Eskom	Employer's Requirement Report	Group Technology

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EXECUTIVE SUMMARY

Kriel Power Station Units (1-6) are equipped with two Diesel Generators per unit which are connected in parallel for the essential standby supplies and for the full power supply redundancy. Diesel Generators serve as a back-up power to the 380V Essential Boards in the event of total loss of AC supplies on the unit. Both Diesel Generators are required to be operational in the event of power supply failure at Kriel Power Station since each 380V Essential Board is loaded with independent loads, although most of the critical loads are fed from 380V Essential Board B. Critical essential loads that are supplied from the 380V Essential Boards include jacking oil pumps, main turbine barring gear, 24Vdc, 110Vdc and 220Vdc battery and chargers. The above stated systems are required to safely operate the units and in the event of power failure they are required to be kept operational to allow the unit to run down safely.

The existing Diesel Generators at Kriel P/S for U3-U6 have been in operation since 1973 with OEM ceasing manufacturing of the sets in 1995. The Diesel Generators for U3 to U6 have surpassed the operational lifespan of 35 years: compounded by frequent breakdowns due to aging and spares obsolescence (24V starter, 24V alternator, water temperature sensors, oil pressure sensors, couplings between the engine and the rotor, and unreliable diesel governors).

Kriel Power Station requires an urgent replacement of U3-U6 Diesel Generators to bring back the reliability of the unit back up system.

The detail design for this project shall be performed by the Contractor in accordance with the Diesel Generator Standard (240-62772907) and only the technical requirements and interfaces required for the replacement of Kriel Diesel Generators for U3 – U6 with an equivalent (400kVA) Diesel Generators shall be define as part of this document. The high level scope of work includes:

- Decommission and removal of existing U3-U6 Diesel Generators and preserved for spare items.
- Detail design, manufacturing, construction, factory acceptance testing, transporting, offloading, installation, site acceptance testing and commissioning of eight (8) new Diesel Generators (400kVA) for U3-U6.
- Ensure that the new U3-6 diesel generator systems provided are compatible and functional with the Employers installed controllers.
- Verify, configure and commission any new logics and programming on the existing Deep Sea controllers.
- Retrofit the termination panels to suit the design and interface requirements.
- Provide and terminate all new control and alarm cables required for the Works.
- Retrofit the existing diesel generator breaker panel to be used as inter-connector box between the new diesel generator breakers and the 380V Essential Boards.
- Reroute the existing flexible power cables from the existing diesel generator breaker panel and terminate between the inter-connector box and the new Diesel Generators.
- Decommissioning of the existing battery banks and preserve for spare items.
- Size the new battery banks for Diesel Generators based on the required size of the new Diesel Generators.

- Ensure all new electrical equipment to be installed are earthed and properly bonded to the existing earth mat.
- Carry out a spray test on the existing deluge system and repositioning the nozzles when required.
- Install the ducting between the walls of the diesel generator room and the radiator to ensure that the heat removed from engine is directed outside of the diesel generator room.
- Perform the RAM (Reliability, Availability and Maintainability) studies of the equipment to be replaced in the Works.
- Produce all documentation and drawings for the Works.

It is recommended that the new diesel generators are of similar weight or less than that of the existing diesel generators or the *Contractor* shall have to conduct a detailed structural analysis of the supporting floor if the new generators are heavier and/or have a higher dynamic load than the existing generators.

Project scope exclusions

The existing fire deluge system and existing ventilation system shall be retained. The upstream essential system electrical reticulation (11kV Unit Boards to 380V Unit Essential Boards) will also be excluded.

1. INTRODUCTION

Kriel Power Station Units (1-6) are equipped with two Diesel Generators per unit which are connected in parallel for the essential standby supplies and for the full power supply redundancy. Diesel Generators serve as a back-up power to the 380V Essential Boards in the event of total loss of AC supplies on the unit. Critical essential loads that are supplied from the 380V Essential Boards include jacking oil pump motor, jacking oil booster pump motor, seal oil pump motor, turbine barring gear motor, 24Vdc, 110Vdc and 220Vdc battery and chargers. The above stated systems are required to safely operate the units and in the event of power failure they are required to be kept operational to allow the unit to run down safely.

Diesel Generators for U3 - U6 have surpassed the operational lifespan of 35 years: compounded by frequent breakdowns – exhausts corrosions, couplings and fuel injectors failures, oil leaks, radiator fouling, controls and spares obsolescence. The exhaust system on U5 Set B Diesel Generator failed during normal routine testing on July 2016. The unit 5 Diesel Generator room was filled with smoke due to corroded exhaust and eventually the U5 Set B Diesel Generator shut down. Currently there is only one Diesel Generator in service for Unit 5 (Set A) and thus imposing a higher risk for the safe shutdown and return to service of the unit during abnormal AC supply conditions.

The Station requires an urgent replacement of U3-U6 Diesel Generators to bring back the reliability of the unit back up system.

2. SUPPORTING CLAUSES

2.1 SCOPE

The project requires the replacement of U3-U6 Diesel Generators to restore the full unit backup system and thus retaining the baseline for two Diesel Generators per unit at Kriel Power Station.

2.1.1 Purpose

The purpose of this document is to define the technical requirements and interfaces required for the replacement of Kriel U3-U6 Diesel Generators. The detail design shall be done as detailed in the Specification for Diesel Generators (240-62772907, rev 3), as well as all standards and specifications referenced.

2.1.2 Applicability

This document shall apply to Kriel Power Station, Group Technology Engineering and the Contractor.

2.2 NORMATIVE/INFORMATIVE REFERENCES

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

2.2.1 Normative

[1] Appendix O: Unit Diesel Generator Philosophy: EEP1054-1

[2] Specification for Diesel Generator systems: 240-62772907, rev 3

2.2.2 Informative

[3] 240-53113685: Design Review Procedure (https://hyperwave.eskom.co.za/240-53113685)

[4] 240-52844017: Eskom System Reliability, Availability and Maintainability Analysis Guideline

[5] 240-56536505: Hazardous Locations Standard

[6] SANS 10100-1 The structural use of concrete Part 1: Design

[7] SANS 10100 -2 The structural use of concrete Part 2: Materials and execution of work

[8] SANS 10162-1 The structural use of steel Part 1: Limit-states design of hot-rolled steelwork

[9] SANS 50025: Hot rolled products of structural steel.

2.3 DEFINITIONS

Definition	Description
Set	Engine + Alternator
Auxiliary systems	Main controller (Deep Sea) + Engine Control Unit (ECU), starting system, cooling system, fuel supply system, and generator breakers).
Diesel Generator System	Controllers + Chop-over sequence + Diesel Generators and DCS.

2.3.1 Disclosure Classification

Controlled Disclosure: Controlled Disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
AC	Alternating Current
AKZ	Anlagenkennzeichnungs system
AVR	Alternating Voltage Regulator
C & I	Control and Instrumentation
CoE	Centre of Excellence
CTs	Current Transformers
DCS	Distributed Control System
DC	Direct current
DVD	Digital Versatile Disc
ECU	Engine Control Unit
EDMS	Electronic Document Management System
EDWL	Engineering Design Work Lead
FAT	Factory Acceptance Tests

Abbreviation	Description
AC	Alternating Current
AKZ	Anlagenkennzeichnungs system
AVR	Alternating Voltage Regulator
GA	General Arrangement
HAZLOC	Hazardous Location
IP	Ingress Protection
ITP	Inspection Test Plan
LOSS	Limits of Supply and Service
LPS	Low Pressure Services
LV	Low Voltage
MV	Medium Voltage
OEM	Original Equipment Manufacturer
P&ID	Piping and Instrument Diagram
PEI	Production Engineering Integration
PT&M	Protection, Telecommunication and Measurements
P/S	Power Station
QCP	Quality Control Plan
QC	Quality Control
RAM	Reliability, Availability and Maintainability
SANS	South African National Standard
SAT	Site Acceptance Tests
SSME	Station Support Matter Expect
VDSS	Vendor Document Submittal Schedule

2.5 ROLES AND RESPONSIBILITIES:

Compiler: The document compiler is responsible for ensuring that this document is up-to-date and that this document is not a duplication of an existing documentation, regarding the document's objectives and content.

Functional Responsibility: The Functional Responsible Person shall determine if the document is fit for purpose, before the document is submitted for authorisation.

Authoriser: The document authoriser is a duly delegated person with the responsibility to review the document for alignment to business strategy, policy, objectives and requirements. He/she shall authorise the release and application of the document.

Lead Discipline Engineer: The role of the Lead Discipline Engineer is to manage the technical integrity of the design and be accountable for the management of the interfaces within their specific

engineering domain. In addition, the Lead Discipline Engineer coordinates the discipline specific activities for the particular package/plant/system/asset such as Protection, Telecommunications, Control, Metering, Turbine, Boiler, Bulk Materials Handling (BMH), Civil, Electrical, Control and Instrumentation (C&I), Chemical, Low Pressure Services (LPS), etc. In addition, the Lead Engineer is accountable for the provision and establishment of all documentation required for a Design Review. The Lead Discipline Engineer is to ensure that a system of check sheets is being used in the review process and before the design review package is put together for the end of phase design review meeting he reviews and signs off on these documents.

Furthermore, design review procedure 240-53113685 defines roles and responsibilities which are applicable in the development of this design phase.

2.6 PROCESS FOR MONITORING

The Engineering Change Management Procedure (240-53114002) will be the document used for monitoring of the project and relevant PCMs will also be used. Changes to the project will be captured through the Project Engineering Change Procedure (240-53114026). All the design work will be reviewed according to the Design Review Procedure (240-53113685). Additional Verification and Validation process will be determined during the project as and when required. A project implementation schedule will also be used to monitor progress within the project.

2.7 RELATED/SUPPORTING DOCUMENTS

N/A

3. SYSTEM DESCRIPTION (SEE APPENDIX A, B, C, D, E, F, G, AND N, INCLUDING FIGURE 1 & 2)

The 380V power distribution from the diesel generator alternators to the essential loads is provided for through a network of cabling systems and 380V switchgears as indicated in Appendix A and Appendix B. There are two diesel generator sets installed per unit on the zero meter level on the Turbine side in the plant, with a total of twelve generators for the entire station. Units 3 to 6 generator sets comprises of 24V DC battery starter, water cooled Detroit V71 engines and Stamford alternators. The diesel generator auxiliary system piping and instrumentation diagrams for U3-U6 Diesel Generator Set A, is provided in Appendix C.

The room layout, section and elevation plans for U3-U6 diesel generator are as depicted in Appendix D. The existing diesel generator rooms contain a deluge system for fire protection.

There are two controllers (Deep Sea) installed per unit inside the MV & LV Switchgear Room that supervises and controls all engine functions and alarms, refer to Appendix E (MV & LV Switchgear Room Electrical Equipment Layout). The MV & LV Switchgear Room and Diesel Generator room are located on the zero meter level in each unit on the Turbine side, approximately 30 meter apart.

For fuel system, each back up diesel generator has its own dedicated fuel tank (2060L) which is installed next to the diesel generator inside the diesel generator room for U3-U6, as indicated in Appendix C.

Figure 1 below depicts a typical Single Line Diagram of the existing installed Diesel Generator System of a single system for U3 to U6, showing the relevant communication and Control interfaces.

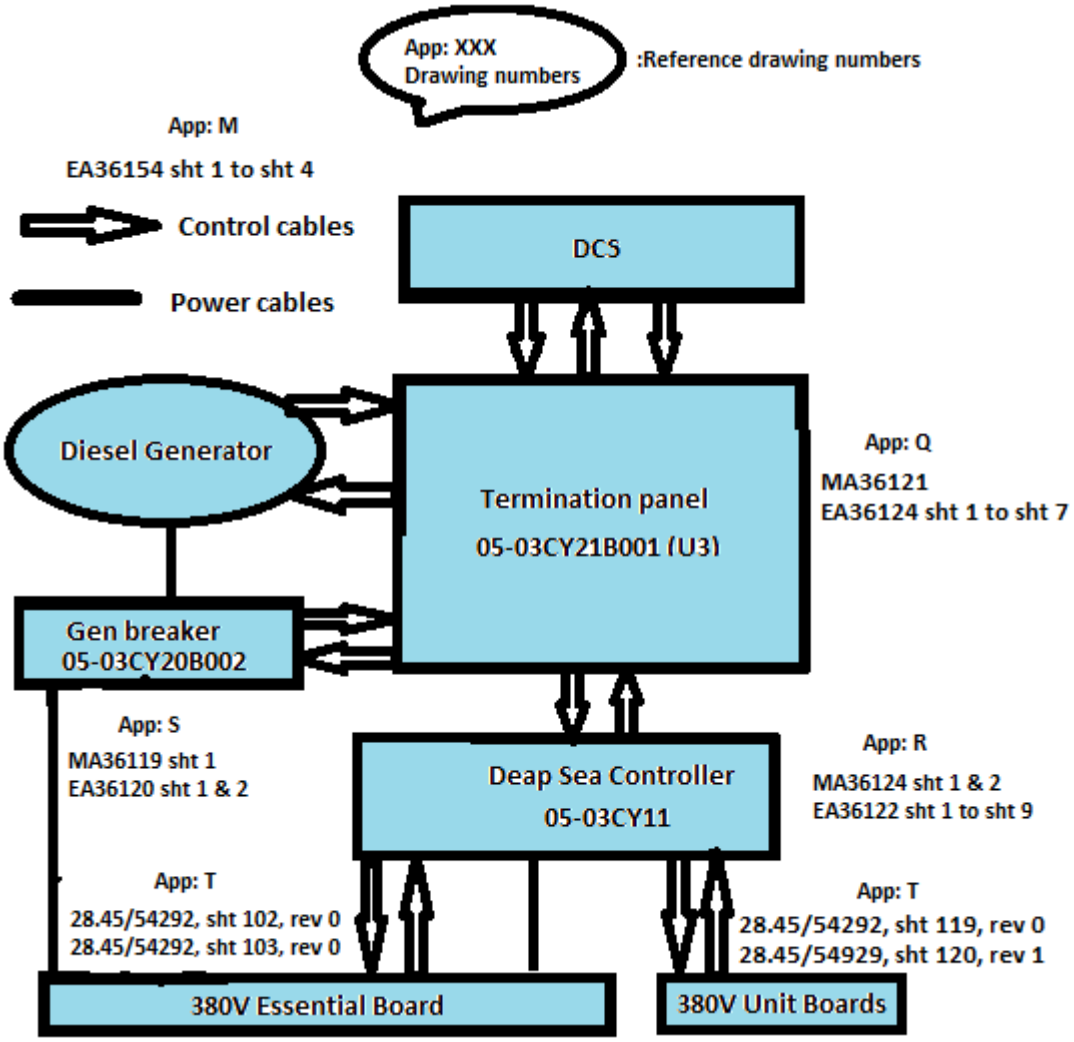

Figure 1: Existing Diesel Generator System single configuration for U3 to U6

The diesel generator operating, control and protection philosophy for the system is as described on the Kriel Diesel Generator Philosophy, Appendix O.

4. DESCRIPTION OF WORKS

The required Contractor scope of work is as depicted in figure 2 below. The Contractor shall comply with the requirements stipulated in the Specification for Diesel Generators (240-62772907), as well as all standards and specifications referenced.

In case there is a conflict between the documents that form part of the Works, the order of preference is as follows: Technical Schedule AB as depicted in Appendix L, this document, the *Employer's* Diesel Generator Specification (240-62772907) followed by all other reverenced documents.

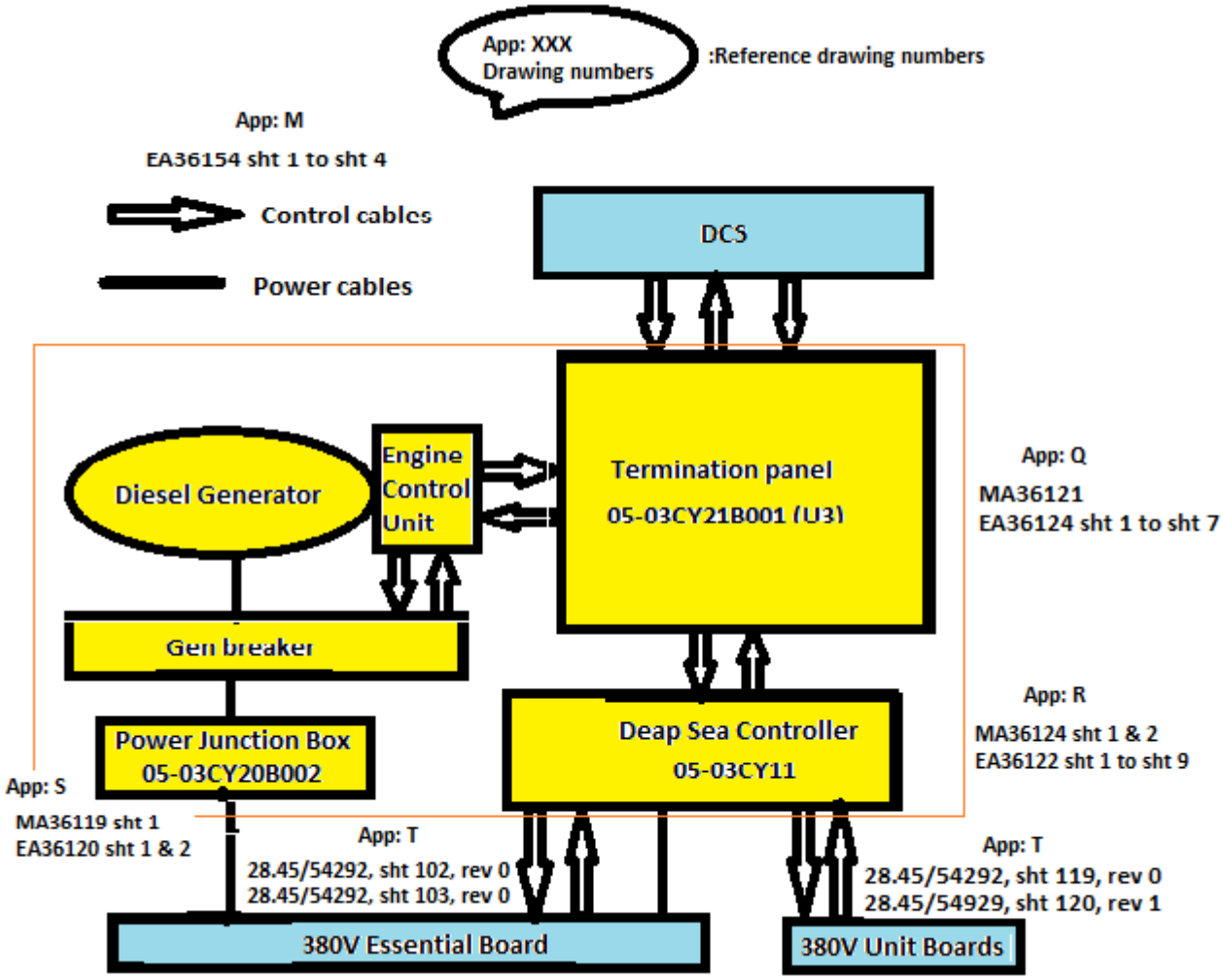

Figure 2: Required Diesel Generator System single configuration for U3 to U6

Refer to Appendix J (Electrical LOSS Diagram) and Appendix K (Low Pressure Service LOSS Diagram

4.1 DIESEL GENERATORS REQUIREMENTS

The scope of work for Diesel Generators is as follows:

- Decommission and removal of existing U3-U6 Diesel Generators and preserved for spare items.
- Detail design, manufacturing, construction, factory acceptance testing, transporting, offloading, installation, site acceptance testing and commissioning of eight (8) new Diesel Generators (400kVA) for U3-U6.

The power supply for the existing Diesel Generator auxiliaries (charger and heater element) is fed from the 380V Unit Board * via a 16MCB. The Contractor shall confirm if this supply will be sufficient for auxiliaries of the new Diesel Generators.

4.2 DIESEL GENERATOR CONTROLLER REQUIREMENTS

Each of the unit diesel generators is equipped with a diesel generator control panel (05-03CY11) which is located adjacent to the 380V Low Voltage Essential Boards (refer to Appendix F & Appendix G) inside the MV & LV Switchgear Electrical Equipment Room, refer to equipment layout drawing in Appendix E.

The Diesel Generator Controllers for U1-U6 were replaced with new controllers (Deep Sea, model 8620) in 2012. The existing Deep Sea controllers for U3-U6 shall be retained.

4.2.1 U3-U6 Controller interface

With reference to the controller interface cable block diagram in Appendix M and figure 2 above:

The detailed schematic and termination drawings for U3-6 termination panel *5 03CY21B001 which houses (the battery charger) are provided in Appendix Q or drawing number MA36121, EA36124 sheet 1-9, for general arrangement, schematic drawings and terminal arrangements drawings for the existing diesel generator on-board controller.

Refer to Appendix R or drawing number MA36124 sheet 1-2, EA36122 sheet 1-9, for general arrangement, schematic drawings and terminal arrangements drawings for the existing controller (Deep Sea).

Refer to Appendix T or drawing numbers (28.45/54292, sheet 119, rev 0, 28.45/54929, sheet 120, rev 1, 28.45/54292, sheet 102, rev 0 and 28.45/54292, sheet 103, rev 0) for the current U1-U6 Deep Sea controller interface to electrical boards (380V Units Boards and 380V Essential Boards) schematic and termination drawings.

The Diesel Generator Breaker panel *5 03CY20B002 general arrangement, schematic drawings and terminal arrangements drawings are provided in Appendix S or drawing number MA36119, EA36120 sheet 1-2.

The Contractor scope of work for the controllers includes:

- The Contractor design shall ensure that the new U3-6 diesel generator systems provided are compatible and functional with the Employers installed controllers.
- The diesel generators prime mover, alternator, engine management system , diesel generator system protection devices, auxiliaries and monitoring and alarm systems to comply with the technical requirement's stipulated in the Standard 240-62772907, rev 3 to retain the current philosophy described in Appendix O with the use of the Employers installed controllers.
- The Contractor may retain or retrofit the termination panel *5 03CY21B001 to suit the design and interface requirements.
- The Contractor shall provide and terminate all new control and alarm cables required for the Works.
- The Employer shall provide the Contractor with access to the existing Deep Controllers and the Contractor shall have the capability to verify, configure and commission any new logics and programming on the existing Deep Sea controllers when required.

4.3 DIESEL GENERATOR BREAKER REQUIREMENTS

The existing power cables (400mm^2) from the 380V Low Voltage Essential Boards to the existing diesel generator breaker panel shall be retained.

With reference to Appendix S or drawing number MA36119, EA36120 sheet 1-2, for general arrangement for the existing diesel generator breaker, schematic drawings and terminal arrangements drawings, the scope of work for the existing U3-U6 diesel generator breakers is as follows:

- Retrofit the existing diesel generator breaker panel to be used as inter-connector box between the new diesel generator breakers and the 380V Essential Boards.

4.4 STARTING SYSTEM REQUIREMENTS

The starting system for U3-U6 Diesel Generators is using a battery starting system. Each Diesel Generator has its own independent Nicad batteries and the battery link panel installed inside the Diesel Generator rooms. The scope of work includes:

- Decommissioning of the existing battery banks and preserve for spare items.
- Size the new battery banks for Diesel Generators based on the required size of the Diesel Generator, considering the starting philosophy as defined in the latest Specification for Stationary Diesel Generators (5 consecutive start attempts. Maximum duration of 10 seconds each, with rest period of not more than 10 seconds between attempts). If the fifth start attempt is unsuccessful, the start failure shall be activated.

4.5 IP RATING REQUIREMENTS

All new electrical equipment to be installed inside the Diesel Generator room (battery charger panels and circuit breaker panels) shall be rated IP55 as a minimum due to the existing deluge system installed inside the Diesel Generator rooms, instead of IP54 as specified in the Specification for Diesel Generators.

4.6 CABLING AND CABLE RACKING REQUIREMENTS

With reference to Appendix M or drawing number EA36154, sheet 1-4, for cable schedule and termination point for the existing Diesel Generator system, the Contractor shall:

- Reroute, install, test and commission the existing flexible power cables between interconnector box and the new diesel generators.
- Manufacture/procurement, transport, supply, install, test and commission the new control cables between the existing controllers / termination panels and new diesel generators.
- Ensure interfacing with all the other system requirements of the plant/installation.
- Test all cables and provided certificate.
- Develop, finalise and implement the optimised cable routing.
- Produce exact cable routing designs of all the cables.
- Cater for cable servitudes and cable racking.

- Implement all cable routing designs as approved.
- Implement all cable terminations.
- Produce all documentation and drawings

The power cables and cable racks shall be done in accordance with 240-56227443 (Requirements for Control and Power Cables for Power Stations Standard).

4.7 EARTHING AND LIGHTNING PROTECTION REQUIREMENTS

For the earthing and lightning protection Works, the Contractor shall:

- Ensure all new electrical equipment to be installed by the Contractor are earthed and properly bonded to the existing earth mat.
- Conduct an earth continuity tests and provide certification for quality controls.
- Ensure that new equipment is interfacing with all the other system requirements of the plant/installation.
- Produce all documentation and drawings for the design.

Earthing and lightning protection shall be done in accordance with the Earthing and Lightning Protection Standard (240-56356396).

4.8 C&I REQUIREMENTS

- Instruments must be available for purchase as All analogue instruments to be 4-20mA HART SMART instruments and must have 6 year drift-free guarantees for all instruments
- The controller should have a life of minimum 18 years
- Standardization of instrumentation spares and user replaceable
- Analogue instrumentation with software limit switching is preferred to binary instrumentation
- Motor Control and Protection as per Motor OEM best practice
- Alternator Control and Protection as per Alternator OEM best practice

4.8.1 Alarm signals and indications requirements

There are only three alarm signals available at the unit control room (for all units), interfacing to existing DCS at Kriel Power Station, namely:

- Gen "A" or "B" running,
- Gen "A" or "B" faulty
- Gen "A" or "B" trip

The unit control room is situated at U3 on the 22 meter level. The existing remote plant alarm signals at the unit control room shall be retained. All other alarms and trip signals shall be integrated and displayed as a minimum on the existing local control panels (Deep Sea Controllers) as recommended in the Specification (240-62772907) and Schedule A.

The *Employer* in collaboration with the *Contractor* shall rationalise the alarms in the detail design phase to match the existing alarms and indications at Kriel Power Station.

NB: The fuel oil levels on the on board fuel tanks shall be monitored locally on the existing local control panel (Deap Sea Controllers).

4.8.2 Applicable C&I standards

- All the instrument will be in accordance to : Field Instrument Installation Standard (240-56355754) and Pressure Measurement Systems Installation Standard (240-56355843)
- The Junction Boxes will be in accordance to the: Junction Boxes and Cable Termination (240-56355815)
- Human Machine Interface Design Requirements Standard (240-56355728)

4.9 FIRE PROTECTION REQUIREMENTS

The existing deluge system in each diesel generator room shall be retained, refer to drawing number 28.45/34072 or Appendix N for the position of the spray and fire detection nozzles. The deluge valves are automatically activated using service air from the station compressors. The appointed Contractor shall be required to carry out a spray test on the existing deluge system for verification to the *Employer* that the system is functional, and also responsible for repositioning the nozzles classified as Tyco HV26 nozzles if deemed necessary.

There is fire detection installed in each diesel generator room, and if any fire is developed in the existing diesel generator room, the signal is sent to the Electrical Operated Desk.

4.10 DIESEL GENERATOR ROOM VENTILATION REQUIREMENTS

The existing ventilation system in each diesel generator building shall be retained and utilised for the works.

4.11 FUEL SYSTEM REQUIREMENTS

The new diesel generators shall be designed with an on board fuel tank. The Contractor shall ensure that the design of the generator's on board fuel tank as a minimum ensure continuous operation of 4 hours at full load. Filling of the diesel shall be addressed by the *Employer.*

4.12 COOLING SYSTEM REQUIREMENTS

The new diesel generators shall be designed with an air cooling system (radiator). The Contractor shall install the ducting between the walls of the diesel generator room and the radiator to ensure that the heat removed from engine is directed outside of the diesel generator room.

4.13 CIVIL REQUIREMENTS

Civil structures affected by this project are the supporting ground floor slabs on which the diesel generators shall rest. The concrete floor slab is as indicated in figure 3 below and it is 600mm deep,

4000mm long and 1700mm wide. The new generator supporting skid must not exceed the 4m (length) x 1.7m (width) dimensions as the plinth will still be required to support the generator.

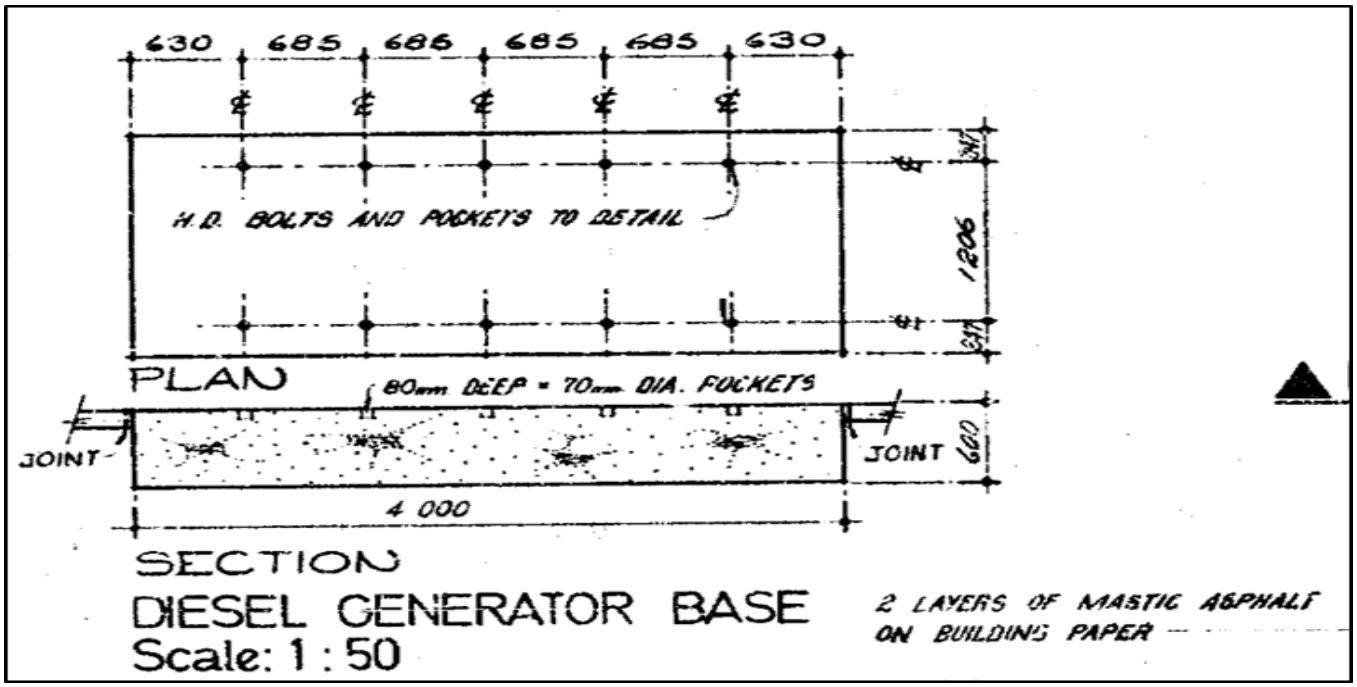

Figure 3: Concrete Floor Slab

The *Contractor* shall note that the concrete strength for the slab is 20MPa. Cover to reinforcement is 50mm and all reinforcing is Mild steel. The existing generator skid is bolted on to the supporting concrete floor, thus the vibrational loads on the supporting concrete floor imposed by the generator shall be taken into consideration. In addition, the new generator skid shall preferably have the same hole sizes for bolts and shall be aligned with the bolts on the supporting floor.

It is recommended that the new generators shall be of similar weight or less than that of the existing generators. The *Contractor* shall conduct a detailed structural analysis of the supporting floor if the new generators are heavier and/or have a higher dynamic load than the existing generators. If the weight and/or dynamic loads of the new generators are much higher than the existing generators, the *Contractor* shall determine if structural modifications are required.

The new design data shall include all the load details of the new equipment as well as the dimensions. Based on the information received, the *Employer* shall determine whether any structural modifications will be necessary or not. In the event that structural modifications are required on the diesel generator plinths, the *Contractor* shall provide the proposed designs to the Employer for approval.

All civil and structural works required for the project shall be done in accordance with the applicable Eskom and SANS standards as listed in section 2.2.2 above.

4.13.1 Additional Civil requirements and prerequisites

Concrete:

- All concrete work is required to be in accordance with SANS 2001-CC1 and SANS 10100-2 unless otherwise stated.

- All concrete surfaces and cast-in items is required to be inspected and accepted by the Employer in writing before casting of concrete may commence.
- The *Contractor* is required to obtain written acceptance from the *Employer* for the use of any add-mixture or the use of ready mixed concrete, to pump concrete, or to use cement or cement blends other than ordinary portland cement (OPC)
- Compaction of concrete is required to be done by means of mechanical vibrators only.
- The *Contractor* is required to submit the concrete mix design to the *Employer* for acceptance.
- The *Contractor* is required to demonstrate, by means of a report from an approved laboratory, that the aggregates do not exhibit excessive shrinking properties in accordance with SANS 1083 and is also required to demonstrate that the aggregates do not have a potential alkali silica reaction.
- All concrete is required to have a maximum water/cement ratio of 0.45 with a minimum cement content of 420 kg/m3
- The *Contractor* is required to perform a slump test on the same batch of concrete every time a sample is taken and the result recorded.

The table below indicates particular specifications pertaining to SANS 2001-CC1 and must be read in conjunction with the code.

Table 1: Civil clauses pertaining to SANS 2001-CC1

Clause	Particular Specification
3.5	**Concrete – Strength characteristics**
3.4.3	Concrete Grade is required to be: ➢ Class 15 MPa/ 19 mm for Blinding Concrete (28 days), ➢ Class 35 MPa/ 19 mm for Structural Concrete (28 days).
4.2	**Materials**
4.2.7	In general, one of the following types of non-shrink grout are required to be used: ➢ Cement-based non-shrink grout, not less than 50 MPa; ➢ Special proprietary non-shrink or expansive grout, not less than 50 MPa.
4.2.3.5	The following tests are required: ➢ drying shrinkage on fine and course aggregates; ➢ drying shrinkage of concrete; ➢ flakiness index of the stone; ➢ alkali-silica reaction.
4.4	**Reinforcement**
4.4	All reinforcement is stamped with a SANS quality assurance mark
4.4.3.1	Cast in-situ concrete cover is required to be a minimum of: ➢ 50 mm for exposed to earth or water;

Clause	Particular Specification
	➢ 40 mm for above ground or not in contact with soil.
4.7	**Quality of Concrete**
4.7.1.1	*Contractor* submits to the *Employer* full details and samples of all materials which he proposes to use for making concrete at least 28 days before the concreting of the works is due to commence.
4.7.10	Add the following: ➢ A layer of blinding concrete of 50 mm minimum thickness is required to be placed under foundations. ➢ A polyethylene sheet with a minimum thickness of 250 microns is required under ground slabs
4.7.12.2.3	All angled corners are chamfered 20 mm x 20 mm, unless such other larger size is detailed on the Drawings.
4.7.19.3	*Contractor* submits a detailed procedure for acceptance by the *Employer* on how he intends to carry out the repairs of structural concrete defects
4.7.22	For concrete pour records, the *Contractor* submits a detailed Quality Control Plan to the *Supervisor* for acceptance. In addition the *Contractor* supplies the *Employer* with two copies of these records each day covering works carried out the preceding day.
5.1	**Testing**
5.1.1.4	Six 150 mm cube samples taken from each batch or place of concrete deposition, three cubes are tested at 7 days and three at 28 days. Strength at 7 days is required to be at least two thirds of 28 day strength.
5.1.2.1	Any of the cube samples tested indicating a result more than 3 MPa below the specified strength is disregarded.
5.1.3.3	Unless no more than three batches of concrete is being mixed.
5.2	**Tolerances**
5.2.1	Tolerances on all concrete work is required to be a level II degree of accuracy as specified in SANS 2001-CC1 with and is to be carefully maintained throughout the construction.
5.2.2	Holding-down bolts: The permissible deviation between any two bolts that share the same base-plate is limited to 2mm for bolt sizes up to and including M24, and 3mm for bolts larger than M24.

4.14 RELIABILITY AND AVAILABILITY REQUIREMENTS

The *Contractor* shall perform the RAM (Reliability, Availability and Maintainability) studies of the equipment to be replaced in the Works, in accordance with the *Employer's* System RAM Analysis Guideline [4].

The objective of the studies is to achieve the following:

- Predicting the availability and reliability of each subsystem and the complete system.

- Determining an optimized maintenance philosophy for the equipment making up the complete system.
- Performing redundancy studies on the systems.
- Using the above studies to optimize the system's spares holding.

The reliability of the system and the individual sub-systems shall be equal to or greater than 98.88%. The availability of the system and the individual sub-systems shall be equal to or greater than 98.88%.

4.15 HAZLOC REQUIREMENTS

The existing diesel generator rooms for Kriel Power Station were classified as safe area due to due existing adequate ventilation, refer to Appendix H. The *Contractor* shall therefore utilize the appropriate type of equipment during the designs to be installed inside the diesel generator room in accordance with the Employer classification. The classifications were conducted in accordance with the *Employer's* Hazardous Locations Standard [5].

4.16 PROPOSED PROCUREMENT STRATEGY

Based on the defined scope of work for this project and the technical interfaces required to complete this project, it is recommended that this project is executed as an Engineering, Procurement, Installation and Commissioning (EPIC) Project, via open enquiry.

4.17 SPARES REQUIREMENTS

All spares shall be delivered in packaging suitable for the storage of the item until it is brought into use by the *Employer*. This packaging shall remain the property of the *Employer*. Any special requirement for the storage and handling of the spares shall be identified.

All spares shall be directly interchangeable with corresponding parts installed in the Works and shall meet the requirements of the original specification.

The Contractor shall compile a list of recommended spares to be held at the Power Station. The Contractor shall indicate any items that are recommended to be manufactured at the same time as the main Plant to obtain the benefit of concurrent manufacture.

4.17.1 Operational spares requirements

The Contractor shall provide an itemised and priced list of recommended operational spares and consumables for the first five (5) years of operation.

4.17.2 Overhaul spares requirements

The Contractor shall provide an itemised and priced list of recommended overhaul spares, if any.

4.17.3 Strategic spares requirements

The Contractor shall provide an itemised and priced list of recommended spares that would avoid a delay in return to service following breakdown. Justification for such a holding shall be provided.

4.18 SYSTEM INTEGRATION REQUIREMENT

4.18.1 Quality requirements

No work shall be done without a QCP that is approved by the Employer. A QCP must be submitted to the Employer for all that will be done 3 days before that part of the work is to be commenced.

QCP's and related documentation shall be subject to comment and approval by the Employer's Quality Control personnel as well as Engineering. QCP's will make provision for signatures for interventions by at least the Contractor's QC Representative, the Employers QC Representative, the Employer's Engineering Department and the site AIA representative.

Intervention points will be signed as the work progresses and no back-dating will be allowed.

Notification for hold and witness points shall be in writing and shall be done at least 24 hours in advance.

The following minimum hold points must be included for the Employer's Quality Control Department:

- Approval of QCP
- Approval of General Arrangement drawings
- Electrical Schematic drawings
- Manuals for controllers, alternator, engine, etc
- Components specifications i.e. breakers, governor, etc
- Factory Acceptance Tests check sheets,
- Punch lists,
- Certificate of Compliance,
- Factory release certificate

4.18.2 Drawing Requirements

The creation and control of all Engineering Drawings will be in accordance to the latest revision of 240-86973501 (Engineering Drawing Standards – Common Requirements).

The Contractor shall provide detailed "As Required" arrangement/dimensional drawings for each part of work to be done. No work will commence without approval of these drawings approved by the Engineering representative of the Employer.

After the works have been completed, detailed "As-built" drawings must be provided by the Contractor. The "As-built" drawings are subject to the Employer's Engineering representative comments and approval.

All drawings will indicate all the new installation/modified parts as well as enough of the existing pipework to which the items are connected. This must be done in sufficient detail to easily identify the location of the installation.

To aid in the production of the drawings, the Contractor may request copies of P&ID's and the equipment's original drawings from the Employer's Library. The availability of current plant drawings

cannot be guaranteed. Any costs associated with the creation of the drawings, including measurements taken of the equipment on site, will be for the Contractor.

4.18.3 Configuration Management and Document Management

4.18.3.1 Document Submission requirements

All documents shall be submitted to the Eskom Documentation Centre. The Contractor is required to submit the Contractor Document Submission Schedule VDSS (refer to Appendix P) as per agreed dates to the Eskom Documentation Centre. Eskom will pre-allocate document numbers on the VDSS and send back to the Contractor. The VDSS is revisable and changes must be discussed and agreed upon by all parties and properly documented. Changes in the VDSS can be additional documentation to be submitted, changes in submission dates or corrections in documentation descriptions, document numbers, etc. The Contractor Document Submission Schedule VDSS shall indicate the format of documents to be submitted. Eskom shall be responsible to manage the schedule i.e. creates a document register that will be used to track submission progress of documentation by the Contractor as per the committed dates on the VDSS.

4.18.3.2 Transmittal requirements

The *Contractor* lists all project documents (soft copies and hard copies) for submittal on the transmittal with the following metadata fields:

- Title of the document
- Document Unique Identification number
- Revision number
- Name of Discipline
- Reason for issuing/submission
- Sender's detail
- Sent date
- Recipient's Details
- Date received
- Quantity of documentation referenced on the transmittal
- Number of copies
- Format/medium submitted (eg: paper, DVD, etc)
- Sender signature
- Recipient signature, once submitted, to acknowledge receipt

4.18.3.3 Plant Codification requirements

Coding of the design shall be based on the AKZ coding system and the Employer shall undertake the coding in line with its coding and labelling standards. The AKZ coding shall be applied during the design review stage(s) and cross referenced to all arrangement drawings, schematics, wiring diagrams, instructions and manuals and where practical to spare parts list/manuals. The Contractor will be required to include allocated codes to the electronic design drawings. The Contractor shall issue the Employer with the drawings as well as the equipment list for verification before commissioning.

4.18.3.4 Plant Labelling requirements

The *Employer* shall manufacture and install AKZ labels to identified plant items.

4.18.3.5 Email Subject requirements

The email subject shall as a minimum have the following:

(Project Name_Discipline_Subject)

The Contractor submits documentation to the Eskom Representative copying Eskom Documentation Centre through generic email address (drmsharedservices@eskom.co.za) Electronic copies larger than 2MB will be sent via large file transfer protocol and/or hard drives to the Project Documentation Centre. A notification email, with a transmittal note attached, shall be sent to the project generic email address. The Representative will be copied on the email as well.

- Hard copies shall be submitted to the Eskom Representative accompanied by the Transmittal Note.
- The format of the final documentation handover will be specified in the Vendor Document Submittal Schedule.

4.18.3.6 Documentation requirements

All documents supplied by the *Contractor* shall be subject to the Employer for approval. Documents such as QCP's, Method Statements and other documents impacting the work must be approved by the *Employer* at least 3 working days prior to commencement of the Works.

Each revision of a document or drawing shall be accompanied with a list of the comments made by the *Employer* on the previous revision if applicable and the response/corrective action taken by the *Contractor.* Changes will be recorded in a revision table contained on/in each drawing/document.

Documents and drawings shall indicate the *Employer's* drawing number as allocated by the *Employer*. The *Contractor* may have his own internal document or drawing number on the document or drawing, but where reference is made among documents or drawings, the *Employer's* number shall be used.

The *Contractor* is required to provide the following Engineering Documentation accordingly as a minimum:

- Design calculations if any.
- Approved QCP / ITP (FAT check sheets, punch list,
- General Arrangement drawings "As built"
- Wiring diagrams
- Schematic drawings
- Updated cable schedules, including cable routing
- Termination schedule
- Instrument schedule

- Updated switchgear schedules
- Panel Interface List and related data
- Functional Logic Diagrams
- IO Block Diagrams
- Limits of Supply and Services
- Junction Box Allocations and Positions
- Operating and control philosophy of the upgraded system to be provided
- Controller diagrams and P&IDs to be provided of the upgraded system
- Manuals for controller, alternator, engine, etc.
- Parts catalogue and or component specifications (breakers and electronic governor)
- Factory release documents
- Certificates
- Maintenance manual
- Installation Procedure
- Storage, packing and transportation instruction

4.18.3.7 Documentation

For consistency it is important that all documents used within the project follow the same layout, style and formatting standard. Therefore the contractor shall ensure that the 240-76992014: Technical Document and Record Management Work Instruction is used for any documentation requirements.

4.18.3.8 General Requirement

The Contractor includes the Employer's drawing number in the drawing title block. This requirement only applies to design drawings developed by the Contractor and his Subcontractors. It does not apply to drawings developed by manufacturers for equipment and material such as valves, instruments, etc. Drawing numbers will be assigned by the Employer as drawings are developed.

The project name shall be listed on all drawings, including manufacturers' drawings. Tag numbers and equipment names shall be listed on all manufacturers' drawings. A separate sheet may be attached to the submittal if needed to adequately list all tag numbers associated with the drawings such as valves or instruments which may have numerous tag numbers associated with it.

The language of all documentation shall be in the English language. The units of measure shall be metric.

The Contractor retains project design calculations and information for the entire life cycle of the plant and provides these to the Employer on prior written notice at any time notwithstanding the expiry or termination of the contract.

4.18.3.9 Engineering Change Management

All Design change management shall be performed in accordance to the latest revision of the Eskom Project Change Management Procedure (240-53114026) and the Employer shall ensure that Contractor is provided with latest revisions of this procedure. Any uncertainty regarding this procedure should be clarified with the Employer and clarification updates should be reflected in updated versions of this procedure.

4.19 RISK AND ISSUE REGISTER

- Refer to Appendix I for the project risk register.

4.20 DRAWINGS ISSUED BY THE EMPLOYER

This is a list of drawings issued by the Employer at or before the Contract Date and which apply to this contract. It is the responsibility of the Contractor to verify the correctness of the drawings dimensions.

Note: Some drawings may contain both Works Information and Site Information.

Drawing list		
Drawing number	**Revision**	**Description**
0.45/5196	3	Sets 1 and 2 Diesel Generator Room Plan, Section and Elevations
0.45/30689	1	U3 MV & LV Switchgear Room Electrical Equipment Layout
28.45/49593	0	U1 Diesel Generator A System Piping and Instrumentation Diagram
MA36121 sheet 1/1	-	General Arrangement of Unit 3A Engine Termination Panel
EA36124 sheet 1-9	-	Circuit diagram Unit 3A Engine Termination Panels (master copy)
EA36124 sheet 1-7	-	Circuit diagram Unit 3A Engine Termination Panels
EA36154 sheet 1-4	-	Cable Schedules
MA36124 sheet 1-2	-	General Arrangement of Unit 3A General Control Panels
EA36122 sheet 1-9	-	Circuit diagram Unit 3A General Control Panels
MA36119 sheet 1/1	-	General Arrangement of Unit 3A alternator circuit breaker panel
EA36120 sheet 1-2	-	Circuit diagram Unit 3A Alternator Circuit Breaker Panel
28.45/54929 Sheet 11	0	U3 380V Essential Board A General

		Arrangement Drawing
28.45/54930 Sheet 11	0	U3 380V Essential Board B General Arrangement Drawing
0.45 05196	3	Diesel generator room plan, sections and elevations
0.45 07429 SHT1	0	Diesel generator room footings and roof slab
0.45 07429 SHT 2	0	Diesel generator room footings and roof slab
0.45 07429 SHT 3	0	Diesel generator room footings and roof slab
0.45 10337		General arrangement of 300kVA stand by unit control panel
0.45 07428		Diesel generator room footings and roof slab
0.45 07500		Diesel generator bases reinforcing details and bar schedule
0.45 08783		Layout of the 250/350 generator sets in existing diesel generator room
0.45 14081	3	Diesel generator room plan, sections and elevations

- Switchgear schedule for unit 380V Essential Board A, and
- Switchgear schedule for unit 380V Essential Board B.

5. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
[redacted]	Lead Discipline Engineer– Electrical CoE
[redacted]	Kriel SSME, Electrical CoE,
[redacted]	Essential Power Supplies SME, Electrical CoE
[redacted]	Kriel Power Station – Diesel Generator System Engineer (Auxiliary)
[redacted]	Kriel Power Station – Diesel Generator System Engineer (Electrical)
[redacted]	Lead Discipline Engineer – C&I CoE
[redacted]	CoE C&I Design Application: Coal & Renewables Manage
[redacted]	Lead Discipline Engineer – Civil and Structural Design, CoE
[redacted]	Lead Discipline Engineer – Low Pressure Services
[redacted]	Kriel Power Station Plant EDWL – System Design

Name	Designation
[redacted]	Lead Discipline Engineer– Electrical CoE
[redacted]	Senior Consultant - PEI

6. REVISIONS

Date	Rev.	Compiler	Remarks
September 2018	0.1	[redacted]	First draft document for review
October 2018	1	[redacted]	Final report

7. DEVELOPMENT TEAM

- [redacted]
- And Other LDEs

8. ACKNOWLEDGEMENTS

- [redacted] (Kriel Maintenance)
- [redacted] (Senior Supervisor PT&M)

9. LIST OF APPENDICES

Appendix A: U1 380V Essential Board A and B Single Diagram

Appendix B: Unit 6 MV and LV Electrical Reticulation

Appendix C: U1 Diesel Generator Set A, System P&ID

Appendix D: U3-U6 Diesel Generator Room Layout

Appendix E: MV and LV Switchgear Room Electrical Equipment Layout

Appendix F: U3 380V Essential Board A General Arrangement Drawing

Appendix G: U3 380V Essential Board B General Arrangement Drawing

Appendix H: HAZLOC Study Report

Appendix I: Project Risk Register

Appendix J: EC&I LOSS Diagram

Appendix K: Low Pressure Service LOSSS Diagram

Appendix L: Technical Schedule AB

Appendix M: Cable schedules

Appendix N: Deluge system and fire protection nozzles positions

Appendix O: Unit Diesel Generator Philosophy

Appendix P: Vendor Document Submittal Schedule

Appendix Q: Engine Control Unit design drawings

Appendix R: Deep Sea Controller design drawings

Appendix S: Diesel Generator breaker design drawings

Appendix T: Deep Sea Interface schematic drawings to 380V Unit Boards and 380V Essential Boards