor shall supply, deliver, and install closed-circuit television, access control and all supporting infrastructure as indicated on this document below for this site at 99-steps. All work shall include all necessary required ancillaries for a complete operational security system.

3.45. TECHNICAL SPECIFICATION – ELECTRONICS ENGINEERING WORKS

1.1 Closed Circuit Television (CCTV) Control Room

Video Management System (VMS) in the Control Room to be indicated by PRASA.

a) Focus of Attention Interface

The Focus of Attention interface redefines the experience for monitoring live video. It helps increase operator effectiveness by providing an overview of events occurring across all cameras in the site, including analytic events, Unusual Motion Detection (UMD) events, motion events, and alarms. Operators can quickly triage the most important events at a given time by reviewing the associated live and recorded video to determine if a response is required.

b) Appearance Search Technology

CCTV shall be equipped with appearance Search technology which is a sophisticated artificial intelligence (AI) search engine that enables investigators to sort through hours of footage with ease and quickly locate a person or vehicle of interest across an entire site. Confirmed matches can also be used to initiate additional searches from other ACC sites. Search for a person of interest by entering their physical description, or by finding an example in recorded video. The search engine recognizes characteristics of a person's face to find matches, even if the person's clothing changes over time. Using Appearance Search technology can dramatically improve incident response time and enhance forensic investigations by allowing investigators to build robust video evidence and create a powerful narrative of events.

c) Self-Learning Video Analytics

The system shall have video management software that enables analytic events and alarms to be viewed and searched through an intuitive user interface. Real-time events and forensic capabilities shall detect and notify operators of scene changes and rules violations.

d) Unusual Motion & Activity Detection

The system shall be advanced with artificial intelligence technology that highlights the unanticipated by automatically flagging unusual motion and activity. This edge-based intelligence technology must distinguishes between typical and atypical events by continuously learning from observation of scenes over time. Unusual Motion Detection (UMD) detects atypical movement, while Unusual Activity Detection (UAD) is object-aware and detects the anomalous behavior (speed and location) of people and vehicles.

e) Cybersecurity & Privacy Protection

Video security measures shall include strong password enforcement, connection authentication and data encryption, as well as strict user permissions to access search functionality that uses personally, identifiable information. The system shall be equipped with blurred export to help support compliance with new data protection and privacy requirements of GDPR by allowing the user to export appearance search results in software while blurring the background of the camera view to feature only the person of interest in the video.

f) Video Intercom Support

This shall enables operators to monitor and control access at entry points through two-way audio communication, video certification, and the ability to send a door grant through the software.

g) Access Control Unification

Video Management Software (VMS) works together with the Access Control Manager (ACM) system to receive and act on ACM door events, hardware input events and access grants, enabling operators to unlock access doors directly from a camera view. Identity Verification dynamically displays ACM credentials with video camera views. Identity Search can help find a person of interest using their ACM cardholder information.

h) Facial Recognition

The system shall be AI-powered facial recognition technology that helps organizations accelerate response times by identifying people of interest. People of interest are identified based on one or more secure watch lists managed by authorized users at the organization. Populate watch lists easily by either uploading images or finding a face from recorded video.

A set of configurable controls are available to support the management of the various watch lists.

The service providers' cameras shall have a license for facial recognition will seek to identify potential matches based on the watch list(s), and if a match is found, the user is alerted through the FOA interface within VMS software, helping security personnel quickly determine if further action is necessary.

1.2 Equipment Specification

Network Video Recorders (NVR)

FIPS Series Service providers Network Video Recorders (NVR) provide secure, reliable and scalable platforms for high performance end-to-end security solutions. Service Provides network security recorders shall be pre-hardened to meet FIPS 140-2 Level 2 Security requirements and protect data-at-rest. All NVRs must be preloaded with video management software that uses FIPS-compliant cryptography for secure network video recording and video encryption. Cameras connected to the NVR's must encrypt data-in-flight using FIPS-compliant cryptography.

Enhanced Security Deployment

System must have video data encrypted at rest to FIPS 140-2 L2, secured with on-board TPM, via Windows BitLocker, OS drive encrypted to FIPS 140-2 L2, secured with TPM. Server 2016 STIG-compliant Windows OS.

Enhanced Security Deployment

Video data encrypted at rest to FIPS 140-2 L2, secured with on-board TPM, via Windows BitLocker, OS drive encrypted to FIPS 140-2 L2, secured with TPM. Server 2016 STIG-compliant Windows OS.

Risk Management Framework

Hardening guide to help customers secure their deployment and ensure all solution components meet stringent Risk Management Framework cyber requirements.

Superior Redundancy and Reliable Data Storage

NVR's must have reliable storage with RAID-configured redundancy offers a highly available and resilient system that protects your data. The suppliers shall have FIPS NVRs that include reliable hard drives with RAID 6 redundancy.

Federal Government Compliant Facility

NVR's must have built in a Federal Government compliant facility for ensuring authenticity and to help maintain strict adherence to procurement Federal Acquisition Regulations (FAR), trade agreements (TAA), and NDAA regulations

Solid-State Drive

Encrypted operating systems on a redundant array of Solid-State Drives designed for greater reliability and speed.

Embedded With Secure Video Management Software

Pre-configured with Video Management System software, optimized and provisioned to use FIPS-compliant cryptography for secure network video recording and video encryption.

Single Point of Contact for End-To-End Technical Support

All NVRs shall be backed by a 5-year hardware warranty with on-site part replacement service and lifetime 24/7 Service providers telephone technical support. Keep your drive warranty ensures the replaced drive remains in customer custody.

User-friendly graphical user interface	:	Simple data entry without need to leave main programme to reset configurations
Composite video inputs	:	4, 8, 12, 16 or more
Composite video inputs in networked configuration	:	Unlimited
Alarm inputs	:	1 per video channel
Alarm outputs	:	3 outputs, non-specific
Serial comms In/Out	:	2
Parallel port	:	1
Ethernet Comms	:	1 x 10/100 Mbps
Controller	:	Mouse and keyboard, point & click device for all operations
Image compression type	:	MPEG 4 version 2
Video resolution	:	550 TVL
Picture quality	:	768 x 576 @ 16 million pix
Recording quality	:	Option for 3 levels: 640 x 480, 320 x 240, 192 x 144 (standard default settings)
Frame rate	:	2.5 frames per second per input
Viewing frame rate	:	To view at same rate as recorded to confirm recording detail without need of playback
Print image to PC printer	:	Include camera name, extract detail and time/date text
Save to Bitmap	:	Extract, analyze, enhance and save relevant frames to any location
Main storage medium	:	Western digital hard drive 100gb or 120gb, 7 200 rpm
Main screen VGA video display	:	1, 2, 4, 8, 9, 13, 16
Record and playback/	:	

review simultaneously		Yes
Video motion detection/activity detection	:	Selectable per camera, with adjustable sensitivity and zone display
Schedule events	:	Daily programmable for 365 days of the year. Differentiate between alarm/motion detection/ scheduled (time specific) and mix of each
Playback time/date search	:	Quad playback with option to switch to single view. Comprehensive file search – specific to system, camera, date, time sequence
Search engine	:	Colour coded for easy data search. Differentiate between alarm, scheduled and instant recordings. Ability to zoom in/out on key time incident areas
Watchdog feature	:	Monitor software. Time set period will allow complete reset to last working configuration
Playback functions	:	Play forward, select speeds slow/fast on slide scale x 10 in both directions. Circular mode on single file or continuous file playback. Ability to pause each playback within quad and resume each separately or play/pause/stop all
Housekeeping	:	Manage all files with a view to move/copy to any chosen locating including CD writer and DVD writer. Playback and review multiple files of sequenced time specific view to confirm chain of events prior to detailed analysis on playback
Security	:	Two level log on. Supervisor & operator, (password protected) Audit trail including alarm log, playback server & remote server.

		Ability to embed system with restriction of access to all other programmes. Check watermark facility to show tamperproof integrity on all recorded files
Remote dial in software	:	Dial in/out to server location, view live video, playback, download key files, alarm notification, PTZ control, housekeeping of all data
Remote station software	:	PAN, LAN, WAN, DSL, ATM access to server location, view live video on multiple sites simultaneously, playback, download key files, alarm notification, PTZ control, control audio settings, chat server, housekeeping of all data

NVR general requirements:

- The system shall support colour and monochrome cameras.
- All video inputs shall be fully multiplexed, encrypted and compresses to maximize the recording capability of the system and recorded to the Hard Disk Drive (HDD). Key System activities shall be registered within the Audit Trial log for easy recall by event, time or date.
- Circular motion recording to overwrite previously recorded information within a pre-determined time frame or when the hard disk is full
- Option for alarm files to be retained while circular motion takes place.
- A buffer should be clearly seen of not less than 7% Reserved Space on each hard drive with a 10% File Retention Limit to assist with stability of Operating System.
- File management to enable access to recorded information by camera number date/time/event triggered recordings and the like.
- Password protection to control access to system functions, operations and the like.
- Immediate on demand printing via a local colour (photo quality) printer (printer not part of Contract).

- Storage of compressed video to Hard Disk.
- Archiving of stored compressed video to CD Writer, DVD writer or nominated archived media, for extended storage periods.
- Receiving and handling alarms. Alarm inputs shall support Normally Open/Normally Closed functionality.
- Allow network client connections for replay and viewing of video data.
- Logging all events that occur each day.
- Manage multiple user connections.
- Allows images of interest to be exported to a removable portable storage medium (floppy disk, CD-ROM, ZIP disk or similar) as a Bitmap file for evidence.
- The DVR shall run on fully Licensed Microsoft Windows, etc NT4 Windows 2000 Professional or Windows XP Professional. A license certificate number should be affixed to the outside of each ATX Tower.
- Supplied with SVGA 19" monitor, 12 function PS2 keyboard (101 types preferred), USB optical mouse.

Recording Requirements

- The video inputs of the DVR Server shall be recorded on to the NVR Hard Disk Drives
- The DVR Server shall be configured to record each camera input upon alarm activation, motion detection, time scheduled or continuous mode recording as nominated for each camera/input.
- Review of pre-recorded video shall be displayed in various modes including, but not limited to full screen and quad screen mode.
- All recorded information shall be date time stamped and stored as MPEG 4 Version 2 within clearly demarcated folders for easy retrieval. This should be computer name/camera/date/time/event.
- The DVR system shall be configured with adequate Hard Disk Drive capacity to:

- Allow for 14 days event (Motion Detection) recording assuming:
 - 50% Motion at peak hours (7h00 – 9h00; 12h00 – 14h00 and 16h00 – 18h00)
 - 40% Motion during normal working hours (7h00 – 18h00 excluding peak hours above)
 - 30% Motion during quiet hours (0h00 – 7h00 and 18h00 – 0h00)
- Hard Drives must be configured to a suitable File Structure for long term stable recording without deterioration over time.
- The DVR shall provide, but not be limited to, the following recording functions:
 - Utilize the latest technology.
 - Provide a resolution frame size of 768 x 576 pixels (Full Frame).
 - Record up to 14 days on Hard Disk Drive.
 - Provide review of archive video and alarm data.
 - Provide transfer of video and alarm data from CD read/writer, DVD writer or nominated archived media to Hard Disk Drive.
 - Each video frame shall have time date stamp.
 - Provide authentication software algorithms for all recording to prove that tampering has not occurred, and recordings have not been altered (water marked).
 - Provide simultaneous playback of any file while recording current video inputs.
- The DVR shall be tested and configured to confirm the number of alarm/motion events on site to ensure a minimum of 14 days recorded information on set hard disk space.
- All recorded information shall be accessible without disruption to the recording process, duplex operation. Recordings shall be instantly accessible even though the event is still recording, instant playback without any delay.
- All recorded information shall meet the evidentiary requirements for the presentation of video information. A check watermark facility must be available to confirm if files have been changed in any way. This facility should accompany any evidence removed to CD or other evidential presentation material.

Cabling

Double screened 50 OHM coaxial cable shall be supplied. Suitable cable with Flooding Compound shall be use where cable may lie in water, in sleeves or conduit.

1.3 Network Video Recorder Specification

A. Throughput: NVR system must be capable of managing a combined 1,150 Mbps of total

Through-put with handling for simultaneous recording, playback and live streaming.

- Recording: 700 Mbps.
- Playback: 450 Mbps.

B. Search Capacity: Provide products capable of supporting the following:

- Events search such as motion, digital input, classified object, arbitrary events and tampering across all features enabled cameras connected to the system.
- Object similarity search up to 200 cameras simultaneously. When combined with facial recognition the system must be capable of supporting up to 100 cameras using object similarity and up to 50 cameras using facial recognition features.

System Design:

- Operating System: Microsoft Windows Server 2016.
- Operating System: Microsoft Windows 10 Enterprise Embedded.
- Processor: Intel Xeon.
- RAM: 16GB DDR4.
- Video Output: VGA.

Operating System Storage: Two (2) M.2 SSD drives configured with subsequent write capability, data mirroring, and redundancy, such that one (1) drive may be removed, replaced, or fail without system compromise (RAID 1).

Video Data Storage Capacity: Provide system with the following configurations:

- Default Effective Storage Capacity: 10 TB
- Maximum Drive Count: Maximum eight (8) 3.5-inch drives.
- Maximum Data Capacity: 10 TB raw (10 TB effective).
- Data Storage Virtualization: Provide drive array capable of subsequent read and write, with data mirroring, and redundancy, such that up to two (2) drives may be removed, replaced, or fail without system compromise (RAID 6).

Mounting: Standard server enclosure (rack) mounting, requiring no greater than a 2U configuration.

Network: Provide four (4) 1Gb Ethernet RJ-45 ports (1000Base-T).

Remote Access: Provide hardware-integrated support for remote access control.

Basis of Design: iDRAC 9 Express by Dell Technologies or similar

Electrical Power:

- Input: 100 to 240 V AC, 50 Hz, auto-switching.
- Power Supply: Provide single power supply. NETWORK VIDEO RECORDERS28 05 19.15-4
- Redundant Power Supply: Appliance must be configurable for dual power supplies that may be replaced without the need to power down (hot-swappable).
- Power Consumption:
 - Maximum: 750W
 - Average: 269W

Operating Range:

- Temperature: 10 to 35 degrees C (50F to 95F).
- Relative Humidity: 10–80 percent (non-condensing).
- Altitude: 3048 meters (10,000 ft).
- Vibration: 0.26 Grms at 5 Hz to 350 Hz.
- Shock: One pulse on each side of the system of 71 G for up to 2 ms.

ACCESSORIES

- Power Supplies: - NVR4X-750W-2NDDPS: Redundant, hot-swappable power supply for NVR4X STD.
- Connectivity:
 - NVR4X-STD-10GBE: Network Card, DP 10G-SFP+.
 - HD-NVR4-SFPPLUS-DA: SFP+ 10GbE Twinax Direct Attach Cable 3m.
 - NVR4X-SFPPLUS-SR: SFP+ 10GBASE-short range transceiver.
 - AVA-HED1-NVR4X-STD-CONNECT
- Software:
 - NVR4-IDRAC-ENT-UPG: iDRAC Enterprise upgrade.
- Warranty Upgrade:
 - NVR4X-STD-WARR-5Y4HMC: 4 hour mission critical response service-level agreement upgrade.
- Hard Drives:
 - NVR4-HDDS-HOT-8TB: Spare hard drive, 8TB, front or rear bay.
 - NVR4-HDDS-HOT-4TB: Spare hard drive, 4TB, front or rear bay.

1.4 Camera Specification

Camera Type 1 – IR Bullet Camera with Analytics 3MP

- 1 / 1.8” Progressive Scan CMOS
- Full HD1080p video
- Dual video streams
- 9 - 22mm vari-Focal lens
- 140dB Wide Dynamic Range
- 100db True Dynamic Range
- 3D Digital Noise Reduction
- Backlight Compensation
- DC12V & PoE (ePoE capabilities)
- Support H.264
- Up to 60m IR LEDs range
- 20 images per second at full resolution
- Protection (IP67 weather-proof) IK10
- Metallic housing & bracket
- Mobile Monitoring via EZVIZ P2P or iVMS-4500
- Mobile monitoring via CC Mobile or ACC Remote client
- Conformant with ONVIF Profile S

Camera shall have a 5-Year Warranty

H.265 & HDSM Smartcodec Technology

Shall combine newest compression technologies to maximize bandwidth and storage savings.

Focus of Attention

Leverages AI and video analytics technologies to determine what information is important and should be presented to security operators.

Teach By Example Technology

Camera Type 2 – High Speed PTZ Camera (250m IR)

- 1 / 2.8” Progressive Scan CMOS
- Full HD1080p video @ 60FPS
- IR Illumination to a distance of 250m
- Dual video streams
- 120dB Wide Dynamic Range
- 3D Digital Noise Reduction
- Backlight Compensation
- DC12V & PoE ++
- Support H.265+
- Supports Full Duplex Audio
- Supports face detection.
- 500 Presets
- Electronic Stabiliser
- IP67 weather-proof protection
- Metallic housing & bracket
- Mobile Monitoring via EZVIZ P2P or iVMS-4500
- Mobile monitoring via CC Mobile or ACC Remote client
- Conformant with ONVIF Profile S

Camera shall have a 5-Year Warranty

H.265 & HDSM Smartcodec Technology

Shall combine newest compression technologies to maximize bandwidth and storage savings.

Next-Generation Video Analytics

Expanded object classifications and more accurate detection in crowded scenes so you can detect and act faster.

Focus of Attention

Leverages AI and video analytics technologies to determine what information is important and should be presented to security operators.

Supported Analytics Events

Objects in Area - The event is triggered when the selected object type moves into the region of interest.

Object Loitering - The event is triggered when the selected object type moves into the region of interest and then stays for an extended amount of time.

Objects Crossing Beam - The event is triggered when the specified number of objects have crossed the directional beam that is configured over the camera's field of view. The beam can be unidirectional or bidirectional.

Object Appears or Enters Area - The event is triggered by each object that enters the region of interest. This event can be used to count objects.

Object Not Present in Area - The event is triggered when no objects are present in the region of interest.

Objects Enter Area - The event is triggered when the specified number of objects have entered the region of interest.

Objects Leave Area - The event is triggered when the specified number of objects have left the region of interest.

Object Stops in Area - The event is triggered when an object moves into a region of interest and then stops moving for the specified threshold time.

Direction Violated - The event is triggered when an object moves in the prohibited direction of travel.

Tamper Detection - The event is triggered when the scene unexpectedly changes.

Object Types of Classification - Vehicle, sub-types: Car, Truck, Bicycle, Motorcycle, Bus, and Person

Teach By Example Technology

1.5 12 U Cabinet

A 12U cabinet shall be supplied and installed with a 5kVA, 230V uninterrupted power supply fitted within the cabinet.

3.46. WORK REQUIRED IN THE COMMISSIONING OF PROTECTION EQUIPMENT

The commissioning of protection equipment for LV systems and electronics can be broken up into a number of broad categories.

- Panel tests and visual Inspection;
- Implementation of applicable technical instructions;
- Secondary tests;
- Primary tests;
- Review and submission of documentation;
- Energisation and on load checks;

- Sign off and handover of electrical and electronic plants for use and operation by the owner.

Each of the categories requires documentation to reflect that the test(s) required have been completed. The documentary evidence must include:

- The relevant equipment or panel name.
- The checks performed;
- The name of the person who performed the checks;
- The date on which the checks were performed;
- The signature of the person who performed the checks.

3.47. PANEL TESTS AND VISUAL INSPECTION

The purpose of this group of activities is to check and produce documentary evidence that:

- The panel and all contained equipment is visibly intact and mechanically sound,
- The panel and contained equipment have not been damaged in transit,
- The panel is wired according to the application drawings supplied, and that the design version between the equipment and the drawings is the same.
- The equipment contained in the panel corresponds in make, model and function to the application drawings.
- The panel and associated equipment is correctly earthed according to the SANS standards.

3.48. IMPLEMENTATION OF APPLICABLE TECHNICAL INSTRUCTIONS.

The purpose of this activity is to ensure that modifications to the protection panels required by approved technical instructions are implemented to the protection equipment prior to secondary injection. Documentation is to be in the form of the instruction with reference

number, the name of the person who implemented the instruction and the date of implementation is required.

3.49. SECONDARY TESTS

This group of activities comprises the following:

- Application of settings of all protection devices.
- Relay characteristic tests and logic functions according to settings provided and manufacturer specifications.
- End to end checks for Impedance and current differential schemes.
- Supervisory controls, alarms, indications and analogue outputs are correct to the control centre.
- To ensure that test blocks and shorting strips function correctly.

3.50. PRIMARY TESTS

All primary tests must be according to relative SANS regulation.

3.51. NORMALISATION OF CIRCUITS

During the primary and secondary injection tests, the trip and alarm circuits are usually rendered inoperative by the removal of isolating links, relay trip latches and so on. It is therefore essential that, when the primary and secondary injection tests have been completed, the tripping and alarm circuits be checked. Certain settings may have been altered during testing and these have to be normalized. Certain protection functions may have been deactivated in order to test other complimentary functions and these have to be reactivated as per the settings and configuration documentation.

3.52. CONSOLIDATION AND REVIEW OF TEST RESULTS

The purpose of this group of activities is to consolidate the test results and;

- Ensure sure that all tests originally planned have been completed
- Ensure that all test results are consistent with reasonable Employer expectations
- Ensure that any defects have been addressed
- Ensure that the head of commissioning is satisfied that the equipment is ready to be made live and arrangements have been made with an authorized person and to clear all outstanding work permits.
- Complete the equipment test sheet that permits the equipment to be energised.
- Certificate of Compliance (CoC) must be issued will all other test results reports.

3.53. ENERGISATION AND ON LOAD CHECKS

There are some checks and tests that cannot be performed while the equipment is de-energised.

It must be stressed that the equipment cannot be considered to be completely commissioned until on-load checks have been completed and results documented.

The following checks are required:

- Correct phase rotation.
- Current measurement checks / on-load confirmation of CT ratios.
- On-load stability checks for differential schemes
- On-load directional checks for directional overcurrent and impedance relays.
- Confirmation of transducer loading if applicable.

On the successful completion of the on-load checks, a handover document / mechanism is required that indicates that the equipment has been fully commissioned.

3.54. TRAINING

Electrical Installations

Contractor shall train the PRASA staff on new equipment on how to operate the LV panel and other electrical related installations. Training shall include how to clear faults on the system once it has been attended to. Training to include all other electrical related issues that will be require by maintenance and operating PRASA staff.

3.55. FINAL DOCUMENTATION

The purpose of this phase of the process is to ensure that all documentation and test results are compiled and submitted to the Employer.

- a) Handover Certificate: is to be signed by the Contractor and the Supervisor.
- b) Completed Checklists: A hard copy of the all of checklists of completed activities to be forwarded to the Project Manager. All appropriate tests, dates, responsible persons and signatures are required. Electronic copies of scanned hard copy documents are also acceptable.
- c) Commissioning Test Results: four sets of hard copies of the Commissioning Test Results, including hard copies of manuals, etc. are required to be submitted to the Employer. Dates, responsible person's name and signatures are required. Electronic copies of scanned hard copy documents are acceptable. The above shall be included in the data packs to prove completion.
- d) Proof that all applicable technical instructions have been implemented:
 - i. Technical Instructions that may be applicable to the equipment concerned.
- e) Proof of Applied Settings: All settings applied to all relays to be retrieved from the relays (downloaded) and hard or electronic copies to be forwarded to the Project Manager.

SECTION 5 – MECHANICAL ENGINEERING

1. SCOPE OF WORK

The mechanical services consist of heating, ventilation and air conditioning, wet services and fire services. The scope is as follows:

- Supply and four 9kg Dry Chemical Powder portable fire extinguishers.
- Supply and installation fire, directional, and safety signage.
- Commission and testing of all HVAC and fire protection systems.

2. DOMESTIC WATER RETICULATION

The wet services scope shall be limited to restoring the existing wet services in various facilities; all defective water piping and fittings shall be replaced and concealed as stated in this section.

2.1. DOMESTIC WATER PIPING

The following are applicable:

- Unless stated otherwise, the cold-water reticulation shall be through plastic polymer piping.
- All Piping Shall be concealed inside the ceiling voids or chased on the wall for increased security.
- All Piping Shall be concealed inside the ceiling voids or crashed on the wall for increased security.
- All Plastic Piping should be protected from direct sunlight.
- Attention shall be given to the burning characteristics of plastic materials used in high fire risk areas or close to sources of heat that can impair their performance.

- Unless plastic pipes or fittings are suitably protected, they shall not be used in a position where the permeation of gas or any other substance can cause (or is likely to cause) contamination of the water in them.
- Piping systems manufactured from polyethylene shall comply with the requirements of SANS 4427-1, SANS 4427-2, SANS 4427-3 and SANS 4427-5.
- Piping systems manufactured from polypropylene shall comply with the requirements in SANS 15874-1, SANS 15874-2, SANS 15874-3 and SANS 15874-5. The working pressure (for cold water temperatures exceeding 20 °C) of polyethylene and polypropylene pipes shall be rated in accordance with the requirements in SANS 4427-1, SANS 4427-2, SANS 4427-3 and SANS 4427-5, and SANS 15874-1, SANS 15874-2, SANS 15874-3 and SANS 15874-5, respectively.
- PVC-U pipes and fittings that comply with the requirements of SANS 966-1; PVC-M pipes and fittings shall comply with the requirements in SANS 966-2 and PVC-O pipes shall comply with the requirements in SANS 16422.
- Plastics pipes and fittings for hot and cold-water supply systems shall comply with one of the following standards:
 - for PE-X (cross- linked polyethylene): SANS 15875-1, SANS 15875-2, SANS 15875-3 and SANS 15875-5;
 - for PB (polybutylene): SANS 15876-1, SANS 15876-2, SANS 15876-3 and SANS 15876-5;
 - for PVC-C (chlorinated polyvinyl chloride): SANS 15877-1, SANS 15877-2, SANS 15877-3 and SANS 15877-5;
 - for PE-RT (raised temperature cross linked polyethyelene): SANS 22391-1, SANS 22391-2, SANS 22391-3 and SANS 22391-5; and
 - PE-X Multi-layer piping systems: SANS 21003-1, SANS 21003-2, SANS 21003-3 and SANS 21003-5.
- The minimum rating of a polymer pipe used in hot and cold-water systems in buildings is class 2, PN16 at 20 °C, 8 bar at 70 °C, and shall be marked as such on the pipe.
- Algae growth can occur in plastics pipes if there is any translucence. Plastic pipes on hot and cold systems shall only be used inside buildings.
- For pipes and fittings, guidance on the application of the system shall be found in SANS 4427-5, SANS 15874-5, SANS 15875-5, SANS 15876-5, SANS 15877-5, SANS

22391-5 and SANS 21003-5. Any plastic piping systems for hot water use shall be class 2 (70 °C operating temperature) and shall have a minimum operating pressure (M.O.P) of 600 kPa (6 bar) at 70 °C.

- For thermal expansion, loop requirements refer to specification.
- All water piping chassed on the wall shall be wrapped with Heavy brown paper as a sheath for expansion.
- Pipe supports should be so positioned that they should be at least 500mm away from a change of direction fitting i.e. tee, elbow, etc.

SECTION 6 - OCCUPATIONAL HEALTH AND SAFETY

Contractors must comply with but not limited to:

- National Building Regulations and Building Standards Act, 1977 (Act 103 of 1977)
- Occupational Health and Safety Act 85 of 1993.
- Construction Regulations 2014
- National Environmental Management Act 107 of 1998
- Hazardous Biological Agents Regulations (Covid19)

Contractor to ensure that all work surfaces area sanitized and that there is clean water for washing hands.

Contractor to ensure that they are registered with the workman's compensation fund and have a valid in date Letter of Good Standing.

Contractor to ensure that the Department of Labour has been notified in writing of any construction works that may be undertaken.

Where demolition works are being undertaken, the Contractor must appoint a competent person in writing to supervise all demolition works.

Contractor must ensure that all excavation works being undertaken, the Contractor must appoint a competent person in writing to supervise all excavation works.

Contractor to ensure that all works are managed by competent persons that are appointed in writing as per legal register.

Contractor to ensure that provisions for Personal Protective Equipment, Signage and barricading is provided at all times.

Contractor to ensure that scope of works is aligned as per drawings that shall be issued.

Contractor must ensure that the work area is barricaded and has a separate entrance for the site.

Contractor to ensure that where scaffolding is being used that they comply with the following:

- Appoint a competent scaffold erector and dismantler in writing.
- Appoint a competent scaffold inspector in writing.
- To green tag scaffolding that is safe to use.

Contractor to ensure that all electrical works being undertaken must be done by a competent electrician appointed in writing and are done as per drawings and when works are completed, they must have certificates of conformance for the works.

SECTION 7 – RELEVANT CODES AND STANDARDS

The following codes are relevant:

- SANS 1200 A – General
- SANS 1200 C – Site Clearance
- SANS 1200 LB – Bedding (Pipes)
- SANS 1200 LC – Cable Ducts
- SANS 1200 MF – Bases
- SANS 1200 AH – General (Structural)
- SANS 1200 G – Concrete
- SANS 1200 H – Structural Steel
- SANS 2001-CC1 – Construction works – Part CC1: Concrete Works (Structural)
- SANS 2001-CS1 – Construction works – Part CS1: Structural Steelwork
- SANS 10100-1 – The structural use of concrete Part 1: Design
- SANS 10100-2 – The structural use of concrete Part 2: Materials and execution of work
- SANS 10144 – Detailing of steel reinforcement for concrete
- SANS 10160 – Basis of structural design and actions for buildings and industrial structures
- SANS 10162-1 – The structural use of steel Part 1: Limit-states design of hot-rolled steelwork
- SANS 10162-2 – The structural use of steel Part 2: Cold-formed steel structures
- SANS 10400 – The application of the National Building Regulations
- PART A – General Principles and Requirements
 - PART B – Structural Design

- PART C – Dimensions
 - PART D – Public Safety
 - PART F – Site Operations
 - PART J – Floors
 - PART K – Walls
 - PART L – Roofs
 - PART M – Stairways
 - PART N – Glazing
 - PART O – Lighting and Ventilation
 - PART P – Drainage
 - PART R – Stormwater Disposal
 - PART T – Fire Protection
 - PART W – Fire Installation
- SANS 10142 -1 - Code of Practice for the wiring of premises.
 - SANS IEC 60614 (1) - General requirements of conduits.
 - SANS 61035 - Installation of Conduit Fittings.
 - SANS IEC 61084 - Electrical Installation Ducting & Trunking Systems.
 - SANS 1507 & 1574 - PVC Insulated Single Core Voltage Conductors.
 - SANS 1464 and IEC 598-1 - Mounting & Positioning of Luminaries.
 - SANS 10114 - Code of Practice for Artificial Interior Lighting.
 - SANS 1973/61439 - Distribution Boards.
 - SANS 1973-1 - Low voltage switchgear & control gear.
 - SANS 10313 - Code of Practice for the Protection of Structures against Lightning.
 - SABS 1424-1987 - Filters for air-conditioning and general ventilation
 - Machinery and Occupational Safety Act
 - IEC 60364-7-712, Electrical installations of buildings - Part 7-712: Requirements for special installations or locations - Solar photovoltaic (PV) power supply systems.
 - IEC 61727, Photovoltaic (PV) systems - Characteristics of the utility interface.

- IEC 61683, Photovoltaic systems - Power conditioners - Procedure for measuring efficiency.
- IEC 62093, Balance-of-system components for photovoltaic systems - Design qualification natural environments.
- IEC 62116, Test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters.
- IEC 62446, Grid connected photovoltaic systems - Minimum requirements for system documentation, commissioning tests and inspection.
- IEC 61724, Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis.
- IEC 61850-7, Communication networks and systems for power utility automation - Part 7-420: Basic communication structure - Distributed energy resources logical nodes.
- IEC 60870, Tele-control equipment and systems.
- SANS 10222-5-1-2:2007 Electrical security installations CCTV installations – CCTV surveillance systems for use in security applications: System design requirements and Operational requirements
- SANS 10222-5-1-2:2007 Electrical security installations CCTV installations – CCTV surveillance systems for use in security applications: Installation, planning and implementation requirements, testing, commissioning and hand-over requirements
- Occupational Health & Safety Act 85 of 1993.
- The Local Authority by-laws and any special requirements for the district concerned.
- Local Fire Regulations.
- National Building Regulations

SECTION 8 – MAINTENANCE

1. Solar system

This specification covers the on-site routine preventative maintenance requirements to ensure effective management of the solar system and low voltage electrical installations to provide an appropriate return on investment life cycle of the asset.

All maintenance work and repairs carried out must be done by a qualified electrician who possess a wireman's licence, 400V installation, and PV Green Card Certificate.

Prior to performing any maintenance or repairs, the respective Project Manager must issue a permit signed by both parties prior to any isolation or switching, unless emergency switching is required to ensure the safety of personnel or equipment. The Maintenance Manager must witness all isolation, earthing and lock-out procedures.

Working on building low voltage electrical installations is inherently high risk and it is therefore important that the following minimum safety procedures be adhered to prior to performing any maintenance activities:

- Inform the respective Project Manager of any preventative maintenance work planned with a notification period of minimum 14 calendar days.
- The Maintenance Manager must inform all affected parties of any planned maintenance and arrange preventative measures to limit risk, where required.
- Sign the Isolation Permit that must contain all the names of personnel who will work on the solar system and low voltage electrical installation.
- Ensure that all personnel have done the Client's safety induction and will always adhere to the Clients minimum safety requirements.
- Acquaint and discuss with all staff involved the safety procedures prior to carrying out maintenance work.

- Always Wear the required personal protective equipment (PPE) (i.e. Safety harness, gloves, safety glasses, etc.).

A detailed report must be forwarded to the PRASA's Project Manager within 3 working days after the preventative maintenance or breakdown repairs was completed. The report must contain the following minimum information:

- Date of attendance.
- Commencement and completion times.
- Confirmation of all planned work carried out.
- All other defects found that could not be rectified.
- Recommendation on actions to be taken and proposed date to rectify the defects.
- Estimated cost to effectively rectify the defects if not included in the schedule of rates.
- Company electricians name and signature.
- Company supervisor name and signature.

The following minimum routine preventative maintenance procedures shall be performed to solar panels and low voltage electrical installations:

NO	DESCRIPTION	Maintenance Cycle
1	Check rubble that's accumulated on the panels and clear away if necessary.	Bi-Annually
2	Use a leaf blower, soft broom or spray with a garden hose pipe to sweep off dust, bird nest or leaves.	Bi-Annually
3	Check the condition of all panels. Replace if broken or cracked.	Bi-Annually

NO	DESCRIPTION	Maintenance Cycle
4	Any inefficiency or under performance shall be attend to within 2 days, investigate the cause and report to PRASA. Repair or replace broken equipment.	On-going
5	Manual electrical testing such as open-circuit voltage, operating current, or field I-V curve tracing is used as a method to detect faults in the DC system that the monitoring system is not able to detect	Bi-Annually
6	Because the above testing must be performed inside the isolated combiner while the system is operational, arc-flash PPE is required for all testing—which can limit the speed of effective inspections and can pose a potential safety risk to operators.	Annually
7	Battery storage system, two parallel strings of batteries are connected so that one may be taken out of service for maintenance while the other string provides at least some storage for continued operations.	General
8	Temperature, charge/discharge rates (amps), and the DOD each have a major influence on the cycle life of the cells	General
9	Check the distribution board cover to make sure it is properly secured.	Bi-Annually
10	Inspect and test all DB cover plates are fitted correctly square key locks to operate correctly. Make necessary adjustments if required or replace.	Bi-Annually
11	Ensure that all open spare spaces on the cover plate are fitted with blank cover plates.	Annually
12	Check that the distribution board is equipped with a correct designated label and a legend card which corresponds to the circuit breakers, contactors, fuses, etc. If not, fit a typed legend card.	Annually
13	Check that each of the circuit breakers, contactors, fuses, etc. are properly labelled, if not, fit labels.	Annually
14	Ensure that all circuit breakers, contactors, fuses, etc. are securely fastened.	Annually

NO	DESCRIPTION	Maintenance Cycle
15	Check and correct covers on all bedhead trunking. Check that no wiring or connections are damaged during opening or closing. Check and correct labelling to show circuit data.	Bi-Annually
16	Test the correct operation of all earth leakage units, replace all defective units.	Annually
17	Inspect all electrical distribution boards to ensure that the distribution board frame is securely mounted in position.	Annually
18	Inspect to make sure that the electrical distribution board door hinges are in place and the door barrel bolts and locking mechanisms are in place and that the doors open and close correctly, make necessary adjustments. Fit new doors where required.	Annually
19	Inspect the distribution board for any corrosion, rectify or treat appropriately where necessary.	Annually
20	Check whether the distribution board labels and legend are fitted and readable. If not, fit new labels and legends in accordance to the specification.	Annually
21	Check the distribution board cover for corrosion and to be the correct colour in accordance with the source of supply. (Normal Power - WHITE. Essential Power - RED and UPS Power – BLUE)	Annually
22	Ensure that a label is fitted below the main circuit breaker on the cover plate indicating the source, main supply cable size, operating voltage and fault level of the distribution board.	Annually
23	Record all checks and tests, ensure that the Maintenance Manager sign off and the contractor's supervisor prior to submission to PRASA's Project Manager.	Annually

2. CCTV System Preventative Maintenance

Camera Performance

- Inspect image quality for clarity, colour accuracy, and resolution.
- Check for any signs of image distortion or flickering.
- Test camera functionality, including PTZ, and focus (if applicable).

Recording and Storage

- Check the status of the recording equipment, such as Network Video Recorders (NVRs).
- Verify that sufficient storage space is available for continuous recording.
- Test playback functionality to ensure recorded footage accessibility.

Power Supply

- Inspect power sources, including backup power systems such as Uninterrupted Power Supply.
- Test the system's response to power fluctuations or outages.

Cable and Connection Inspection

- Inspect cables for signs of wear, damage, or exposed wiring.
- Ensure all connections are secure, including power, video, and data cables.

Visual Inspection

- Check for physical damage to cameras, cables, and housings.
- Verify proper camera positioning and angles for optimal coverage.

- Ensure clear visibility of camera lenses from dirt, debris, or obstructions.

Cleaning and Maintenance

- Regularly clean camera lenses, housings, and cables to prevent dirt and debris build-up.
- Use appropriate cleaning solutions and tools to avoid damage to sensitive components.