POWER SYSTEM CONFIGURATION, SHORT CIRCUIT ANALYSIS AND MOTOR STARTING STUDY OF AN OFFSHORE PLATFORM

By

NOR AFIFAH BINTI MOHD NOR

FINAL PROJECT REPORT

Submitted to the Electrical & Electronics Engineering Programme
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Universiti Teknologi Petronas
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

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CERTIFICATION OF APPROVAL

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Approved:

IR Perumal Nallagownden
Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

June 2008

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Nor Afifah binti Mohd Nor

ABSTRACT

An offshore oil platform can be defined as a large structure used to house workers and machinery needed to drill and then to produce oil and natural gas wells in the ocean. Platform usually consists of few modules such as drilling module, power generation module, gas lift module and etc. Normally, an oil platform consists of a central processing platform and few satellite platforms. This document defines the simulation for power system of an offshore platform. The study will be done based on Melor Lahor Tangga Barat gas field, MLTTB platform. Offshore structures and installation design requires highest consideration because any disruption may jeopardize safety of personnel and can cause equipment failure which will cause a lot of money and maintenance. This document outlines the factors needed to be considered in preparing a power system, equipment sizing and configuration, short circuit analysis and also motor starting study. The simulation will be done using electrical power transmission and distribution system software called EDSA.

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Offshore installations are for industrial oil processing plants that operate in highly corrosive and humidity environments. Interruption in the operations such as power failure can cause production loss and will also jeopardize lives of personnel. Therefore in platform system design, a lot of considerations need to be taken.

Power system should be safe to operate, reliable and also energy sufficient. Short circuit studies were run to confirm that buses, switchboards, motor control centers (MCC), transformers and feeder cables would operate within their short circuit ratings and to determine the short circuit of all bus. The system was modeled based on the electrical overall single line diagram of MLTTB platform [11].

A motor starting study is prepared in order to analyze the transient effect of the system's voltage profile during motor starting. The system loading for the motor starting study will be accordance with the voltage drop study [10].

In the electrical system design, distribution and protection studies of the overall system shall be considered as well. Fault in power generation or distribution will affect the operation of a platform, Emergency total shutdown will cause major disruption and will affect the cause of the project.

1.2 Problem statement

Offshore structures can be designed for installation in protected waters, in the open sea, many kilometers from shore lines. The design and analysis of offshore platform must be done taking into consideration many factors including the environmental parameters, soil characteristic, technical standard regulations and intensity level of consequences of failure [14].

The equipment selection will depend on the hazardous area classification and the installation should be safe, reliable and requires minimum maintenance. Interruptions to production caused by equipment failure are costly and its maintenance is complex. The levels of electricity demand and available generating capacity are important, and both are influenced by many factors [15].

Basically, factors to be considered in designing optimum generation system are its reliability, adequacy and economically. Distribution and protection studies of the overall system need to be considered. Fault in power generation or distribution will influence the operation of a platform and shutting down the operation will effect the production and cost of the project.

A fault is a disruption in the normal flow of electricity, which can occur if a conducting object falls across one or more phases of live equipment. This is known as a short circuit. When a short circuit occurs, increasing current rushes toward the location of the fault from contributing motors and generators. High levels of current and voltage cause the air to ionize resulting in an arc flash of electricity, and incident energy is released. The purpose of a short circuit study is to determine how much current is available during a fault. A short circuit study simulates a worst case (three-phase) fault at every possible location and gives the available current that result [16].

Starting large motors can cause disturbances to the motor and other loads on other buses. In the worst cases the starting motor may stall and be unable to start the driven load. One of the most common side effects of starting large motors is a serious voltage dip on the buses throughout the facility. This voltage dip will cause other motors to slow down; in severe cases other motors may reach the stall point causing a domino effect to the voltage drop. Control relays may not hold and auxiliary equipment may be affected. In addition to these secondary effects the life of all motors on the system may be shortened. Ideally a transient motor starting study should be preformed which shows a time/voltage waveform for the motor bus. Motor starting studies should be performed prior to the ordering of large motors, such that the motor can be installed with confidence that the motor's life and applications performance will be satisfactory and the remainder of the power distribution system will not be adversely affected [23].

In designing the electrical power generation, we need to first produce the load analysis to know the expected load to be used in the platform. This is essential especially in sizing the equipment. Load analysis is produced based on the information from other disciplines such as the mechanical, structural, instrument and process. Studies need to be done to determine the number of equipment needed in order for the platform to operate optimally. The number of generating sets to be installed and their individual ratings depend on the maintenance requirement, economic size and reliability and availability.

1.3 Objective and scope of study

The objectives of the project are outlined as below:

1) To understand power system configuration and analysis by conducting research on power system fundamental and design requirements.
2) To familiarize with the methods involved in preparing short circuit and motor starting study for the oil and gas industry.
3) To perform short circuit and motor starting calculation manually and make comparison with the results obtained in EDSA software.

The scope of study can be summarized as review on the basic of electrical system installations for an offshore platform including the power system simulation based on the demand of facilities. The power system analysis will cover short circuit analysis and motor starting study. The report will focus on the generation, distribution and protection consideration.

CHAPTER 2

LITERATURE REVIEW

2.1 System design requirements

The design of the electrical power generation and distribution systems shall be based on good engineering practice and internationally accepted national standards and shall provide [13]:

- Safety to personnel during operation and maintenance of the platforms.
- Reliability and continuity of service of electrical systems to ensure maximum production of gas and condensate.
- Energy efficient power distribution and utilisation.
- Ease of operation, minimum manning and minimum maintenance of equipment.
- Continuous central monitoring of platform power systems and automatic protection of electrical equipment.
- Remote control facility.
- Fail-safe features for safety-related controls.
- Standardization of components for maximum interchange ability and minimal spare stockholding.
- Ease of future additions to the loads and extensions to existing facilities.

To ensure that the electrical supply is economical and has minimum risk of failure, a supply network must have:

- Adequate power to cope with the highest possible load.
- Provision of surplus power and distributing equipment capacity.
- Switchgear, transformers and cables are capable to carry the maximum short circuit fault currents and operate continuously in most rough conditions.

- A protective system capable of isolating faulty equipment with minimum of interference to the rest of the network and with minimum possible damage.

2.2 Power system design and equipment selection

Power system analysis mainly deals with the fundamentals of electrical systems which focus on power generation, transmission and distribution.

- Power generation – 6.6 kV HV turbine generator
  - 400 V LV diesel generator
  - 400 V LV microturbine
- Distribution – 6.6 kV HV switchgear
  - 6.6 kV/0.42 kV distribution transformer
  - 400 V LV switchboard
  - 400 V MCC
- Consumer – Uninterruptible Power Supply
  - Distribution board
  - Lighting and small power outlet

The power systems shall be designed to meet the objective, primarily safety to operating and maintenance personnel, reliability and continuity of power supply for maximum production and energy-efficient operation. In the design of electrical system there are few important factors need to be considered.

2.2.1 Regulations

Petronas Technical Standard (PTS) is a guideline used in all PETRONAS offshore as well as onshore operation. They are based on the experience obtained during the involvement with the design, construction, operation and maintenance of processing units and also facilities. PTS is also made in reference of the national and international standards and codes of practice.

2.2.2 Hazardous area.

There are three main sources of ignition in industrial electrical equipment, which are hot surfaces, electrical sparks, friction and impact sparks. To ensure that the electrical equipment does not become a source of ignition, there are four principles involved [13]:

- Explosive mixture can penetrate the item of electrical equipment and be ignited. Measures are taken to ensure that the explosion cannot spread to the surrounding atmosphere.
- The item of equipment is provided with an enclosure that prevents the ingress of a potentially explosive mixture and / or contact with sources of ignition arising from the functioning equipment.
- Potentially explosive mixture can penetrate the enclosure but must not be ignited. Sparks and temperatures capable of causing ignition must be prevented.
- Potentially explosive mixture can penetrate the enclosure but must not be ignited. Sparks and temperatures must only occur within certain limit.

Basically, conditions in hazardous area are divided into 3 parts which are gases vapors, dusts and methane dusts. For gas vapors, if the flammable substances is present continuously or for long periods, the area is classified as zone 0, if it is likely occur in normal operation occasionally, it is known as zone 1 and if it is not likely to occur in normal operation but if it does occur for a short period only, it is classified as zone 2. Same goes with dusts substances, zone 20 if it is present continuously or for long period, zone 21 if it is likely occurs in normal operation and lastly zone 22 if it is not likely to occur in normal operation but if it does occur, will be for short period only.

Electrical equipment enclosure shall be selected based on the location of the equipment to provide adequate protection to the equipment and it shall also continuously provide safety and sufficient access to operators for operation and maintenance activities. As a minimum, electrical equipment for installation in process area shall be certified to Zone 2, Gas Group IIA, Temperatures Class T3 (unless otherwise stated) and shall be selected in accordance with IEC 60079 – 'Electrical Apparatus for Explosive Gas Atmosphere' or equivalent CENELEC Standards. All equipment selected for hazardous area shall be certified preferably by certifying authorities such as BASEEFA or other independent internationally recognised authorities [13].

All outdoor located equipment enclosures exposed to the atmosphere shall be weather proof, water proof and protected against ingress of dust. The enclosures shall have a minimum ingress protection of IP 56. Electrical equipment certified for use in hazardous areas shall carry the EEx code and Ex symbol. A certificate of conformity shall be furnished for electrical apparatus used in Zone 0, 1 and 2 hazardous areas [13].

2.2.3 Environmental and design conditions

Environmental conditions [13]

Location : 185 km offshore east coast of Peninsular Malaysia
Environment : Tropical marine, humid, corrosive and salt-laden
Ambient temperature : 36^0C - Maximum
20^0C – Minimum
Design Amb. Temperature : 36^0C
Relative humidity : 100% - Maximum
Wind velocity : 40 meters/second (tropical cyclone) (1 minute mean)

Design Conditions

Outdoor

Electrical Design Temperature : 36°C
Design Relative Humidity : 100%
Degree of Ingress Protection : IP56 minimum

Indoor (Air-Conditioned Environment)

Electrical Design Temperature : 55°C (for components within equipment enclosures)
Design Relative Humidity : 100%
Degree of Ingress Protection : IP41 minimum

2.2.4 Main power supply

In the Oil & Gas industry and other industrial applications, power is generated by electric generators using, as prime movers, gas turbines, steam turbines, or reciprocating engines. Turbo-expanders are also used for power generation where a gas under pressure is expanded for process reasons, or made available for power recovery. The type of power generation will be selected depending on the requirement of the facilities. Centralized power generation and distribution can maximize the system's reliability and improves its safety. Below are few ways to generate power:

a) ***Rotating turbines*** - Attached to electrical generators produce most commercially available electricity. Turbines are driven by a fluid which acts as an intermediate energy carrier. The fluids typically used are:
   - Steam – Water is boiled by nuclear fission or burning of fossil fuels.
   - Water – Turbine blades are acted by flowing water, produced by hydroelectric dams or tidal forces.
   - Wind – Generates electricity from naturally occurring wind.
   - Hot gases – Turbine are driven directly by gases produced by combustion of natural gas or oil.

b) ***CCVT*** (closed-cycled vapour turbogenerator)

c) ***Submarine cable*** – The two main concerns are high cost installation and the material that will be used.

d) ***Diesel generator*** - combination of a diesel engine with an electrical generator (often called an alternator) to generate electric energy.

e) ***HVDC (high voltage direct current)*** – Requires large conversion from DC to AC, therefore it is not suitable to be used in offshore platform.

f) ***Solar panel*** – Although it is environmentally save, it is only practical for small power distribution usage.

Based on the study done on each power source, the gas turbine generator is recommended due to its higher availability, reliability and maintenance flexibility than the other power generators.

2.2.5 Power transmission and distribution.

Include the studies for power distribution equipment like transformer, switchgear, switchboard etc.

a) ***Distribution transformer*** – Transfer electrical energy from a primary distribution circuit, to a secondary distribution circuit, or within a secondary distribution circuit, or to a consumer's service circuit. Synchronizing and switching facilities usually provided to allow momentary paralleling of transformers so that any transformer can be taken out of service without interrupting the power system.

b) ***High voltage switchgear*** - Consist of vacuum circuit breakers (VCB) for generator incomers, bustie and for transformer feeders, while for motor starters and other outgoing circuits, it consists of fused vacuum contactors (VCU).

c) ***Low voltage switchboard*** - To provide the switching flexibility and to service the large 400V AC loads.

2.2.6 Cable system

All power (both high voltage and low voltage), control and lightning cables shall be of the low smoke zero halogen (LZSH) type with stranded high conductivity copper conductors and cross-linked polyethylene (XLPE) insulation except fire-resistant low voltage power, control and lighting cables which shall have ethylene-propylene rubber (EPR) insulation instead. Cable shall be sized according to the thermal rating under site conditions, prospective fault current and its duration, and voltage drop, whichever are the limiting conditions [13].

2.2.7 Emergency Power Sources

The electrical load analyses are categorized as continuous, intermittent and standby load. The definitions of the above criteria are based on criticality of the equipment installed [13].

i) **Continuous loads**: All loads that required continuously operate on the platform at normal operation mode. This is critical load that may jeopardise the process operation in case there is any electrical power outage or shutdown

ii) **Intermittent loads**: All process and utility loads required for normal operation but neither operating simultaneously or continuously. The load will operate on the process demand or need as a supplementary to the duty unit in order to boost up the operational system.

iii) **Standby loads**: All loads required when the duty (continuous) system are under maintenance program or during abnormal condition. Act as a replacement to the duty load.

The emergency diesel generator is installed to provide electricity during emergency (to vital loads) and black start conditions. A vital service is safety-related. The failure of the service during operation or when failing if called upon can cause major damage to the installation. The energy source, lines of supply and the equipment performing a vital service shall be duplicated. Vital loads include:

- LQ life support loads.
- Emergency lighting and escape lighting.
- Safety pressurisation and ventilation systems.
- AC UPS systems.
- Potable water supply system.
- Compressed air system.

2.3 Platform operation philosophy

TBCP-A platform comprises of 3 x 6 MW gas turbine generators 6.6 kV, 50 Hz, 3 phase generators. Two units of the gas turbine generators are capable in operating with either fuel gas/ diesel fuel in case of gas supply disruption. Generated electrical power will then be fed into 6.6 kV switchgear for main power distribution of 6.6 kV loads [11].

For the low voltage system, four transformers are installed. Transformers are rated 2.5 MVA, 6600/420 V. These transformers are divided into two separate 400 V low voltage system with 2x100%. The buses of the switch board will be linked using Automatic Transfer Switch Logic ATSL which is normally closed.

For emergency vital loads and black start purpose, emergency diesel generator 1500 kW (1875 kVA), 400 V, 50 Hz, 3phase is installed. The emergency diesel generator is connected to an Air Circuit Breaker which is open during normal condition. On detection to a dead bus, emergency diesel generator will automatically start.

2.4 Power system analysis

2.4.1 Short circuit analysis

When a short circuit occurs, a high fault current will flow from source to fault point which leads to dissipation of thermal energy and mechanical damage to installations. Two common factors causing short circuit condition are failure of insulation within equipment and wrong connection of termination [27]. All electrical systems are vulnerable to short circuits and the abnormal current levels they create. Therefore, it's important to protect personnel and equipment by calculating short circuit currents during update and design [3].

The protection for an electrical system should not only be safe under all service conditions but, to insure continuity of service, it should be selectively coordinate as well. A coordinated system is one where only the faulted circuit is isolated without disturbing any other part of the system. Once the short circuit levels are determined, the engineer can specify proper interrupting rating requirements, selectively coordinate the system and provide component protection [8].

A short circuit study is basically performed to:

- Calculate the fault current at various locations in the plant.
- Ensure power system components can withstand mechanical and thermal stresses that occur during a fault.

- Specify the ratings of the equipments for future expansions.
- Improve the reliability of the system.

Circuit breakers and fuses come with an over current rating (or size), and a short circuit interrupting rating. The over current rating specifies the amount of electrical current the device should tolerate without the fuse blowing, or circuit breaker tripping. The short circuit rating is the maximum electrical current the device can tolerate before it fails [6].

To provide the required protection, we must determine the extent of short circuit current at various points of our power distribution system. This determination requires a calculation. We must calculate the maximum 3 phase fault current the breaker will be required to interrupt. This current can be defined as the short circuit current available at the terminals of the protective device. We can assume that 3 phase short circuits are bolted or have no impedance. In addition, a 3 phase short circuit can be considered a balanced load, which means we can use a single phase circuit to analyze one of the phases and the neutral [3].

Distribution equipment, such as circuit breakers, fuses, switchgear, and MCCs, have interrupting or withstand rating defined as the maximum rms values of symmetrical current. A circuit breaker cannot interrupt a circuit at the instant of inception of a short circuit. Instead, due to the relay time delay and breaker contact parting time, it will interrupt the current after a period of five to eight cycles, by which time the DC component will have decayed to nearly zero and the fault will be virtually symmetrical [3].

2.4.1.1 Characteristics of short circuit

i) Sources of fault current

Fault current basically comes from rotating electric machinery, usually in the form of synchronous generators, synchronous motors and condensers, induction machines, and electric utility systems. The magnitude of fault current from these sources is limited by the impedance between the machine and the fault itself.

As a *synchronous generator* has a prime mover and an externally excited field, its fault current will continue unless interrupted by some switching means, *Synchronous motors* and *condensers* supply current to a fault in much the same way as synchronous generator, however, their fault current diminishes as their magnetic fields decay. *Induction motor* fault current is generated by inertia that is driving the motor in the presence of a field flux, which is produced by induction from the motor's stator [1].

Short circuit calculations should be done at all critical points in the system. These would include [8]:

- Service entrance
- Panel boards
- Motor control centers
- Motor starters
- Transfer switches
- Load centers
- Disconnects
- Motor starters

ii) The basics

A balanced 3 phase fault implies that all three phases of the power system are simultaneously short circuited to each other through a direct or bolted connection. Although the probability of this happening is small, relative to the probability of other types of unbalanced fault occurring, we still use a balanced 3 phase fault for a short circuit study for the following reasons [1].

a) Often, a 3 phase fault produces the larges short circuit current magnitude; thus this worst case result is then used as the basis to select the short circuit capabilities of switchgear from the manufacturer's tables.

b) Short circuit calculations are simplest for a balanced 3 phase fault because symmetry of the fault connection permits us to consider only one of the three phases.

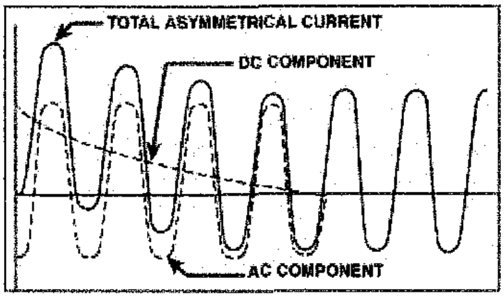

Figure 2.1: Short circuit current components

This figure shows the short circuit current to be made up of two components:

a) The symmetrical alternating current component.
b) The direct-current component which decays with time

This total current as pictured is called the "asymmetrical current". The root mean square (rms) value of the asymmetrical short circuit current waveform is the basis for the selection of the short circuit capabilities of circuit breakers and fuses. Calculation of the precise rms value of an asymmetrical current at any time after the inception of a short circuit may be very involved. Accurate decrement factors to account for the DC component at any time required, as well as factors for the rate of change of the apparent reactance of the generators. This precise method may be used, if desired, however simplified methods have evolved whereby the DC components is accounted for by the simple multiplying factors. These multiplying factors convert the rms value of the symmetrical AC component (symmetrical rms current) into rms current of the asymmetrical waveform, including the DC component (asymmetrical rms current or short circuit current duty) [1].

2.4.1.2 Method of calculation

Short circuit calculation shall be prepared by means of theoretically or using digital computer utilizing a commercially available software package. In this paper work, basic point to point procedure will be considered. In order to determine the fault current at any point in the system, first draw a one line diagram showing all the sourced of short circuit current feeding into the fault, as well as the impedances of the circuit components.

To begin the study, the system components, including those of the utility system are represented in the diagram. The impedance tables include three phase and single phase transformers, cable and busway. These tables can be used if information form the manufacturers is not available.

It must be understood that short circuit calculations are performed without current limiting devices in the system. Calculations are done as though these devices are replaced with copper bars, to determine the maximum available short circuit current. This is necessary to project how the system and the current limiting devices will perform [8].

The application of the point to point method permits the determination of available short circuit currents with a reasonable degree of accuracy at various point for either 3phase or 1phase electrical distribution system. The result obtained can be compared to the result from digital computer software in order to analyze the accuracy [8].

Computer based software

The study calculates the maximum short circuit current at the various points throughout the system. The chosen software is **EDSA** Electrical Power System Design and Simulation Software. EDSA's Short Circuit Analysis program delivers a first-of-a-kind solution to allow power system specialists to calculate the short circuit current based on IEEE or IEC standards. The Short Circuit Analysis program has integrated EDSA's Protective Device Evaluation (PDE) program for checking the interrupting capabilities of the switching devices, such as CBs, fuses, and switches. EDSA's Short Circuit Analysis program is a very powerful and proven tool for electrical engineers, having been proven in demanding, real-world applications and in precise software testing based on long hand calculation. Both 3-phase and single-phase networks can be modeled, and any type of fault can be simulated: 3P, L-L, L-L-G, L-G. Only EDSA Short Circuit Analysis program calculates sliding faults, an important feature for impedance protection operation or for calculating the L-G faults needed for towers grounding [9].

Some of the program features are listed below:

- Unlimited bus simulation (50,000+).
- IEEE and IEC standards;
- 3-phase and single-phase network on the same model.
- All types of faults: 3P, L-L, L-L-G, L-G: solid faults or via an fault impedance,
- Integrated Protective Device Evaluation (PDE) program.
- Short circuit current calculation inside MCC schedule.
- Considering the lines mutual couplings.
- Sliding faults and series faults.
- Program fully integrated with electrical one-line diagram.
- Flexible, fast and accurate.
- Flexible selection of faulted bus, directly on the one line diagram or text driven selection.
- User-defined groups of faulted buses.
- Fault at all buses or selected buses – user defined.
- Online back annotation or customized text output report.
- Fast and reliable solution technique.
- Easy-to-use and results are at a glance as per user selection.
- Comprehensive monitoring of the bus short circuit results.

The short circuit study that will be done comprised of the following steps:

1) Data collection – Information on all the components is obtained from electric utility, vendors or calculated from field data.
2) Single line diagram – A power system diagram that show how all components are electrically connected. Additional data needed for the study such as cable impedances can be obtained with information from this diagram.
3) Computer analysis – Using EDSA software, the system data is input and the short circuit currents at various points in the system are calculated.

2.4.2 Motor starting study

A motor starting study is performed to determine the voltages, currents, and starting times involved when starting large motors. Such a study is critical before installing a large motor to make certain that your system can start the motor successfully. It may also be performed anytime a change in the power supply is implemented [23]. In general, a motor starting study should be made if the motor's horsepower exceeds approximately 30% of the supply transformers base kVA rating. If a generator is supplying the motor, use 10 –15% of the generator kVA rating. Motor starting studies can vary from basic voltage drop on the system to a detailed waveform presentation of motor bus voltage, motor speed and motor torque, acceleration torque, load torque, power factor, rotor and stator currents, motor slip, real, reactive and total power [23].

A motor starter is an electrical or electronic circuit composed of electro mechanical and electronic devices which are employed to start and stop an electric motor. Regardless of the motor type (AC or DC), the type of starters differ depending on the method of starting the motor. Two most common starting methods are Direct On Line (D.O.L) method and soft starting method. A D.O.L starter connects the motor terminal directly to the power supply. Hence, the motor is subjected to the full voltage of the power supply. Consequently, high starting current flows through the motor [21]. A soft start method starts the motor at lower voltage and slowly ramping up to operation voltage [23].

2.4.2.1 Direct-On-Line start (D.O.L)

This method of starting is by far the most common starting method available in the market. The components consist of only a main contactor and thermal or electronic overload relay. The disadvantage with this method is that it gives the highest possible starting current. A normal value is between 6 to 7 times the rated motor current but values of up to 9 or 10 times the rated current exist. During a direct on line start, the starting torque is also very high, and is usually higher than required for most applications. The torque is the same as the force, and an unnecessary high force unnecessary high stresses on couplings and the driven application. Naturally, there are cases where this starting method works perfectly and in some cases also the only starting method that works [20].

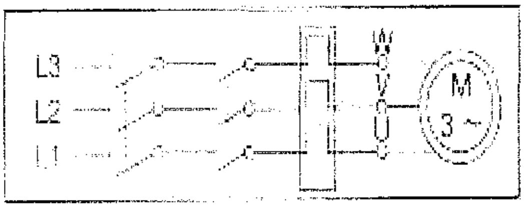

Figure 2.2: DOL starting

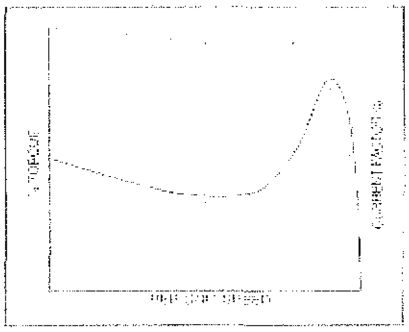

Figure 2.3: DOL motor start characteristics

Disadvantages of D-O-L method [19]:

- High inrush current (typically 6 times full load which can cause several problems).
- Necessities over sizing of installation
- Limit expansion
- Reduces service life of electrical components
- Excessive applied starting torque (typically 2.5 times full load)
- Increases wear on drive chain components
- Reduces service life of mechanical components

2.4.2.2 Star - Delta

This method requires both connections for each phase to be taken to the starter. Three contactors are used to first connect the motor in star and then to delta after a given time. Connecting the motor in star reduces the voltage applied to each winding to about 60% of the line voltage. This reduces the starting torque and current, typically 3.5 times full load current [19]. To reach the rated speed, a switch over to delta position is necessary, and this will very often result in high transmission and current peaks [20] . Its main advantages are that it is relatively simple and low cost.

The major problem in using this method is that the reduced voltage level is in a single stage and it is also fixed. In some cases, this voltage is not ideal, the torque it produces may be too small and the motor stalls or does not give complete acceleration. If the torque is too large, the motor still starts with a pronounced snatch [19]. This starting method only works when the application is light loaded during the start. If the motor is heavily loaded, there will not be enough torque to accelerate the motor up to speed before switching over to delta position. Applications with load torque higher than 50% of the motor rated torque will not be able to start using the star-delta starter [20].

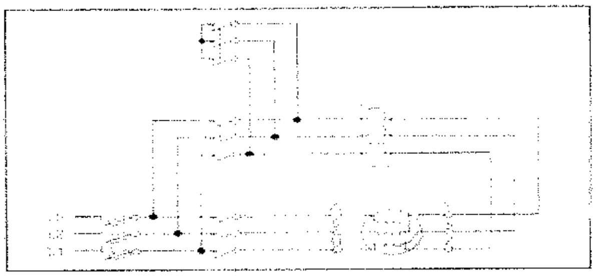

Figure 2.4: Star-delta starter

2.4.2.3 Auto transformer starter

This method uses transformer action to reduce the voltage applied to the motor and current seen by the supply [19]. Auto transformers are generally equipped with taps at each phase in order to adapt the starting parameters to the application starting requirement. During starting, the motor is connected to the auto transformer taps. With the star and auto transformer contactors closed, the motor is under reduced voltage. Consequently, the torque is reduced as the square of the applied voltage. When the motor reaches the 80 to 90% of the nominal speed, the star contactor opens. Then the line contactor closes and the auto transformer contactor opens. The motor is never disconnected from the power supply during starting and this eliminates transient phenomena [20].

Normally, the voltage is applied to the motor in voltage steps through the transformer with the taps being selected through contactors. Typical tappings are 50%, 70%, followed by full voltage being applied to the motor. The major disadvantages are size and cost and also mechanical snatch at switch is not controllable and can still cause problems [19].

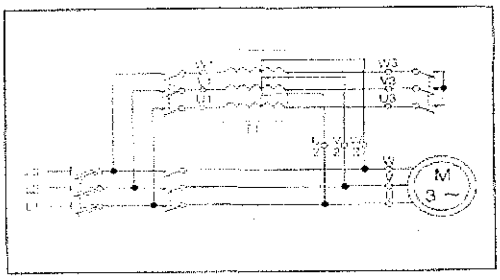

Figure 2.5: Auto transformer starter

2.4.2.4 *Soft starter*

A soft starter has different characteristics to the other starting methods. It has thyristors in the main circuit, and the motor voltage is regulated with a printed circuit board. The soft starter makes use of the fact that when the motor voltage is low during start, the starting current and staring torque is also low. During the first part of the start, the voltage to the motor is so low that it is only able to adjust the play between the gear wheels or stretching driving belts or chains etc. This eliminates unnecessary jerks during the start.

Gradually, the voltage and the torque increase so that the machinery starts to accelerate. One of the benefits with this starting method is that the possibility to adjust the torque to the exact need, whether the application is loaded or not. Another feature of the soft starter is the soft stop function which is very useful when stopping pumps where the problem is water hammering in the pipe system at direct stop as for direct-on-line starter. The soft stop function can also be used when stopping conveyor belts to prevent material from damage when the belts stop too quickly [20].

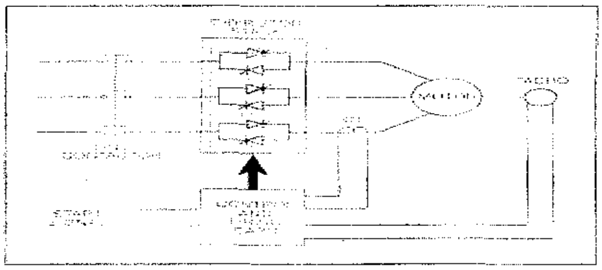

Figure 2.6: Soft starter

The advantages of soft starts are [23]:

- Reduced starting current, starting torque and mechanical stress.
- Lower inventory of spare mechanical parts and operating costs.

- Increased production rates by reducing machine maintenance downtime.
- Prolonged life of electrical switchgear with lower inrush currents.
- Soft stops on pumping applications reduce piping system stresses and "hammer" effect.
- Energy optimizing reduces motor energy losses when operating motor below maximum capacity.

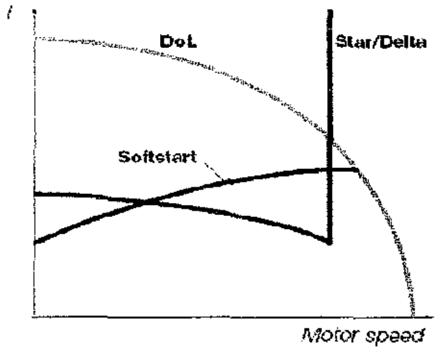

Figure 2.7: Motor current

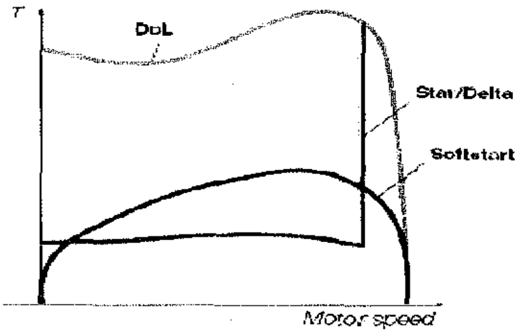

Figure 2.8: Torque

CHAPTER 3

METHODOLOGY/ PROJECT WORK.

3.1 EDSA work flow

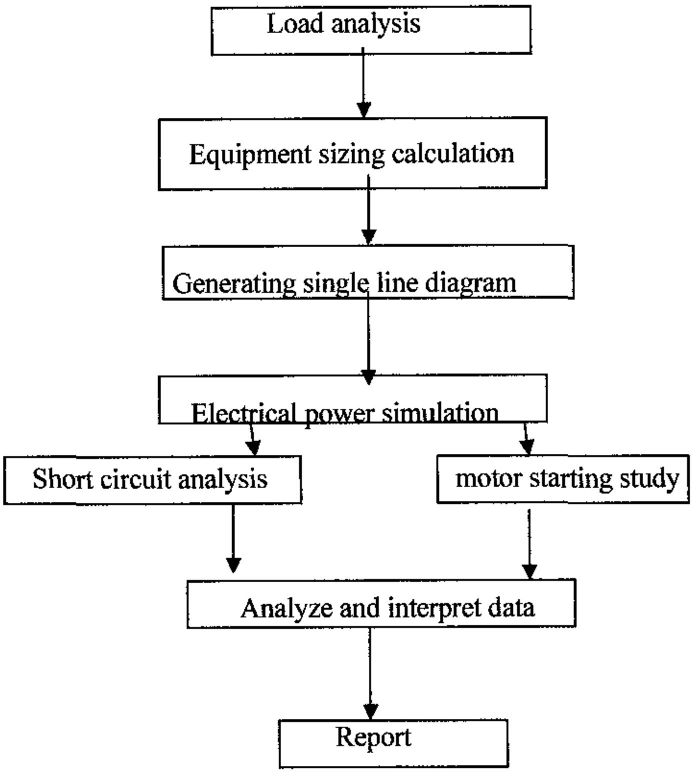

Figure 3.1: EDSA work flow

The load analysis will be done using excel spread sheet and the electrical power simulation will be done using EDSA software.

3.2 Short circuit comparison work flow

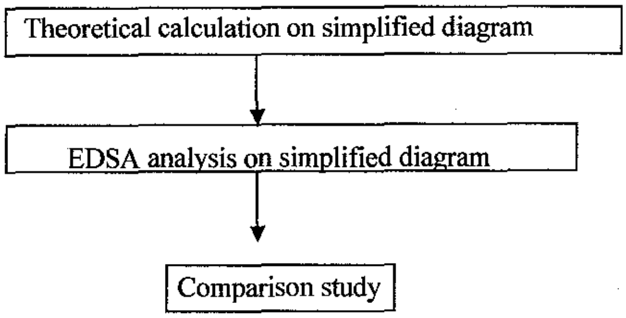

Figure 3.2: Short circuit comparison work flow

3.3 Motor starting study comparison work flow

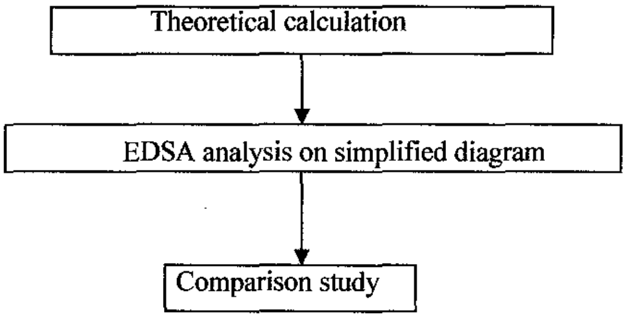

Figure 3.3: Motor starting comparison work flow

3.4 Producing Single line diagram

In power engineering, a single-line diagram is a simplified notation for representing a three-phase power system. The single-line diagram has its largest application in power flow studies. Electrical elements such as circuit breakers, transformers, capacitors, bus bars, and conductors are shown by standardized schematic symbols. Instead of representing each of three phases with a separate line or terminal, only one conductor is represented [17]. The following are some of data and calculations involve in producing TBCP-A single line diagram.

1) Gas turbine generator (GT-7510, GT-7520, GT-7530)

- ISO rating = 5750 kW, 7188 kVA

- System voltage = 6600 V, 50 Hz

- Power factor = 0.80

Reactance (taken from vendor catalogue)

- Subtransient reactance, X"d = 15%

- Transient reactance, X'd = 22.3%

- Synchronous reactance, Xd = 138.9%

- X/R ratio = 42.7

- Neutral earthing = resistance earthing

2) Transformer (TF-7540, TF-7550, TF-7560, TF-7570)

- Rating = 2500 kVA

- Voltage = 6600 V/400 V

Reactance and resistance (taken from vendor catalogue)

- Reactance, X = 6.4%

- Resistance, R = 0,8%

- X/R ratio = 8

3) Emergency diesel generator (GD-7700)

- Rating = 1500 kW, 1875 kVA

- System voltage = 400 V, 50 Hz

- Power factor = 0.80

- Subtransient reactance, X"d = 14.6%

- Transient reactance, X'd = 22.3%

- Synchronous reactance, Xd = 138.9%

- X/R ratio = 42.7

4) Feeder

- Library = IEC- Data from COPARI in Europe

- Cable's power factor, number of phase, length, size and phase are taken from the voltage drop and cable sizing calculation.

- Cable resistances and reactance are taken from vendor catalogue.

5) Circuit breaker

- The ampere rating for each circuit breaker is calculated using the following formula:

$$I = \frac{P}{\sqrt{3}\,V}$$

- The circuit breaker rating will be chosen based on the nearest higher value available in the market.

After all the components and its respected data had been inserted, error checking is done to every bus and load branches to make sure that the components and feeders are correctly connected.

3.5 Short circuit analysis

3.5.1 Case 1: Three phase single transformer system

In order to determine the fault current at any point in the system, we need to draw a single line diagram consisting all of the sources of short circuit current feeding into the fault and also the impedances of the circuit components. The following figure is the single line diagram that will be analyzed using three different methods namely; ohmic method, point to point method and also using EDSA software. The results will later be compared and analyze.

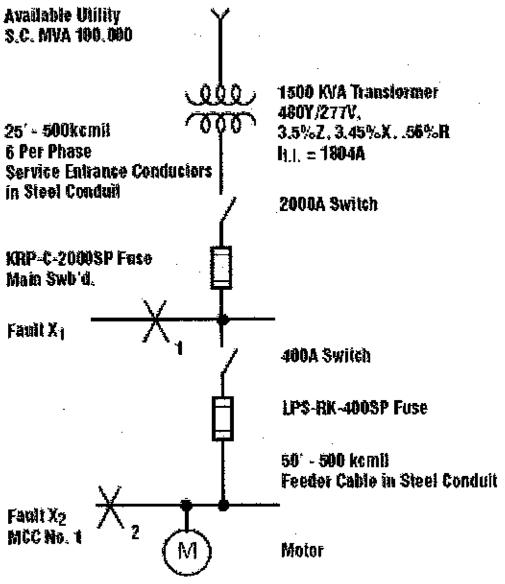

Figure 3.4: 3 phase single transformer system.

3.5.1.1 Ohmic method calculation procedure

Step 1. Calculate the utility impedances using the following formulae:

$$X_{\text{utility}}\ \Omega = \frac{1000\ (KV_{\text{secondary}})^2}{\text{S.C. KVA}_{\text{utility}}}$$

Step 2. Calculate the transformer impedances using the following formulae:

$$X_{\text{trans}}\ \Omega = \frac{(10)(\%X)(KV_{\text{secondary}})^2}{KVA_{\text{trans}}} \qquad R_{\text{trans}}\ \Omega = \frac{(10)(\%R)(KV_{\text{secondary}})^2}{KVA_{\text{trans}}}$$

Step 3. X cable and bus Ω; R cable and bus Ω.

Step 4. Total all X and all R in system to point of fault.

Step 5. Determine impedance (in ohms) of the system by:

$$Z_T = \sqrt{(R_T)^2 + (X_T)^2}$$

Step 6. Calculate short-circuit symmetrical RMS amperes at the point of fault.

$$I_{\text{S.C. sym RMS}} = \frac{E_{\text{secondary line-line}}}{\sqrt{3}\,(Z_T)}$$

Step 7. $I_{\text{sym motor contrib.}} = (4) \times (I_{\text{full load motor}})$

Step 8 $I_{\text{total S.C. sym RMS}} = (I_{\text{S.C. sym RMS}}) + (I_{\text{sym motor contrib.}})$

Step 9. Determine X/R ratio of the system to the point of fault.

$$X/R \text{ ratio} = \frac{X \text{ total } \Omega}{R \text{ total } \Omega}$$

3.5.1.2 Basic Point-to-Point Calculation Procedure

Step 1. Determine the transformer full load amperes (F.L.A.) from either the nameplate, the following formulas :

$$3\text{Ø Transformer } I_{F.L.A.} = \frac{KVA \times 1000}{E_{L-L} \times 1.732}$$

$$1\text{Ø Transformer } I_{F.L.A.} = \frac{KVA \times 1000}{E_{L-L}}$$

Step 2. Find the transformer multiplier.

$$\text{Multiplier} = \frac{100}{{}^{*}\%Z\text{transformer}}$$

Step 3. Determine by formula or Table 1 the transformer let-through short-circuit current.

$I_{S.C.} = \text{Transformer}_{F.L.A.} \times \text{Multiplier}$

Step 4. Calculate the "f" factor.

3Ø Faults $$f = \frac{1.732 \times L \times I_{3Ø}}{C \times n \times E_{L\text{-}L}}$$

1Ø Line-to-Line (L-L) Faults

$$f = \frac{2 \times L \times I_{L\text{-}L}}{C \times n \times E_{L\text{-}L}}$$

1Ø Line-to-Neutral (L-N) Faults

$$F = \frac{2 \times L \times I_{L\text{-}N}\dagger}{C \times n \times E_{L\text{-}N}}$$

Where:

L = length (feet) of conductor to the fault.

C = constant from Table 4 of "C" values for conductors and Table 5 of "C" values for busway.

n = Number of conductors per phase (adjusts C value for parallel runs)

I = available short-circuit current in amperes at beginning of circuit.

Step 5. Calculate "M" (multiplier)

$$M = \frac{1}{1 + f}$$

Step 6. Calculate the available short-circuit symmetrical RMS current at the point of fault. Add motor contribution, if applicable.

$I_{S.C.\cdot\ \text{sym RMS}} = I_{S.C.} \times M$

Step 6A. Motor short-circuit contribution, if significant, may be added at all fault locations throughout the system. A practical estimate of motor short-circuit contribution is to multiply the total motor current in amperes by 4. Values of 4 to 6 are commonly accepted

3.5.2 Case 2: TBCP-A single line diagram

For TBCP-A, the short circuit analysis is performed to the single line diagram using AC IEC 60909 standard. Three phase, half cycle symmetrical configuration will be chosen to calculate the short circuit current. Half cycle of the short circuit current component will give the maximum short circuit value. The short circuit ratings of equipment and cables, including the short circuit making and breaking capacity of circuit switching devices, shall be based on the parallel operation of all supplies [24].

3.6 Motor starting study using EDSA

During starting of direct on line motors, the voltage at the motor terminal shall not deviate by more than +10% or -20% from rated equipment voltage. Transient voltage deviations occurring at switchgear busbars during motor starting shall be maintain a minimum of 90% voltage on switchgear busbars and at least 80% but not more than 110% of rated equipment voltage on all consumers [24].

The voltage dip for motor starting shall be limited to (as per PTS 33.64.10.10.):

At the GTG Terminal	10%
At the Switchgear Bus	10%
At the Motor Terminal	20%

Soft starter starting method is chosen for starting of the largest motor. For Soft Starter method, the starting current is 2.5 times of the full load current in EDSA. Other motors in the 6.6kV System shall be by Direct-On-Line starting method with 5.5 times of the full load current. The voltage dip will be calculated using EDSA and also manually [12]. The result will then be compared in order to prove the reliability of both methods.

3.6.1 Method of calculation

Step 1.Calculate the total current during starting excluding the largest motor to be started

$$I = \frac{\text{Total KVA prior to start up of largest motor}}{\sqrt{3} \times V}$$

Step 2.Calculate voltage generated by EDG

$$E = \sqrt{(Vph \cos\theta + I*RG)^2 + (Vph \sin\theta + I*XD)^2}$$

Step 3.Calculate current & voltage dip during starting of largest motor –soft starter method

i) Voltage dip at EDG terminal

$$E^2 = (VGT \cos\theta + IT*RG)^2 + (VGT \sin\theta + IT*XD)^2$$

$$\%Vdip = \frac{V_{(L-L)} - VGT}{V_{(L-L)}} \times 100$$

ii) Voltage dip at switchgear bus terminal

$$\text{Vdip in the cable} = \sqrt{3} \times IS\,(RC \cos\theta + XC \sin\theta)$$

$$\text{Voltage at bus} = VGT_{(L-L)} - \text{Vdip in the cable}$$

$$\text{Voltage dip at bus} = \frac{V_{(L-L)} - Vbus}{V_{(L-L)}} \times 100$$

iii) Voltage dip at motor terminal

Vdip in the cable = $\sqrt{3} \times I_S (R_C \cos\theta + X_C \sin\theta)$

Voltage at motor terminal = Voltage at bus – Vdip in the cable

Voltage dip at motor terminal = $\dfrac{V_{(L-L)} - V_{motor}}{V_{(L-L)}} \times 100$

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Single line diagram.

Please refer to appendix E for TBCP-A single line diagram.

4.2 Load analysis

Electrical load list is prepared and shall form the basis for provision of the necessary electrical supply and distribution system capacity. The preparation of an electrical load list involved the followings:

- Calculating the magnitude of each load
- Determining the characteristics, load factor and diversity loads.
- Compiling the loads to obtain the total power required on the platform.

Note: Please refer to appendix A for the electrical load list.

4.3 Configuration of equipment

4.3.1 Configuration of Gas Turbine Generator

TBCP-A platform comprises of 3 x 575 MW gas turbine driven 6.6 kV, 50 Hz, 3 phase generator. The gas turbines will be operated continuously and unattendedly. Two of the generators will operate with either fuel gas or diesel fuel incase of fuel gas disruption.

Generated electric power will then feed into 6.6 kV switchgear with bus-tie closed for main power distribution to the 6.6 kV loads. Other low voltage loads shall be powered via dedicated MCC. Standard form PTS 05.00.10.80 gives formulae for determining the total electric load as:

Peak load = 100%E + 30%F + 10%G

where E = Total Continuous Load
F = Total Intermittent Load
G = Total Standby Load
Minimum required power generation = 125% Peak Load

The spare capacity of 25% is a requirement to cater the future loads. Number of generating sets to be installed depends on:

i. Maintenance requirement.
ii. Economic size.
iii. Unit reliability.
iv. Availability.

Calculation

Generator configuration = 3 x 50%

Peak load = 7481.40 kW , 3819 Kvar

$= \sqrt{(7481.40^2 + 3819^2)}$

= 8400 kVA

Considering peak loads + heating medium heater,

Total kVA = 8400 kVA + 4000 kVA

= 12405.69 kVA.

For this configuration, the load will be shared between 2 gas turbine generators. Each gas turbine generator must meet minimum site rating power of 6202.85 kVA. Therefore we choose 7500 kVA that is the rating available in the market.

4.3.2 Configuration of transformer.

For 400 V loads, 6.6 kV supply is stepped down to 400 V at SB-7710 & SB-7720 by 4 distribution transformer. (TF-7540, TF-7550, TF-7560, TF-7570). Two transformers are identical in kVA rating for emergency reason. ATSL is used to automatically open & close the bus-tie breaker in the event of switch over from one transformer to the other. Busducts are used for power connection to accommodate full load current.

Calculation

TRANSFORMER TF-7540 and TF-7550

Total kVA for SB-7710 = 1380.37 kVA + 561.44 kVA

= 1941.81 kVA

Considering 10% spare, for future load growth

= 1941.81 x 1.1

= 2135.99 kVA

Therefore selected Transformer size is 2500 kVA each.

TRANSFORMER TF-7560 and TF-7570

Total kVA for SB-7720 = 1,823.32 kVA + 179.07 kVA

Considering 10% spare, for future load growth

= 2002.39 x 1.1

= 2202.629 kVA

Therefore selected Transformer size is 2500 kVA each.

4.3.3 Configuration of emergency diesel generator.

Diesel generator used to start up one of dual fuelled gas turbine generator. Gas turbine generator will be transferred to fuel gas once stabilize and synchronized with emergency diesel generator. Load will be shared and transferred to gas turbine generator. Emergency diesel generator will shutdown and remain on standby mode for vital loads in case of power generator failure.

Calculation

Total kVA = 1376.6 kVA

Considering 15% spare, for future load growth

= 1376.6 VA x 1.15

= 1583.09 kVA

= 1875 kVA (round-up to the rating available in the market)

Therefore selection of Emergency Diesel Generator (EDG) shall be based on size 1875 kVA.

4.4 Nominal high voltage selection.

The selection of operating voltages is governed by PTS 33.64.10.10 Electrical Engineering Guidelines section 3.3.1. The selection basis of motor voltages and power ratings should conform to the following (as stated in the PTS 33.64.10.10):

Table 4.1: Selection basis of motor voltages and power ratings

Switchgear Nominal Voltages	Maximum LV motor rating	Minimum HV motor rating
3.3 kV	110 kW	132 kW
6.6 kV and higher	185 kW	200 kW

4.5 Power generation simulation.

The design shall minimise the short circuit fault levels within the ratings of standard commercially available equipment as well as keep voltage dips during large motor starting within allowable limits to avoid affecting the operation of other loads supplied from the same power busbars.

A short circuit study shall be performed to establish the short circuit fault levels on both the 6600 V and 400 V power systems to ensure that short circuit current withstand and power interrupting ratings of electrical equipment are correctly specified. Motor starting study is performed in accordance to the deviations in supply voltage and frequency as stated in PTS 33.64.10.10.

4.5.1 Short circuit analysis

4.5.1.1 Case 1: Simple single line diagram

i) Ohmic method

Fault at X1

Calculate resistances and reactances

i) Utility

S.C MVA 100000, 480 V,

$$X = \frac{1000\,(\text{KV sec})^2}{\text{S.C KVA}} = \frac{1000\,(0.48)^2}{100{,}000{,}000} = 0.0000023$$

ii) Transformer

1500 kVA, 480 V, 3phase,

3.5% z, 3.45% x, 0.56 %R (refer to appendix F table 1.2)

$$X = \frac{10\,(\%X)\,(\text{kV sec})^2}{\text{kVA}} = \frac{10\,(3.45)\,(0.48)^2}{1500} = 0.0053$$

$$R = \frac{10\,(\%R)\,(\text{kV sec})^2}{\text{kVA}} = \frac{10\,(0.56)\,(0.48)^2}{1500} = 0.00086$$

iii) Conductors in steel conduit

25' – 500kcmil, 6 per phase (refer to appendix F table 5)

$$X = \frac{25'}{1000} \text{ X } \frac{0.0379}{6} = 0.000158$$

$$R = \frac{25'}{1000} \text{ X } \frac{0.0244}{6} = 0.000102$$

iv) Fuse

KRP – C – 2000SP (refer to appendix F table 3)

$X = 0.00005$

Total resistance and reactance

$R = 0.00086 + 0.000102 = 0.000962$

$X = 0.0000023 + 0.0053 + 0.000158 + 0.00005 = 0.00551$

$Z_{\text{total per phase}} = \sqrt{(0.000962)^2 + (0.00551)} = 0.0056\Omega$

$$I_{S.C\ sym\ RMS} = \frac{E_{sec\ line-line}}{\sqrt{3}\,(Z_T)} = \frac{480}{\sqrt{3}\,(0.0056)} = 49489\ \text{A}$$

I sym motor contrib. = 4 x I full load = 4 x 1804 = 7216 A

I total S.C sym RMS (fault X1) = 49489 + 7216 = 56705 A

Fault at X2

Resistance and reactance up to point X1:

R = 0.000962   X = 0.00551

i) Fuse

LPS – RK – 400SP (refer to appendix F table 3)

X = 0.00005

ii) Feeder in steel conduit

50' – 500kcmil (refer to appendix F table 5)

$$X = \frac{50'}{1000} \times 0.0379 = 0.00189$$

$$R = \frac{50'}{1000} \times 0.0244 = 0.00122$$

Total resistance and reactance

$R = 0.000962 + 0.00122 = 0.002182$

$X = 0.00551 + 0.00008 + 0.00189 = 0.00748$

$Z_{\text{total per phase}} = \sqrt{(0.00218)^2 + (0.00748)^2}$

$= 0.00778\Omega$

$$I_{\text{S.C sym RMS}} = \frac{E_{\text{sec line-line}}}{\sqrt{3}\,(Z_T)} = \frac{480}{\sqrt{3}\,(0.00778)} = 35621 \text{ A}$$

I sym motor contrib. = 4 x I full load = 4 x 1804 = 7216 A

I total S.C sym RMS (fault X2) = 35621+ 7216 = 42837 A

ii) Point to point method

Fault at X1

$$I_{\text{full load}} = \frac{\text{KVA X 1000}}{E_{\text{L-L}} \text{ X } 1.732} = \frac{1500 \text{ X } 1000}{480 \text{ X } 1.732} = 1804 \text{ A}$$

$$\text{Multiplier} = \frac{100}{\%Z_{\text{trans}}} = \frac{100}{3.5} = 28.57$$

I S.C = I full load X Multiplier = 1804 X 28.57 = 51540 A

$$f = \frac{1.732 \times L \times I}{C \times n \times E_{L-L}} = \frac{1.732 \text{ X } 25 \text{ X } 51540}{6 \text{ X } 22185 \text{ X } 480} = 0.0349$$ (refer appendix F table 6 for value of C)

$$M = \frac{1}{1 + f} = \frac{1}{1 + 0.0349} = 0.9663$$

$I_{S.C\ sym\ RMS} = 51540 \text{ X } 0.9663 = 49803$ A

$I_{sym\ motor\ contrib.} = 4 \times I_{full\ load} = 4 \times 1804 = 7216$ A

$I_{total\ S.C\ sym\ RMS}$ (fault X1) = 49803+ 7216 = 57019 A

Fault at X2

Use $I_{s.c\ sym\ RMS}$ at point X1 to calculate "f"

$$f = \frac{1.732 \times L \times I}{C \times n \times E_{L-L}} = \frac{1.732 \text{ X } 50 \text{ X } 49803}{22185 \text{ X } 480} = 0.4050$$ (refer appendix F table 6 for value of C)

$$M = \frac{1}{1+f} = \frac{1}{1+0.4050} = 0.7117$$

$I_{S.C\ sym\ RMS} = 49803 \text{ X } 0.7117 = 35445$ A

$I_{sym\ motor\ contrib.} = 4 \times I_{full\ load} = 4 \times 1804 = 7216$ A

$I_{total\ S.C\ sym\ RMS}$ (fault X2) = 35445+ 7216 = 42661 A

Tabulated result for case 1:

Table 4.2 : Short circuit tabulated result

Point	Ohmic (A)	PTP (A)	EDSA (A)
X1	56,705	57,019	52070
X2	42,837	42,661	46192

From the table, we can observe that all three methods of short circuit analysis give acceptable range of result. This verifies the reliability of each method. The suitable method of calculation shall be chosen based on the power system complexity. For a simple single line diagram as in case 1, it is practical enough to use manual calculation. However, for a more complicated power system, it is efficient and practical to use the computer software. EDSA software method is preferred because it is a proven tool in the demanding, real-world applications and in precise software testing based on long hand calculation. It also offers wide range of fault simulation such as 3 Phase, line-line, line-line-ground and line-ground. This software also offers flexible, fast and accurate solution techniques. It is easy-to-use and the results are at a glance as user selection, in report or annotation form.

4.5.1.2 Case 2: TBCP-A single line diagram

In this short circuit analysis, only worst case scenario is carried out which represents the highest fault level condition. This scenario happens in a very short time during the interchange of operation between two transformers for example during maintenance of transformer. By means, during this time the transformers will be in parallel operation, but only for a short time. Hence the busbar will be rated for both transformers connected in parallel.

Worst case scenario:

- 3 turbine generators are running.
- Emergency Diesel Generator is not running.
- All four transformer and tie breakers are closed.

Parameters for the various equipment used in the calculations (EDSA) are as follows:

Alternator for Turbine Generators

ISO Rating	:	5750 kW (7188 kVA at 0.8 p.f)
System Voltage	:	6600 V, 50 Hz
Subtransient reactance X"d	:	15 %
Transient reactance X'd	:	22.3 %
Synchronuos reactance Xd	:	138.9%
X/R ratio	:	42.7
Neutral earthing	:	Resistance earthing

Emergency Diesel Generator

Site Rating : 1500 kW (1875 kVA at 0.8 p.f)
System Voltage : 400 V, 50 Hz
Subtransient reactance X"d : 14.6 %
Transient reactance X'd : 22.3 %
Syncronuos reactance Xd : 138.9 %
X/R ratio : 42.7
Neutral earthing : Solidly earthed

Transformers (TF-7560 & TF-7570

Rating : 2500 kVA
Voltage : 6600 V / 400 V
% Reactance X : 6.4 %
% Resistance R : 0.8 %
X/R ratio : 8

Transformers (TF-7540 & TF-7550)

Rating : 2500 kVA
Voltage : 6600 V / 400 V
% Reactance X : 6.4 %
% Resistance R : 0.8 %
X/R ratio : 8

Summary of EDSA calculation 3phase fault current level is as follows:

Table 4.3: Summary of EDSA calculation 3phase fault current level

Bus ID	Volt (kV)	Current (kA)
A-2500A	6.6	14.65
A-2500B	6.6	14.65
P-6940A	6.6	14.92
GT-7510	0.4	16.67
GT-7520	0.4	16.65
GT-7530	0.4	16.53
MCC-7810	0.4	10.68
MCC-7820	0.4	33.61
MCC-7830	0.4	72.53
MCC-7840	0.4	25.96
P-2510A	6.6	17.8
P-6910A	6.6	15.33
SB-7710 BUS B	0.4	79.13
SB-7710 BUS A/P	0.4	79.1
SB-7720 BUS A	0.4	79.66
SB-7720 BUS B	0.4	79.61
SG-7500 BUS A	6.6	16.78
SG-7500 BUS B	6.6	16.77

The result of short circuit current obtained by EDSA based on the worst case scenario will then be compared to vendor's available equipment short circuit rating. For high voltage system, the available equipment short circuit ratings are 40 kA, 31.5 kA, 25 kA, and 10 kA. As for the low voltage system, the available equipment short circuit ratings are 100 kA, 80 kA, 65 kA and 50 kA.

The highest fault level at the HV bus, SG-7500 is 17 kA, which is within the short circuit rating of 25 kA, RMS symmetrical. The highest fault level at the LV 400 V switchboards for SB-7710 and SB-7720 are 79 kA and 80 kA respectively. These values are within the switchboards short circuit current rating of 100 kA RMS, symmetrical. This condition happens when both transformer from respective LV systems are in parallel. The highest fault level at MCC level is 72.53 kA that is at MCC 7830. The busbar short circuit current rating for this MCC should be at 80 kA.

Changes in short circuit current will take place when there is an equipment addition or deletion. More equipment especially motor will cause the short circuit current value to be higher. From the results obtained, the engineer can specify proper interrupting rating requirement based on vendor's data. Also, using the information gathered, we can selectively coordinate the system and provide component protection.

4.5.2 Motor starting study

In this analysis, emergency scenario for TBCP-A platform will be considered. During this condition, only emergency diesel generator will be operating to cater for all vital loads on the respective bus bar. The scenario shall be described as follow:

- Only Emergency Diesel Generator (EDG) is running to cater all vital loads on SB-7710 Bus A/P.
- Air compressor K-5510 is to started.
- Soft starter method is used.

Manually calculation will be done to calculate value of voltage dip at EDG terminal, switchboard bus terminal and motor terminal voltages. The results will then be compared to results obtained using EDSA. The value of voltage dip calculated using both methods should be in the range of PTS 33.64.10.10 requirement.

4.5.2.1 Manual calculation

Calculate the total current during starting excluding the largest motor to be started

Total KVA prior to start up of largest motor = $1217.98 + j698.64$

$$= 1404.13 \text{ kVA}$$

$$\text{Tan } \theta = \frac{698.64}{1217.98} = 0.5736$$

$$\theta = 29.84$$

$$I = \frac{\text{Total KVA prior to start up of largest motor}}{\sqrt{3} \times V}$$

$$= \frac{1404.13 \times 1000}{\sqrt{3} \times 400} = 2026.7 \text{ A}$$

Calculate voltage generated by EDG

$$V_{ph} = \frac{400}{\sqrt{3}} = 230.9 \text{ V}$$

XD = 14.6% (from catalogue, refer appendix G)

$$= \frac{0.146 \times (400)^2}{1875 \times 1000} = 0.01\ \Omega$$

$$X/R = 9$$

$$RG = \frac{14.6\%}{9} = 1.62\%$$

$$= \frac{0.0162 \times (400)^2}{1875 \times 1000} = 0.0014\ \Omega$$

$E = \sqrt{(V_{ph} \cos\theta + I*R_G)^2 + (V_{ph} \sin\theta + I*X_D)^2}$

$= \sqrt{(230.9 \times 0.87 + 2026.7 \times 0.0014)^2 + (230.9 \times 0.5 + 2026.7 \times 0.01)}$

$= 244.87$ V

Calculate current & voltage dip during starting of largest motor –soft starter method

Motor starting power factor $\cos\theta = 0.30$

$\sin\theta = 0.9539$ (general rule for LV motor)

$\text{KVA of motor} = \frac{185}{0.86} = 215$ kVA

KVAR of motor during starting = 3 x 215 x 0.9539 = 615 kVAR

KW of motor during starting = 3 x 215 x 0.30 = 194 kW

Total KVA during starting as seen by generator = 1217.98 + j698.64 + 194 + j615

= 1411.98 + j1313.64

= 1928.6

$\tan\theta = \frac{1313.64}{1411.98} = 0.9304$

$\theta = 42.93$

$\cos\theta = 0.732$

$\sin\theta = 0.681$

$I_T = \frac{1928 \times 1000}{\sqrt{3} \times 400} = 2783.7$ A

i) Voltage dip at EDG terminal

$$E^2=(VGT \cos\theta + IT*RG)^2 + (VGT \sin\theta + IT *XD)^2$$

$$244.87^2 = (VGT \times 0.732 + 2783.7 \times 0.0014)^2 + (VGT \times 0.681 + 2783.7 \times 0.01)^2$$

$VGT = 222.4$ V

$VGT(L\text{-}L) = 222.4 \times \sqrt{3} = 385.2$ V

$$\%Vdip = \frac{V(L\text{-}L) - VGT}{V(L\text{-}L)} \times 100 = \frac{400 - 384.5}{400} \times 100 = 3.88\%$$

ii) Voltage dip at switchgear bus terminal

Cable selected = 4 x (1C x 630)sq mm

Estimated cable length = 50M

No of cable runs = 4

$$\text{Resistance } Rc = 0.04 \times \frac{50}{4 \times 1000} = 0.5 \times 10^{-3}\ \Omega$$

$$\text{Reactance } Xc = 0.09 \times \frac{50}{4 \times 1000} = 1.125 \times 10^{-3}\ \Omega$$

$$\text{Vdip in the cable} = \sqrt{3} \times IS\,(RC \cos\theta + XC \sin\theta)$$

$$= \sqrt{3} \times 2783.7(0.5 \times 10^{-3} \times 0.732 + 1.125 \times 10^{-3} \times 0.681)$$

$$= 5.46 \text{ V}$$

Voltage at bus = VGT (L-L) – Vdip in the cable

= 384.5 – 5.46

= 379.04 V

$$\text{Voltage dip at bus} = \frac{V\,(L\text{-}L) - V_{bus}}{V\,(L\text{-}L)} \times 100 = \frac{400 - 379.04}{400} \times 100 = 5.24\%$$

iii) Voltage dip at motor terminal

Cable selected = (3C x 240)sq mm

Estimated cable length = 50M

$$\text{Resistance } R_c = 0.0984 \times \frac{50}{1000} = 4.92 \times 10^{-3}\ \Omega$$

$$\text{Reactance } X_c = 0.089 \times \frac{50}{1000} = 4.45 \times 10^{-3}\ \Omega$$

$$RC \cos\theta + XC \sin\theta = (4.92 \times 10^{-3} \times 0.3 + 4.45 \times 10^{-3} \times 0.9539) = 0.0057$$

$$I_m = \frac{185 \times 100}{\sqrt{3} \times 400 \times 0.86 \times 0.96} = 323.43\ \text{A}$$

$$I_s = 3 \times I_m = 3 \times 323.43\text{A} = 970.3\ \text{A}$$

$$\text{Vdip in the cable} = \sqrt{3} \times I_S\,(RC \cos\theta + XC \sin\theta) = \sqrt{3} \times 970.3 \times 0.0057 = 9.58\ \text{V}$$

Voltage at motor terminal = Voltage at bus – Vdip in the cable

= 379.04 – 9.58 = 369.46 V

$$\text{Voltage dip at motor terminal} = \frac{V\,(L\text{-}L) - V_{motor}}{V\,(L\text{-}L)} \times 100 = \frac{400 - 369.49}{400} \times 100 = 7.64\%$$

Tabulated result for motor starting:

Table 4.4: Motor starting study tabulated result

Description	EDSA	manual
At the EDG Terminal (%)	3.43	3.88
At the Switchgear Bus (%)	9.21	5.24
At the Motor Terminal (%)	10.64	7.64

Please refer to appendix E for EDSA result. Based on the tabulated result, it is observed that voltage dip at all the relevant buses was found to be within the specified limits. The value of the voltage dip at these generator terminals was verified with manual calculation, and the result is acceptable within the same order of range. Soft starter method is used for the largest motor to be started in order to obtain lower value of voltage dip. Recommendation for improving the accuracy of results is to undertake this motor study during design period with actual motor designed data instead of using the values given by EDSA.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In this project, I have conducted research on power system fundamental, design requirement, short circuit and motor starting studies in order to achieve better understanding on power system configuration and analysis. I have performed short circuit and motor starting calculation manually and made comparison with the results obtained in EDSA software. It was found that the results are within the acceptable limits. I have concluded that EDSA software is the most practical solution especially considering complicated power system design. The objective to familiarize with the flow and method used in preparing short circuit analysis and motor starting study of an offshore platform in the oil and gas industry is achieved.

5.2 Recommendation

For future work, I would recommend verification of TBCP-A power system short circuit analysis using various manual calculation methods. Other than that, study on other scenario for both short circuit analysis and motor starting study should also be done. Other power system analysis such as power flow, harmonics analysis and transient stability study can be done in order to obtain further understanding on power system analysis.

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	EQUIPMENT										MOTOR RATING/ LOAD RATING	LOAD FACTOR =A/B	EFFICIENCY at load factor C	POWER FACTOR at load factor C	kW = A/D CONSUMED LOAD kVAr = kW * ta						V D I P	B U S B A R	T Y P E	T Y . D I A	REMARKS
	EQUIPMENT NO.	DESCRIPTION	V	E	NE	RS	C	INTT	STB	ABSORBED LOAD [A]	[B]	[C]	[D]	(a)	Continuous [E]		Intermittent and spares [F]		Stand-by [G]						
										kW	kW	in decimals	in decimals	cos. phi	kW	kVAr	kW	kVAr	kW	kVAr					
	SG-7500	6.6kV HV SWITCHGEAR LOADS SUMMARY																							
1	P-8040A	COOLING WATER CIRC PUMP A			X		X			580.00	600.00	0.97	0.960	0.87	604.17	342.40									TBCP-A-B-1142(COOLING WATER CIRC. PUMP)
2	P-8010A	SEAWATER LIFT PUMP A			X		X			827.00	850.00	0.97	0.960	0.87	661.45	488.21									TBCP-A-B-1136(SEAWATER LIFT PUMP TRAIN 1)
3	P-8010B	SEAWATER LIFT PUMP B			X				X	827.00	850.00	0.87	0.960	0.87					661.46	488.21					TBCP-A-B-1137(SEAWATER LIFT PUMP TRAIN 2)
4	P-8040B	COOLING WATER CIRC PUMP B			X				X	580.00	600.00	0.97	0.960	0.87					604.17	342.40					TBCP-A-B-1142(COOLING WATER CIRC. PUMP)
5	A-2500A	REFRIGERANT COMPRESSOR A			X		X			950.00	950.00	1.00	0.960	0.87	989.58	560.82									BASED ON NATCO'S LOAD
6	A-2500B	REFRIGERANT COMPRESSOR B			X		X			950.00	950.00	1.00	0.960	0.87	989.58	560.82									BASED ON NATCO'S LOAD
7	A-2500C	REFRIGERANT COMPRESSOR C			X				X	950.00	950.00	1.00	0.960	0.87					989.58	560.82					
		PRODUCED WATER RE-INJECTION PUMP (FUTURE)			X		X			600.00	650.00	0.94	0.970	0.87	624.74	467.40									

Maximum of normal running plant load :
(Est. x % E + y % F **4,269.53** kW **2419.66** kVAr **4907.51** kVA
x = 100 y = 30 or largest intermittent load
Peak load: **4,515.05** kW **2558.80** kVAr **5189.72** kVA
(Est. x % E + y % F + z G)
x = 100 y = 30 z = 10% or largest standby load
Coincidence factors x, y and z shall be defined for each separate case, subject to principal's approval

	Continuous kW	Continuous kVAr	Intermittent and spares kW	Intermittent and spares kVAr	Stand-by kW	Stand-by kVAr
TOTAL	4269.53	2419.66	0.00	0.00	2455.21	1391.43
kVA=sqrt(kW ²+ kVAr²)	4907.51		0.00		2822.08	

p.f. without compensation (cos. phi) :

p.f. with compensation (cos. phi1) :

Req'd capacitor rating[=kW(tan phi - tan phi1)]:

NOTES:
V - Vital E - Essential
NE - Non-esse RS - Restarting

a) Absorbed loads :
- for pumps, shaft load on duty point;
- for instrumentation, computers, communication, air conditioning, the required load during full operation of plant
- for lighting during dark hours;
- for workshops, the average total load in normal full operation.

b) Consumed Loads:

E - "Continuous" all loads that may continuously be required for normal operation, including lighting and workshops.

F - "Intermittent and spares" the loads required for intermediate pumping, storage, loading etc. all electrical spares of electrically driven units.

G - "Stand-by", loads required in emergencies only, such as fire-water pumps or those of normally not running electrically driven units stand-by for normally running steam-driven ones (e.g. charge pumps, boiler feed pumps).

VDIP : Protection against short-time voltage drop.

TYPE : CB = Circuit Breaker
C = Contactor
CBD = Circuit Breaker and Earth Leakage Relay

VVVF : Variable Voltage Variable Frequency

TY.DIA : Typical Diagram

Project : TBCP-A Client : PETRONAS CARIGALI SDN. BHD. Eng. By: rnz integrated (m) sdn bhd

Rev	Date	Description	Prep'd	Checked	App'd	CLIENT			
C1	28/09/07	POST AFDD	SMD	MRAB	MRAR				
C	06/07/07	APPROVED FOR DETAILED DESIGN	SMD	MRAB	MRAR				
B	-	APPROVED FOR BID	-	-	-				
A	25/04/07	IFC FOR FEED	SMD	MRAB	MRAR				

Note:
1. The total calculated load rating is based on estimated assumed loads and shall be subject to any changes based on the latest revision of the selected vendors.

DOC. TITLE :

ELECTRICAL LOAD ANALYSIS
(HV LOADS)

DOC NO.: **P5155-EL-RP-1005**

TBCP-A FULL LOAD CASE (LV LOADS)-CO_2 REMOVAL SYSTEM NO.1

EQUIPMENT									MOTOR RATING/ LOAD RATING	LOAD FACTOR =A/B	EFFICIENCY at load factor C	POWER FACTOR at load factor C	kW = A/D	CONSUMED LOAD		kVAr = kW * tan phi			V DIP	BUSBAR	TYPE	TY. DIA	REMARKS
EQUIPMENT NO.	DESCRIPTION	V	E	NE	C	NT	STB	ABSORBED LOAD (A)	(B)	(C)	(D)	(a)	Continuous	(E)	Intermittent and spares	(F)	Stand-by	(G)					
								kW	kW	in decimals	in decimals	cos. phi	kW	kVAr	kW	kVAr	kW	kVAr					
SB-7710	LV SWITCHBOARD BUS-P (VITAL LOAD)																						
K-5510	AIR COMPRESSOR A		X		X			172.00	185.00	0.93	0.96	0.86	179.17	105.31									TBCP-A-B-1165 Sht 1/2(AIR COMPR. & UTILITY AIR RECEIVER)
K-5520	AIR COMPRESSOR B		X				X	172.00	185.00	0.93	0.96	0.86					179.17	105.31					TBCP-A-B-1165 Sht 1/2(AIR COMPR. & UTILITY AIR RECEIVER)
	AC START MOTOR FOR GT-7510		X					90.00	110.00	0.82	0.98	0.87											SOLAR T70 (ONLY FOR STARTING)
	AC START MOTOR FOR GT-7520		X					90.00	110.00	0.82	0.98	0.87											SOLAR T70 (ONLY FOR STARTING)
	AC START MOTOR FOR GT-7530		X					90.00	110.00	0.82	0.98	0.87											SOLAR T70 (ONLY FOR STARTING)
MCC-7810	TELECOM EQUIPMENT ROOM																						
	HVAC SYSTEM (TELECOM EQUIPMENT ROOM)																						
HAH-5500A	AIR HANDLING UNIT FAN A		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
HAH-5500B	AIR HANDLING UNIT FAN B		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
HHW-5500A	ELECTRIC DUCT HEATER			X		X		4.00	4.00	1.00	1.00	1.00			4.00	0.00							
HPF-5500A	PRESSURIZATION FAN A		X		X			4.00	5.50	0.73	0.87	0.84	4.60	2.97									
HPF-5500B	PRESSURIZATION FAN B		X				X	4.00	5.50	0.73	0.87	0.84					4.60	2.97					
HEF-5500A	EXHAUST FAN (BATTERY ROOM)			X	X			0.05	0.25	0.20	0.68	0.73	0.08	0.07									
HEF-5500B	EXHAUST FAN (BATTERY ROOM)			X	X			0.05	0.25	0.20	0.65	0.73	0.08	0.07									
	ACCU III																						
CK-5500A-A	COMPRESSOR A		X		X			16.00	18.50	0.86	0.91	0.82	17.58	12.27									
CF-5500A-A	CONDENSING FAN A		X		X			4.00	5.50	0.73	0.87	0.84	4.60	2.97									
	ACCU IV																						
CK-5500B-A	COMPRESSOR A		X				X	16.00	18.50	0.86	0.91	0.82					17.58	12.27					
CF-5500B-A	CONDENSING FAN A		X				X	4.00	5.50	0.73	0.87	0.84					4.60	2.97					
MCC-7810	LQ LOADS																						
HSS-7800	HELICOPTER STARTER SOCKET OUTLET		X			X		10.00	10.00	1.00	0.85	0.80			11.76	8.82							
ALV-4200	SURVIVAL CRAFT NO 1	X					X	10.58	11.00	0.96	0.90	0.82					11.76	8.21					
ALV-4210	SURVIVAL CRAFT NO 2	X					X	10.58	11.00	0.96	0.90	0.82					11.76	8.21					
ALV-4220	SURVIVAL CRAFT NO 3	X					X	10.58	11.00	0.96	0.90	0.82					11.76	8.21					
DB-7712A	EMERGENCY LIGHTING DB ON MAIN DECK		X		X								3.00	1.29									
DB-7712B	EMERGENCY LIGHTING DB LEVEL 1		X		X								3.59	1.54									
DB-7712C	EMERGENCY LIGHTING DB LEVEL 2		X		X								3.68	1.58									
DB-7712D	EMERGENCY LIGHTING DB LEVEL 3		X		X								2.17	0.93									
DB-7712E	EMERGENCY LIGHTING DB LEVEL 4		X		X								3.30	1.42									
DB-7715A	SMALL POWER DB (KITCHEN)		X			X									9.46	4.58							
DB-7715B	SMALL POWER DB (KITCHEN)		X			X									17.07	8.27							
	HVAC (LQ-2nd FLOOR (SER. CCR OFFICE SICK BAY)																						
HAH-5020A	AIR HANDLING UNIT FAN A		X		X			15.00	18.50	0.81	0.91	0.82	16.48	11.51									
HAH-5020B	AIR HANDLING UNIT FAN B		X				X	15.00	18.50	0.81	0.91	0.82					16.48	11.51					
HHW-5020A	ELECTRIC DUCT HEATER			X		X		12.00	12.00	1.00	1.00	1.00			12.00	0.00							
HPF-5020A	PRESSURIZATION FAN A		X		X			4.00	5.50	0.73	0.87	0.84	4.60	2.97									
HPF-5020B	PRESSURIZATION FAN B		X				X	4.00	5.50	0.73	0.87	0.84					4.60	2.97					
HEF-5020A	EXHAUST FAN			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
HEF-5020B	EXHAUST FAN			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
	ACCU I																						
CK-5020A-A	COMPRESSOR A		X		X			20.00	22.00	0.91	0.91	0.85	21.98	13.62									
CK-5020A-B	COMPRESSOR B		X		X			20.00	22.00	0.91	0.91	0.85	21.98	13.62									
CF-5020A-A	CONDENSING FAN A		X		X			8.00	11.00	0.73	0.90	0.85	8.89	5.51									
CF-5020A-B	CONDENSING FAN B		X		X			8.00	11.00	0.73	0.90	0.85	8.89	5.51									
	ACCU II																						
CK-5020B-A	COMPRESSOR A		X				X	20.00	22.00	0.91	0.91	0.85					21.98	13.62					
CK-5020B-B	COMPRESSOR B		X				X	20.00	22.00	0.91	0.91	0.85					21.98	13.62					
CF-5020B-A	CONDENSING FAN A		X				X	8.00	11.00	0.73	0.90	0.85					8.89	5.51					
CF-5020B-B	CONDENSING FAN B		X				X	8.00	11.00	0.73	0.90	0.85					8.89	5.51					
	HVAC (LQ 1st FLOOR GALLEY/DINING MESS)																						
HAH-5010A	AIR HANDLING UNIT FAN A		X		X			20.00	22.00	0.91	0.91	0.82	21.98	15.34									
HAH-5010B	AIR HANDLING UNIT FAN B		X				X	20.00	22.00	0.91	0.91	0.82					21.98	15.34					
HHW-5010A	ELECTRIC DUCT HEATER			X		X		12.00	12.00	1.00	1.00	1.00			12.00	0.00							
HPF-5010A	PRESSURIZATION FAN A		X		X			1.81	2.20	0.73	0.91	0.82	1.99	1.39									
HPF-5010B	PRESSURIZATION FAN B		X				X	1.81	2.20	0.73	0.91	0.82					1.99	1.39					
HEF-5010A	KITCHEN HOOD EXHAUST			X	X			0.80	1.10	0.73	0.77	0.78	1.04	0.84									

TBCP-A FULL LOAD CASE (LV LOADS)-CO_2 REMOVAL SYSTEM NO.1

	EQUIPMENT									MOTOR RATING/ LOAD RATING	LOAD FACTOR =A/B	EFFICIENCY at load factor C	POWER FACTOR at load factor C	kW = A/D	CONSUMED LOAD			kVAr = kW * tan phi		V DIP	BUSBAR	TYPE	TY. DIA	REMARKS
	EQUIPMENT NO.	DESCRIPTION	V	E	NE	C	INT	STB	ABSORBED LOAD [A]	[B]	[C]	[D]	(a)	Continuous [E]		Intermittent and spares [F]		Stand-by [G]						
									kW	kW	in decimals	in decimals	cos. phi	kW	kVAr	kW	kVAr	kW	kVAr					
	HSF-5010B	DRYER SUPPLY FAN (LAUNDRY)			X	X			0.27	0.37	0.73	0.68	0.75	0.40	0.35									
	HEF-5010C	LAUNDRY ROOM EXHAUST FAN			X	X			0.41	0.55	0.75	0.73	0.74	0.56	0.51									
	HEF-5010D	DRYER EXHAUST FAN (LAUNDRY)			X	X			0.10	0.25	0.40	0.68	0.73	0.15	0.14									
	HEF-5010E	SMOKE ROOM EXHAUST FAN			X	X			0.10	0.25	0.40	0.68	0.73	0.15	0.14									
		ACCU #1																						
	CK-5010A-A	COMPRESSOR A		X		X			25.00	30.00	0.83	0.92	0.84	27.17	17.55									
	CK-5010A-B	COMPRESSOR B		X		X			25.00	30.00	0.83	0.92	0.84	27.17	17.55									
	CF-5010A-A	CONDENSING FAN A		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
	CF-5010A-B	CONDENSING FAN B		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
		ACCU #2																						
	CK-5010B-A	COMPRESSOR A		X				X	25.00	30.00	0.83	0.92	0.84					27.17	17.55					
	CK-5010B-B	COMPRESSOR B		X				X	25.00	30.00	0.83	0.92	0.84					27.17	17.55					
	CF-5010B-A	CONDENSING FAN A		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
	CF-5010B-B	CONDENSING FAN B		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
	HPF-5020A	PRESSURIZATION FAN A		X		X			4.00	5.50	0.73	0.87	0.84	4.60	2.97									
	HPF-5020B	PRESSURIZATION FAN B		X				X	4.00	5.50	0.73	0.87	0.84					4.60	2.97					
	HPF-5040A	PRESSURIZATION FAN A		X		X			4.00	5.50	0.73	0.87	0.84	4.60	2.97									
	HPF-5040B	PRESSURIZATION FAN B		X				X	4.00	5.50	0.73	0.87	0.84					4.60	2.97					
	HPF-5030A	PRESSURIZATION FAN A		X		X			4.00	5.50	0.73	0.87	0.84	4.60	2.97									
	HPF-5030B	PRESSURIZATION FAN B		X				X	4.00	5.50	0.73	0.87	0.84					4.60	2.97					
	MCC-7830	VITAL LOAD																						
	P-6720A	DIESEL TRANSFER PUMP A		X				X	3.40	3.70	0.92	0.85	0.85					4.00	2.48					TBCP-A-B-1171 Sht 2/2 (DIESEL DAY TANK & DIST.)
	P-6720B	DIESEL TRANSFER PUMP B		X				X	3.40	3.70	0.92	0.85	0.85					4.00	2.48					TBCP-A-B-1171 Sht 2/2 (DIESEL DAY TANK & DIST.)
	P-5240A	POTABLE WATER PUMP A		X		X			15.00	18.50	0.81	0.91	0.82	16.48	11.51									TBCP-A-B-1178(POTABLE WATER STORAGE)
	A-5210A	POTABLE WATER MAKER A (RO FEED PUMP)		X		X			23.00	23.00	1.00	0.94	0.83	24.47	16.44									TBCP-A-B-1177(POTABLE WATER MAKERS)
	P-5110A	SERVICE WATER PUMP A		X		X			50.00	55.00	0.91	0.94	0.83	53.19	35.74									TBCP-A-B-1181(SERVICE WATER SYSTEM LIFT PUMPS)
	P-5110B	SERVICE WATER PUMP B		X				X	50.00	55.00	0.91	0.94	0.83					53.19	35.74					TBCP-A-B-1181(SERVICE WATER SYSTEM LIFT PUMPS)
	A-5210B	POTABLE WATER MAKER B (RO FEED PUMP)		X				X	23.00	23.00	1.00	0.94	0.83					24.47	16.44					TBCP-A-B-1177(POTABLE WATER MAKERS)
	P-5240B	POTABLE WATER PUMP B		X				X	15.00	18.50	0.81	0.91	0.82					16.48	11.51					TBCP-A-B-1178(POTABLE WATER STORAGE)
	E-5545/5570	AIR COMPRESSOR OIL/AIR COOLER FAN		X			X		7.50	11.00	0.68	0.90	0.82			8.33	5.82							TBCP-A-B-1165 Sht 1/2(AIR COMPR. & UTILITY AIR RECEIVER)
	E-5615/5610	AIR COMPRESSOR OIL/AIR COOLER FAN		X				X	7.50	11.00	0.68	0.90	0.82					8.33	5.82					TBCP-A-B-1165 Sht 1/2(AIR COMPR. & UTILITY AIR RECEIVER)
	DB-7401	TBCP-A PROCESS LOADS			X	X			18.17	36.33	0.50	0.91	0.95	19.98	6.56									
	UPS-7850A	400/230 AC UPS FOR INSTRUMENT	X			X			50.00	100.00	0.50	0.91	0.80	54.95	41.21									
	UPS-7820A	400/230 AC UPS FOR TELECOM	X			X			20.00	40.00	0.50	0.91	0.80	21.98	16.48									
	NCCP-7825A	AC UPS FOR NAVIGATIONAL AIDS	X			X			2.50	5.00	0.50	0.91	0.80	2.75	2.06									
	NCCP-7825B	AC UPS FOR NAVIGATIONAL AIDS	X			X			2.50	5.00	0.50	0.91	0.80	2.75	2.06									
	P-7712	EMERGENCY GENERATOR HYDRAULIC PUMP CHARGING			X			X	3.00	3.70	0.81	0.84	0.84					3.57	2.31					
	P-6340	FIREWATER HYDRAULIC PUMP CHARGING			X			X	3.00	3.70	0.81	0.84	0.84					3.57	2.31					
	P-6350	FIREWATER HYDRAULIC PUMP CHARGING			X			X	3.00	3.70	0.81	0.84	0.84					3.57	2.31					
	E-6300	HP FLARE K.O. DRUM HEATER			X	X			100.00	100.00	1.00	1.00	1.00	100.00	0.00									TBCP-A-B-1148(HP FLARE KO DRUM)
	DB-7812	EMERGENCY LIGHTING DISTRIBUTION BOARD (MOD. 1)		X		X								1.58	0.66									
	DB-7822	EMERGENCY LIGHTING DISTRIBUTION BOARD (MOD. 2)		X		X								0.73	0.31									
	DB-7832	EMERGENCY LIGHTING DISTRIBUTION BOARD (MOD. 3)		X		X								1.46	0.63									
	DB-7842	EMERGENCY LIGHTING DISTRIBUTION BOARD (MOD. 4)		X		X								0.73	0.31									
	DB-7852	EMERGENCY LIGHTING DISTRIBUTION BOARD (MOD. 5)		X		X								0.49	0.21									
	DB-7862	EMERGENCY LIGHTING DISTRIBUTION BOARD OUTDOOR (MOD. 6)		X		X								2.64	1.13									
	DB-7882	EMERGENCY LIGHTING DISTRIBUTION BOARD (MOD. 8 & MSF NORTH)		X		X								1.94	0.83									
	DB-7868	SMALL POWER DISTRIBUTION BOARD (MOD. 6, SWGR RM-SPACE HEATER)		X		X								29.31	12.57									
		HVAC - SWITCHGEAR ROOM																						
	HAH-5000A	AIR HANDLING UNIT A		X		X			25.00	30.00	0.83	0.92	0.84	27.17	17.55									
	HAH-5000B	AIR HANDLING UNIT B		X				X	25.00	30.00	0.83	0.92	0.84					27.17	17.55					
	HPF-5000A	PRESSURIZATION FAN A		X		X			1.61	2.20	0.73	0.81	0.82	1.99	1.39									
	HPF-5000B	PRESSURIZATION FAN B		X				X	1.61	2.20	0.73	0.81	0.82					1.99	1.39					
	HHW-5000	ELECTRIC DUCT HEATER					X		12.00	12.00	1.00	1.00	1.00			12.00	0.00							
		ACCU #1																						
	CK-5000A-A	COMPRESSOR A		X		X			30.00	37.00	0.81	0.93	0.84	32.26	20.84									
	CK-5000A-B	COMPRESSOR B		X		X			30.00	37.00	0.81	0.93	0.84	32.26	20.84									
	CF-5000A-A	CONDENSING FAN A		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
	CF-5000A-B	CONDENSING FAN B		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
		ACCU #2																						
	CK-5000B-A	COMPRESSOR A		X				X	30.00	37.00	0.81	0.93	0.84					32.26	20.84					
	CK-5000B-B	COMPRESSOR B		X				X	30.00	37.00	0.81	0.93	0.84					32.26	20.84					

TBCP-A FULL LOAD CASE (LV LOADS)-CO₂ REMOVAL SYSTEM NO.1

EQUIPMENT NO.	DESCRIPTION	V	E	NE	C	NT	STE	ABSORBED LOAD [A]	MOTOR RATING/ LOAD RATING [B]	LOAD FACTOR =A/B [C]	EFFICIENCY at load factor C [D]	POWER FACTOR at load factor C (a)	CONSUMED LOAD (kW = A/D; kVAr = kW * tan phi) Continuous [E]		Intermittent and spares [F]		Stand-by [G]		VDIP	BUSBAR	TYPE	TY. DIA	REMARKS
								kW	kW	in decimals	in decimals	cos. phi	kW	kVAr	kW	kVAr	kW	kVAr					
CF-5800B-A	CONDENSING FAN A		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
CF-5800B-B	CONDENSING FAN B		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
	HVAC - MCC/UPS ROOM																						
HAH-5810A	AIR HANDLING UNIT A		X		X			25.00	30.00	0.83	0.92	0.84	27.17	17.55									
HAH-5810B	AIR HANDLING UNIT B		X				X	25.00	30.00	0.83	0.92	0.84					27.17	17.55					
HPF-5810A	PRESSURIZATION FAN A		X		X			1.61	2.20	0.73	0.81	0.82	1.99	1.39									
HPF-5810B	PRESSURIZATION FAN B		X				X	1.61	2.20	0.73	0.81	0.82					1.99	1.39					
HHW-5810	ELECTRIC DUCT HEATER			X		X		12.00	12.00	1.00	1.00	1.00			12.00	0.00							
HEF-5810A	EXHAUST FAN A (BATTERY ROOM)		X		X			1.00	1.10	0.91	0.77	0.78	1.30	1.04									
HEF-5810B	EXHAUST FAN B (BATTERY ROOM)		X				X	1.00	1.10	0.91	0.77	0.78					1.30	1.04					
	ACCU II																						
CK-5810A-A	COMPRESSOR A		X		X			30.00	37.00	0.81	0.93	0.84	32.26	20.84									
CK-5810A-B	COMPRESSOR B		X		X			30.00	37.00	0.81	0.93	0.84	32.26	20.84									
CF-5810A-A	CONDENSING FAN A		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
CF-5810A-B	CONDENSING FAN B		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
	ACCU III		X																				
CK-5810B-A	COMPRESSOR A		X				X	30.00	37.00	0.81	0.93	0.84					32.26	20.84					
CK-5810B-B	COMPRESSOR A		X				X	30.00	37.00	0.81	0.93	0.84					32.26	20.84					
CF-5810B-A	CONDENSING FAN A		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
CF-5810B-B	CONDENSING FAN B		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
	GT-7510 GAS TURBINE GEN. UNIT 1 (AUXILIARIES)																						
	AC LIQUID FUEL PUMP		X		X			22.00	22.00	1.00	0.92	0.84	23.91	15.45									SOLAR T70
	BOOST PUMP DRIVER MOTOR		X		X			0.75	0.75	1.00	0.77	0.78	0.97	0.78									SOLAR T70
	PRE POST LUBE OIL PUMP		X		X			4.00	4.00	1.00	0.87	0.84	4.60	2.97									SOLAR T70
	OIL COOLER FAN MOTOR		X			X		5.60	5.60	1.00	0.88	0.84			6.36	4.11							SOLAR T70
	LUBE OIL TANK IMMERSION HEATER		X		X			18.70	18.70	1.00	1.00	1.00	18.70	0.00									SOLAR T70
	ENCLOSURE VENT FAN A		X		X			7.50	7.50	1.00	0.90	0.82	8.33	5.82									SOLAR T70
	ENCLOSURE VENT FAN B		X				X	7.50	7.50	1.00	0.90	0.82					8.33	5.82					SOLAR T70
	GT-7520 GAS TURBINE GEN. UNIT 2 (AUXILIARIES)																						
	PRE POST LUBE OIL PUMP		X		X			4.00	4.00	1.00	0.87	0.84	4.60	2.97									SOLAR T70
	OIL COOLER FAN MOTOR		X			X		5.60	5.60	1.00	0.88	0.84			6.36	4.11							SOLAR T70
	LUBE OIL TANK IMMERSION HEATER		X		X			18.70	18.70	1.00	1.00	1.00	18.70	0.00									SOLAR T70
	ENCLOSURE VENT FAN A		X		X			7.50	7.50	1.00	0.90	0.82	8.33	5.82									SOLAR T70
	ENCLOSURE VENT FAN B		X				X	7.50	7.50	1.00	0.90	0.82					8.33	5.82					SOLAR T70
	GT-7530 GAS TURBINE GEN. UNIT 3 (AUXILIARIES)																						
	AC LIQUID FUEL PUMP		X		X			22.00	22.00	1.00	0.92	0.84	23.91	15.45									SOLAR T70
	BOOST PUMP DRIVER MOTOR		X		X			0.75	0.75	1.00	0.77	0.78	0.97	0.78									SOLAR T70
	PRE POST LUBE OIL PUMP		X		X			4.00	4.00	1.00	0.87	0.84	4.60	2.97									SOLAR T70
	OIL COOLER FAN MOTOR		X			X		5.60	5.60	1.00	0.88	0.84			6.36	4.11							SOLAR T70
	LUBE OIL TANK IMMERSION HEATER		X		X			18.70	18.70	1.00	1.00	1.00	18.70	0.00									SOLAR T70
	ENCLOSURE VENT FAN A		X		X			7.50	7.50	1.00	0.90	0.82	8.33	5.82									SOLAR T70
	ENCLOSURE VENT FAN B		X				X	7.50	7.50	1.00	0.90	0.82					8.33	5.82					SOLAR T70
SB-7718	LV SWITCHBOARD BUS-B																						
MCC-7840	LQ NORMAL LOAD																						
	LAUNDRY FACILITIES																						
F-6205A	WATER HEATER SYSTEM NO.1			X		X		33.00	33.00	1.00	1.00	1.00			33.00	0.00							HOT WATER SYSTEM
F-6205B	WATER HEATER SYSTEM NO.2			X		X		33.00	33.00	1.00	1.00	1.00			33.00	0.00							HOT WATER SYSTEM
	HOT WATER CIRCULATION PUMP			X		X		2.00	2.20	0.91	0.83	0.83			2.41	1.62							
	HOT WATER CIRCULATION PUMP			X			X	2.00	2.20	0.91	0.83	0.83					2.41	1.62					
DB-7871A	NORMAL LIGHTING DB MAIN DECK			X	X								3.33	1.43									
DB-7871B	NORMAL LIGHTING DB LEVEL 1			X	X								4.21	1.81									
DB-7871C	NORMAL LIGHTING DB LEVEL 2			X	X								5.01	2.15									
DB-7871D	NORMAL LIGHTING DB LEVEL 3			X	X								2.99	1.28									
DB-7871E	NORMAL LIGHTING DB LEVEL 4			X	X								3.73	1.60									
DB-7873A	POWER DB MAIN DECK (WORKSHOP)			X		X									9.42	4.56							
DB-7873B	SMALL POWER DB LEVEL 1			X		X									9.24	4.48							
DB-7873C	SMALL POWER DB LEVEL 2			X		X									18.13	8.78							
DB-7873D	SMALL POWER DB LEVEL 3			X		X									26.57	12.92							
DB-7873E	SMALL POWER DB LEVEL 4			X		X									19.02	9.21							
DB-7874A	SMALL POWER DB (WORKSHOP)			X		X									59.50	28.84							
DB-7874B	SMALL POWER DB (LAUNDRY)			X		X									117.33	56.83							
DB-7875C	SMALL POWER DB (KITCHEN)			X		X									169.78	82.23							

TBCP-A FULL LOAD CASE (LV LOADS)-CO_2 REMOVAL SYSTEM NO.1

EQUIPMENT EQUIPMENT NO.	EQUIPMENT DESCRIPTION	V	E	NE	C	INT	STB	ABSORBED LOAD [A]	MOTOR RATING/ LOAD RATING [B]	LOAD FACTOR =A/B [C]	EFFICIENCY at load factor C [D]	POWER FACTOR at load factor C (e)	kW = A/D CONSUMED LOAD kVAr = kW * tan phi Continuous [E]		Intermittent and spares [F]		Stand-by [G]		VDIP	BUSBAR	TYPE	TY.DIA	REMARKS
								kW	kW	in decimals	in decimals	cos. phi	kW	kVAr	kW	kVAr	kW	kVAr					
DB-7870D	SMALL POWER DB(KITCHEN)			X		X									42.40	20.54							
DB-7861	TBCP-A PROCESS LOADS			X	X			18.17	38.33	0.50	0.91	0.95	19.96	6.56									
	HVAC(LD-3rd FLOOR CABINS)																						
HAH-5030A	AIR HANDLING UNIT FAN A		X		X			15.00	18.50	0.81	0.91	0.82	16.48	11.51									
HAH-5030B	AIR HANDLING UNIT FAN B		X				X	15.00	18.50	0.81	0.91	0.82					16.48	11.51					
HHW-5030A	ELECTRIC DUCT HEATER			X		X		10.00	10.00	1.00	1.00	1.00			10.00	0.00							
HEF-5030A	EXHAUST FAN FOR TOILET			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
HEF-5030B	EXHAUST FAN FOR TOILET			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
HEF-5030C	EXHAUST FAN FOR TOILET			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
HEF-5030D	EXHAUST FAN FOR TOILET			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
HEF-5030E	EXHAUST FAN FOR TOILET			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
HEF-5030F	EXHAUST FAN FOR TOILET			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
	ACCU #1																						
CK-5030A-A	COMPRESSOR A		X		X			20.00	22.00	0.91	0.91	0.82	21.98	15.34									
CK-5030A-B	COMPRESSOR B		X		X			20.00	22.00	0.91	0.91	0.82	21.98	15.34									
CF-5030A-A	CONDENSING FAN A		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
CF-5030A-B	CONDENSING FAN B		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
	ACCU #2																						
CK-5030B-A	COMPRESSOR A		X				X	20.00	22.00	0.91	0.91	0.82					21.98	15.34					
CK-5030B-B	COMPRESSOR B		X				X	20.00	22.00	0.91	0.91	0.82					21.98	15.34					
CF-5030B-A	CONDENSING FAN A		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
CF-5030B-B	CONDENSING FAN B		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
	HVAC(LD-4th FLOOR CABINS)																						
HAH-5040A	AIR HANDLING UNIT FAN A		X		X			20.00	22.00	0.91	0.91	0.82	21.98	15.34									
HAH-5040B	AIR HANDLING UNIT FAN B		X				X	20.00	22.00	0.91	0.91	0.82					21.98	15.34					
HHW-5040A	ELECTRIC DUCT HEATER			X		X		12.00	12.00	1.00	1.00	1.00			12.00	0.00							
HEF-5040A	EXHAUST FAN FOR TOILET			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
HEF-5040B	EXHAUST FAN FOR TOILET			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
HEF-5040C	EXHAUST FAN FOR TOILET			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
HEF-5040D	EXHAUST FAN FOR TOILET			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
	ACCU #1																						
CK-5040A-A	COMPRESSOR A		X		X			25.00	30.00	0.83	0.92	0.84	27.17	17.55									
CK-5040A-B	COMPRESSOR B		X		X			25.00	30.00	0.83	0.92	0.84	27.17	17.55									
CF-5040A-A	CONDENSING FAN A		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
CF-5040A-B	CONDENSING FAN B		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
	ACCU #2																						
CK-5040B-A	COMPRESSOR A		X				X	25.00	30.00	0.83	0.92	0.84					27.17	17.55					
CK-5040B-B	COMPRESSOR B		X				X	25.00	30.00	0.83	0.92	0.84					27.17	17.55					
CF-5040B-A	CONDENSING FAN A		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
CF-5040B-B	CONDENSING FAN B		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
	HVAC SYSTEM (LD-MAIN DECK WORKSHOPS)																						
HAH-5000-A	AIR HANDLING UNIT FAN A		X		X			15.00	18.50	0.81	0.91	0.82	16.48	11.51									
HAH-5000-B	AIR HANDLING UNIT FAN B		X				X	15.00	18.50	0.81	0.91	0.82					16.48	11.51					
HHW-5000A	ELECTRIC DUCT HEATER			X		X		10.00	10.00	1.00	1.00	1.00			10.00	0.00							
HEF-5000A	EXHAUST FAN (MECH WORKSHOP)			X	X			0.82	1.10	0.75	0.77	0.76	1.06	0.86									
HEF-5000B	EXHAUST FAN (DARK ROOM)			X	X			0.13	0.25	0.52	0.66	0.73	0.20	0.18									
HEF-5000C	EXHAUST FAN (LAB)			X	X			0.10	0.25	0.40	0.66	0.73	0.15	0.14									
HEF-5000D	EXHAUST FAN (LAB)			X	X			0.10	0.25	0.40	0.66	0.73	0.15	0.14									
HSF-5000E	SUPPLY FAN PAINT ROOM			X	X			0.15	0.25	0.60	0.66	0.73	0.23	0.21									
	ACCU #1																						
CK-5000A-A	COMPRESSOR A		X		X			20.00	22.00	0.91	0.91	0.82	21.98	15.34									
CK-5000A-B	COMPRESSOR B		X		X			20.00	22.00	0.91	0.91	0.82	21.98	15.34									
CF-5000A-A	CONDENSING FAN A		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
CF-5000A-B	CONDENSING FAN B		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
	ACCU #2																						
CK-5000B-A	COMPRESSOR A		X				X	20.00	22.00	0.91	0.91	0.82					21.98	15.34					
CK-5000B-B	COMPRESSOR B		X				X	20.00	22.00	0.91	0.91	0.82					21.98	15.34					
CF-5000B-A	CONDENSING FAN A		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
CF-5000B-B	CONDENSING FAN B		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
SB-7720	LV SWITCHBOARD BUS-A																						
E-6040A	FUEL GAS SUPERHEATER		X		X			400.00	400.00	1.00	1.00	1.00	400.00	0.00									TBCP-A-B-1126 Sht 3/3(FUEL GAS SUPERHEATER)

TBCP-A FULL LOAD CASE (LV LOADS)-CO$_2$ REMOVAL SYSTEM NO.1

EQUIPMENT								ABSORBED LOAD	MOTOR RATING/ LOAD RATING	LOAD FACTOR =A/B	EFFICIENCY at load factor C	POWER FACTOR at load factor C	kW = A/D CONSUMED LOAD kVAr = kW * tan phi						V DIP	BUSBAR	TYPE	TY. DIA	REMARKS
EQUIPMENT NO.	DESCRIPTION	V	E	NE	C	NT	ST	(A)	(B)	(C)	(D)	(a)	Continuous (E)		Intermittent and spares (F)		Stand-by (G)						
								kW	kW	in decimals	in decimals	cos. phi	kW	kVAr	kW	kVAr	kW	kVAr					
E-6010	FUEL GAS PRE-HEATER		X		X			200.00	200.00	1.00	1.00	1.00	200.00	0.00									TBCP-A-B-1125(FUEL GAS PREHEATER)
P-2510A	REGENERATION GAS BLOWER A			X	X			170.00	185.00	0.92	0.85	0.86	176.85	106.18									
P-2510B	REGENERATION GAS BLOWER B			X	X			170.00	185.00	0.92	0.85	0.86	176.85	106.18									
MCC-7850																							
P-6870	COOLING WATER SYS. BATCH COR. INHIBITOR INJECTION PUMP			X	X			0.003	0.25	0.01	0.68	0.73	0.00	0.00									TBCP-A-B-1163(COOLING WATER SYS. BATCH CORR. INJECTION PUMP)
P-5610A	HEATING MEDIUM CIRCULATION PUMP A			X	X			80.00	90.00	0.89	0.95	0.86	84.21	49.97									TBCP-A-B-1130(HEATING MED.EXP. TANK & CIRC. PUMP)
P-5360A	WASH WATER PUMP A			X	X			10.00	11.00	0.91	0.90	0.82	11.11	7.76									TBCP-A-B-1175(WASH WATER SYSTEM)
P-8630A	HYPOCHLORINATOR DOSING PUMP A			X	X			7.50	11.00	0.68	0.90	0.82	8.33	5.82									TBCP-A-B-1182(HYPOCHLORINATOR)
K-8640A	HYPOCHLORINATOR AIR BLOWER			X	X			2.20	3.00	0.73	0.83	0.83	2.65	1.78									TBCP-A-B-1182(HYPOCHLORINATOR)
CH-8610A	TRANSFORMER RECTIFIER FOR HYPO. CELLS A			X	X			30.00	30.00	1.00	0.91	0.73	32.97	30.86									TBCP-A-B-1182(HYPOCHLORINATOR)
P-6420A	CLOSED DRAINS TRANSFER PUMP A			X		X		14.80	15.00	0.99	0.90	0.83			16.44	11.05							TBCP-A-B-1159(CLOSED DRAIN VESSEL & TRANSFER PUMP)
P-6410	CLOSED DRAINS CAISSON PUMP			X		X		0.56	0.75	0.75	0.75	0.76			0.75	0.64							TBCP-A-B-1156(CLOSED & OPEN DRAIN CAISSON)
P-6820	OPEN DRAINS CAISSON PUMP			X		X		0.56	0.75	0.75	0.75	0.76			0.75	0.64							TBCP-A-B-1156(CLOSED & OPEN DRAIN CAISSON)
UPS-7865B	400/230 AC UPS FOR INSTRUMENT		X		X			100.00	100.00	1.00	0.91	0.80	109.89	82.42									
UPS-7760B	400/230 AC UPS FOR TELECOM		X		X			40.00	40.00	1.00	0.91	0.80	43.96	32.97									
DB-7801	NORMAL LIGHTING DISTRIBUTION BOARD (MOD 3)			X	X								9.37	4.38									
DB-7841	NORMAL LIGHTING DISTRIBUTION BOARD (MOD 1)			X	X								9.86	4.53									
DB-7861	NORMAL LIGHTING DISTRIBUTION BOARD (MOD 5)			X	X								10.36	4.75									
DB-7851	OUTDOOR NORMAL LIGHTING DISTRIBUTION BOARD (MOD 4)			X	X								6.62	2.92									
DB-7852	INDOOR NORMAL LIGHTING DISTRIBUTION BOARD (MOD 4)			X	X								8.71	4.22									
DB-7881A	NORMAL LIGHTING DISTRIBUTION BOARD (MOD 6)			X	X								11.49	5.03									
DB-7881B	NORMAL LIGHTING DISTRIBUTION BOARD (MOD 6)			X	X								14.58	6.35									
WSO-7841	WELDING SOCKET OUTLET			X			X	37.00	37.00	1.00	0.91	0.95					40.66	13.36					
WSO-7842	WELDING SOCKET OUTLET			X			X	37.00	37.00	1.00	0.91	0.95					40.66	13.36					
MCC-7860																							
P-5610B	HEATING MEDIUM CIRCULATION PUMP B			X			X	80.00	90.00	0.89	0.95	0.86					84.21	49.97					TBCP-A-B-1130(HEATING MED.EXP. TANK & CIRC. PUMP)
E-5620A	HEATING MEDIUM BYPASS 1ST STAGE COOLER FAN			X		X		5.00	5.50	0.91	0.87	0.64			5.75	3.71							TBCP-A-B-1131(HEATING MED.FILTER & HEATERS)
E-5620B	HEATING MEDIUM BYPASS 1ST STAGE COOLER FAN			X			X	5.00	5.50	0.91	0.87	0.64					5.76	3.71					TBCP-A-B-1131(HEATING MED.FILTER & HEATERS)
E-5620C	HEATING MEDIUM BYPASS 2ND STAGE COOLER FAN			X		X		8.00	11.00	0.73	0.90	0.82			8.89	6.20							TBCP-A-B-1131(HEATING MED.FILTER & HEATERS)
E-5620D	HEATING MEDIUM BYPASS 2ND STAGE COOLER FAN			X			X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					TBCP-A-B-1131(HEATING MED.FILTER & HEATERS)
P-2040A	CONDENSATE PUMP A			X	X			40.00	45.00	0.89	0.93	0.84	43.01	27.78									TBCP-A-B-1105 SHT 1 of 2 (CONDENSATE PUMP)
P-2040B	CONDENSATE PUMP B			X	X			40.00	45.00	0.89	0.93	0.84	43.01	27.78									TBCP-A-B-1105 SHT 1 of 2 (CONDENSATE PUMP)
P-2040C	CONDENSATE PUMP C			X			X	40.00	45.00	0.89	0.93	0.84					43.01	27.78					TBCP-A-B-1105 SHT 2 of 2 (CONDENSATE PUMP)
P-6420B	CLOSED DRAINS TRANSFER PUMP B			X		X		14.80	15.00	0.99	0.90	0.83			16.44	11.05							TBCP-A-B-1159(CLOSED DRAIN VESSEL & TRANSFER PUMP)
P-8630B	HYPOCHLORINATOR DOSING PUMP B			X			X	7.50	11.00	0.68	0.90	0.82					8.33	5.82					TBCP-A-B-1182(HYPOCHLORINATOR)
K-8640B	HYPOCHLORINATOR AIR BLOWER			X			X	2.20	3.00	0.73	0.83	0.83					2.65	1.78					TBCP-A-B-1182(HYPOCHLORINATOR)
CH-8610B	TRANSFORMER RECTIFIER FOR HYPO. CELLS B			X			X	30.00	30.00	1.00	0.91	0.95					32.97	10.84					TBCP-A-B-1182(HYPOCHLORINATOR)
P-5360B	WASH WATER PUMP			X	X			10.00	11.00	0.91	0.90	0.82	11.11	7.76									TBCP-A-B-1175(WASH WATER SYSTEM)
P-6865	COOLING WATER SYSTEM BATCH ANTI SCALING INJ. PUMP			X	X			0.003	0.25	0.01	0.90	0.82	0.003	0.002									TBCP-A-B-1163(COOL. WTR SYS BATCH ANTI C.I SYS)
B-7301	ELECTRIC DRIVEN MONORAIL - 20 MT			X		X		15.00	18.50	0.81	0.91	0.82			16.48	11.51							
WSO-7861	WELDING SOCKET OUTLET			X			X	37.00	37.00	1.00	0.91	0.85					40.66	13.36					
WSO-7862	WELDING SOCKET OUTLET			X			X	37.00	37.00	1.00	0.91	0.85					40.66	13.36					
MCC-7870	BOOST/EXPORT GAS TURBINE COMPRESSOR PACKAGE 1 (KT-2620)																						
	STARTER OIL TANK HEATER			X		X		2.50	2.50	1.00	1.00	1.00			2.50	0.00							ROLL ROYCE
	GG OIL PUMP MOTOR 1			X	X			22.00	22.00	1.00	0.92	0.84	23.91	15.45									ROLL ROYCE
	GG OIL PUMP MOTOR 2			X			X	22.00	22.00	1.00	0.92	0.84					23.91	15.45					ROLL ROYCE
	GG OIL TANK HEATER			X		X		3.50	3.50	1.00	1.00	1.00			3.50	0.00							ROLL ROYCE
	TC MAIN LUBE OIL PUMP 1			X	X			45.00	45.00	1.00	0.94	0.83	47.87	32.17									ROLL ROYCE
	TC MAIN LUBE OIL PUMP 2			X			X	45.00	45.00	1.00	0.94	0.83					47.87	32.17					ROLL ROYCE
	MAIN LUBE OIL HEATER			X		X		12.00	12.00	1.00	1.00	1.00			12.00	0.00							ROLL ROYCE
	GT ENCLOSURE VENT FAN 1			X	X			45.00	45.00	1.00	0.94	0.83	47.87	32.17									ROLL ROYCE
	GT ENCLOSURE VENT FAN 2			X			X	45.00	45.00	1.00	0.94	0.83					47.87	32.17					ROLL ROYCE
B-7311	ELECTRIC DRIVEN MONORAIL - 20 MT			X		X		15.00	18.50	0.81	0.91	0.82			16.46	11.51							
B-7312	ELECTRIC DRIVEN MONORAIL - 20 MT			X			X	15.00	16.50	0.81	0.81	0.82					16.46	11.51					
DB-7811	NORMAL LIGHTING DISTRIBUTION BOARD (MOD 1)			X	X								3.32	1.42									
WSO-7871	WELDING SOCKET OUTLET			X			X	37.00	37.00	1.00	0.91	0.85					40.66	13.36					
WSO-7872	WELDING SOCKET OUTLET			X			X	37.00	37.00	1.00	0.91	0.85					40.66	13.36					
	HVAC SYSTEM (COMPRESSOR CONTROL ROOM)																						
HAH-5100A	AIR HANDLING UNIT FAN A		X		X			15.00	18.50	0.81	0.91	0.82	16.48	11.51									
HAH-5100B	AIR HANDLING UNIT FAN B		X				X	15.00	18.50	0.81	0.91	0.82					16.48	11.51					
HBH-5100A	ELECTRIC DUCT HEATER			X		X		10.00	10.00	1.00	1.00	1.00			10.00	0.00							

TBCP-A FULL LOAD CASE (LV LOADS)-CO_2 REMOVAL SYSTEM NO.1

EQUIPMENT NO.	DESCRIPTION	V	E	NE	C	NT	STE	ABSORBED LOAD [A]	MOTOR RATING/ LOAD RATING [B]	LOAD FACTOR =A/B [C]	EFFICIENCY at load factor C [D]	POWER FACTOR at load factor C (a)	CONSUMED LOAD kW = A/D, kVAr = kW * tan phi: Continuous [E]		Intermittent and spares [F]		Stand-by [G]		VDIP	BUSBAR	TYPE	TY. DIA	REMARKS
								kW	kW	in decimals	in decimals	cos. phi	kW	kVAr	kW	kVAr	kW	kVAr					
HPF-5100A	PRESSURIZATION FAN A		X		X			4.00	5.50	0.73	0.87	0.84	4.60	2.97									
HPF-5100B	PRESSURIZATION FAN B		X				X	4.00	5.50	0.73	0.87	0.84					4.60	2.97					
HEF-5100A	EXHAUST FAN (BATTERY ROOM)			X	X			0.05	0.25	0.20	0.68	0.73	0.08	0.07									
HEF-5100B	EXHAUST FAN (BATTERY ROOM)			X	X			0.05	0.25	0.20	0.68	0.73	0.08	0.07									
	ACCU #1																						
CK-5100A-A	COMPRESSOR A		X		X			16.00	18.50	0.88	0.91	0.82	17.58	12.27									
CF-5100A-A	CONDENSING FAN A		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
	ACCU #2																						
CK-5100B-A	COMPRESSOR A		X				X	16.00	18.50	0.88	0.91	0.82					17.58	12.27					
CF-5100B-A	CONDENSING FAN A		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
SB-7720	LV SWITCHBOARD BUS-B																						
E-6040B	FUEL GAS SUPERHEATER			X			X	400.00	400.00	1.00	1.00	1.00					400.00	0.00					TBCP-A-B-1125(FUEL GAS PREHEATER)
P-2510C	REGENERATION GAS BLOWER C			X			X	170.00	185.00	0.92	0.96	0.89					177.08	105.08					
MCC-7880	BOOST/EXPORT GAS TURBINE COMPRESSOR PACKAGE 2 (KT-2520)																						
	STARTER OIL TANK HEATER			X			X	2.50	2.50	1.00	1.00	1.00					2.50	0.00					ROLL ROYCE
	GG OIL PUMP MOTOR 1			X			X	22.00	22.00	1.00	0.92	0.84					23.91	15.45					ROLL ROYCE
	GG OIL PUMP MOTOR 2			X			X	22.00	22.00	1.00	0.92	0.84					23.91	15.45					ROLL ROYCE
	GG OIL OIL TANK HEATER			X			X	3.50	3.50	1.00	1.00	1.00					3.50	0.00					ROLL ROYCE
	TC MAIN LUBE OIL PUMP 1			X			X	45.00	45.00	1.00	0.94	0.83					47.87	32.17					ROLL ROYCE
	TC MAIN LUBE OIL PUMP 2			X			X	45.00	45.00	1.00	0.94	0.83					47.87	32.17					ROLL ROYCE
	MAIN LUBE OIL HEATER			X			X	12.00	12.00	1.00	1.00	1.00					12.00	0.00					ROLL ROYCE
	GT ENCLOSURE VENT FAN 1			X			X	45.00	45.00	1.00	0.94	0.83					47.87	32.17					ROLL ROYCE
	GT ENCLOSURE VENT FAN 2			X			X	45.00	45.00	1.00	0.94	0.83					47.87	32.17					ROLL ROYCE
B-7311	ELECTRIC DRIVEN MONORAIL - 20 MT			X		X		15.00	18.50	0.81	0.91	0.82			16.48	11.51							
B-7312	ELECTRIC DRIVEN MONORAIL - 20 MT			X			X	15.00	18.50	0.81	0.91	0.82					16.48	11.51					
DB-7121	NORMAL LIGHTING DISTRIBUTION BOARD (MOD 2)			X	X								2.39	1.03									
WSO-7841	WELDING SOCKET OUTLET			X			X	37.00	37.00	1.00	0.91	0.95					40.66	13.36					
WSO-7842	WELDING SOCKET OUTLET			X			X	37.00	37.00	1.00	0.91	0.95					40.66	13.36					
	HVAC SYSTEM (COMPRESSOR CONTROL ROOM)																						
HAH-5200A	AIR HANDLING UNIT FAN A		X		X			15.00	18.50	0.81	0.91	0.82	16.48	11.51									
HAH-5200B	AIR HANDLING UNIT FAN B		X				X	15.00	18.50	0.81	0.91	0.82					16.48	11.51					
HHH-5200A	ELECTRIC DUCT HEATER			X		X		10.00	10.00	1.00	1.00	1.00			10.00	0.00							
HPF-5200A	PRESSURIZATION FAN A		X		X			4.00	5.50	0.73	0.87	0.84	4.60	2.97									
HPF-5200B	PRESSURIZATION FAN B		X				X	4.00	5.50	0.73	0.87	0.84					4.60	2.97					
HEF-5200A	EXHAUST FAN (BATTERY ROOM)			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
HEF-5200B	EXHAUST FAN (BATTERY ROOM)			X	X			0.05	0.25	0.20	0.66	0.73	0.08	0.07									
	ACCU #1																						
CK-5200A-A	COMPRESSOR A		X		X			16.00	18.50	0.88	0.91	0.82	17.58	12.27									
CF-5200A-A	CONDENSING FAN A		X		X			8.00	11.00	0.73	0.90	0.82	8.89	6.20									
	ACCU #2																						
CK-5200B-A	COMPRESSOR A		X				X	16.00	18.50	0.88	0.91	0.82					17.58	12.27					
CF-5200B-A	CONDENSING FAN A		X				X	8.00	11.00	0.73	0.90	0.82					8.89	6.20					
SB-7730	LV SWITCHBOARD																						
E-5600A	HEATING MEDIUM HEATER A			X				2400.00	2400.00	1.00	1.00	1.00											TBCP-A-B-1131(HEATING MEDIUM FILTER & HEATER)
SB-7740	LV SWITCHBOARD																						
E-5600B	HEATING MEDIUM HEATER B			X				2400.00	2400.00	1.00	1.00	1.00											TBCP-A-B-1131(HEATING MEDIUM FILTER & HEATER)
SB-7750	LV SWITCHBOARD																						
E-5600C	HEATING MEDIUM HEATER C			X				2400.00	2400.00	1.00	1.00	1.00											TBCP-A-B-1131(HEATING MEDIUM FILTER & HEATER)
SB-7760	LV SWITCHBOARD																						
E-5600D	HEATING MEDIUM HEATER D			X				2400.00	2400.00	1.00	1.00	1.00											TBCP-A-B-1131(HEATING MEDIUM FILTER & HEATER)

TBCP-A FULL LOAD CASE (LV LOADS)-CO2 REMOVAL SYSTEM NO.1

EQUIPMENT								ABSORBED LOAD [A]	MOTOR RATING/ LOAD RATING [B]	LOAD FACTOR =A/B [C]	EFFICIENCY at load factor C [D]	POWER FACTOR at load factor C (a)	kW = A/D CONSUMED LOAD kVAr = kW * tan phi						V D I P	B U S B A R	T Y P E	T Y . D I A	REMARKS
EQUIPMENT NO.	DESCRIPTION	V	E	NE	C	NT	STB						Continuous [E]		Intermittent and spares [F]		Stand-by [G]						
								kW	kW	in decimals	in decimals	cos. phi	kW	kVAr	kW	kVAr	kW	kVAr					
Maximum of normal running plant load : (Est. x% E + y% F) **3,310.45** kW **1578.53** kVAr **3667.54** kVA x = 100 y = 30 or largest intermittent load											TOTAL		3062.60	1477.24	826.17	337.84	2659.36	1347.19					p.f. without compensation (cos. phi) : p.f. with compensation (cos. phi1) :
Peak load: **3,576.39** kW **1713.25** kVAr **3965.57** kVA (Est. x% E + y% F + z G) x = 100 y = 30 z = 10% of largest standby load Coincidence factors x, y and z shall be defined for each separate case, subject to principal's approval											kVA=sqrt(kW ²+ kVAr²)		3400.25		892.50		2981.12						Req'd capacitor rating(=kW(tan phi - tan phi1)):

V - Vital E - Essential
NE - Non-essential RS - Restarting

a) Absorbed loads :
- for pumps, shaft load on duty point;
- for instrumentation, computers, communication, air conditioning, the required load during full operation of plant
- for lighting during dark hours;
- for workshops, the average total load in normal full operation.

b) Consumed Loads:

E - "Continuous" all loads that may continuously be required for normal operation, including lighting and workshops.

F - "Intermittent and spares" the loads required for intermediate pumping, storage, loading etc. all electrical spares of electrically driven units.

G - "Stand-by", loads required in emergencies only, such as fire-water pumps or those of normally not running electrically driven units stand-by for normally running steam-driven ones (e.g. charge pumps, boiler feed pumps).

VDIP : Protection against short-time voltage drop.

TYPE : CB = Circuit Breaker
C = Contactor
CBD = Circuit Breaker and Earth Leakage Relay

VVVF : Variable Voltage Variable Frequency

TY.DIA : Typical Diagram

Client : PETRONAS CARIGALI SDN. BHD. Eng. By: mz integrated (m) sdn bhd

C1	28/09/07	POST AFDD	SMD	MRAB	MRAR				
C	06/07/07	APPROVED FOR DETAILED DESIGN	SMD	MRAB	MRAR				
B	-	APPROVED FOR BID	-	-	-				
A	25/04/07	IFC FOR FEED	SMD	MRAB	MRAR				
Rev.	Date	Description	Prop'd	Checked	App'd	CLIENT			

Note:
1. The total calculated load rating is based on estimated assumed loads and shall be subject to any changes based on the latest revision of the conceptual design.

DOC. TITLE :

ELECTRICAL LOAD ANALYSIS
(MCC LOADS)

DOC NO P5155-EL-RP-1005

TBCP-A FULL LOAD CASE (LV SWITCHBOARD LOADS)

		EQUIPMENT	CONSUMED LOAD																	
		DESCRIPTION	CONTINUOS		INTERMITTENT		STAND-BY		MAXIMUM			PEAK			PEAK (WITH 10% MARGIN)			TRANSFORMER LOAD	TRANSFORMER RECOMMENDED	
			kW	kVAr	kW	kVAr	kW	kVAr	kW	kVAr	kVA	kW	kVAr	kVA	kW	kVAr	kVA	KVA	QTY	KVA RATING
	SB-7710	400V LV SWITCHBOARD BUS-P																		
1	E-5010A	AIR COMPRESSOR	179.17	106.31	0.00	0.00	0.00	0.00	179.17	106.31	208.33	179.17	106.31	208.33	197.08	116.94	229.17			
2	E-5010B	AIR COMPRESSOR	0.00	0.00	0.00	0.00	179.17	106.31	0.00	0.00	0.00	17.92	10.63	20.83	19.71	11.69	22.92			
3	MCC-7810	TELECOM ROOM	35.82	24.56	4.00	0.00	35.67	24.42	37.02	24.56	44.42	40.58	27.00	48.75	44.64	29.70	53.62			
4	MCC-7820	LQ LOADS	210.89	134.76	62.31	21.68	227.97	150.50	229.58	141.26	269.56	252.36	156.31	296.87	277.62	171.94	326.55			
5	MCC-7830	VITAL LOAD	704.26	354.64	51.42	18.15	370.40	245.93	719.69	360.09	804.74	756.73	384.68	848.89	① 832.40	423.15	933.78			
		TOTAL	1,130.13	620.27	117.73	39.83	813.20	527.16	1,165.45	632.22	1,327.06	1,246.77	684.93	1,423.67	1,371.45	753.43	1,566.03	2183.61 (BUS P+BUS B)	1	2500 AN
	SB-7710	400V LV SWITCHBOARD BUS-B																		
6	MCC-7840	LQ NORMAL LOAD	292.32	189.12	571.97	230.00	252.95	173.67	463.91	258.12	530.88	489.20	275.49	561.44	538.12	303.03	617.58			
		TOTAL	292.32	189.12	571.97	230.00	252.95	173.67	463.91	258.12	530.88	489.20	275.49	561.44	538.12	303.03	617.58	2183.61 (BUS P+BUS B)	1	2500 AN
	SB-7720	400V LV SWITCHBOARD BUS-A																		
7	E-6040A	FUEL GAS SUPERHEATER	400.00	0.00	0.00	0.00	0.00	0.00	400.00	0.00	400.00	400.00	0.00	400.00	440.00	0.00	440.00			
8	E-6010	FUEL GAS PREHEATER	200.00	0.00	0.00	0.00	0.00	0.00	200.00	0.00	200.00	200.00	0.00	200.00	220.00	0.00	220.00			
9	P-2510A	REGENERATION GAS BLOWER A	178.95	106.18	0.00	0.00	0.00	0.00	176.95	106.18	208.08	178.95	106.18	208.08	186.84	116.80	228.89			
10	P-2510B	REGENERATION GAS BLOWER B	178.95	106.18	0.00	0.00	0.00	0.00	178.95	106.18	208.08	178.95	106.18	208.08	196.84	116.80	228.89			
11	MCC-7850	NORMAL LOAD	364.35	243.74	17.94	12.33	81.32	26.73	369.73	247.44	444.89	377.86	250.11	453.14	415.65	275.12	498.46			
12	MCC-7860	NORMAL LOAD	97.14	63.32	47.56	32.47	267.13	132.83	111.41	73.06	133.23	138.12	86.35	162.89	151.93	94.98	179.18			
13	MCC-7870	BOOSTER COMP. PACKAGE #1	170.68	114.30	44.48	11.51	265.01	150.97	184.02	117.76	218.47	210.52	132.65	248.94	231.58	146.14	273.83			
		TOTAL	1,590.08	633.73	109.99	56.31	613.46	310.53	1,623.05	650.62	1,812.75	1,684.40	681.67	1,881.12	1,852.84	749.84	2,069.24	2,262.94 (BUS A+BUS B)	1	2500 AN
	SB-7720	400V LV SWITCHBOARD BUS-C																		
14	E-6040B	FUEL GAS SUPERHEATER	0.00	0.00	0.00	0.00	400.00	0.00	0.00	0.00	0.00	40.00	0.00	40.00	44.00	0.00	44.00			
15	P-2510C	REGENERATION GAS BLOWER C	0.00	0.00	0.00	0.00	177.08	105.08	0.00	0.00	0.00	17.71	10.51	20.59	19.48	11.56	22.65			
16	MCC-7880	BOOSTER COMP. PACKAGE #2	50.09	34.12	26.48	11.51	402.67	230.76	58.04	37.57	69.14	98.31	60.65	115.51	108.14	66.71	127.06			
		TOTAL	50.09	34.12	26.48	11.51	979.75	335.84	58.04	37.57	69.14	156.01	71.15	178.10	171.62	78.27	193.71	2,262.94 (BUS A+BUS B)	1	2500 AN
	SB-7730	400V LV SWITCHBOARD																		
17	E-5660A	HEATING MEDIUM TRIM A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
		TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	SB-7740	400V LV SWITCHBOARD																		
18	E-5660B	HEATING MEDIUM TRIM B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
		TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	SB-7750	400V LV SWITCHBOARD																		
19	E-5660C	HEATING MEDIUM TRIM A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
		TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	SB-7760	400V LV SWITCHBOARD																		
20	E-5660A	HEATING MEDIUM TRIM A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
		TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	TOTAL LOADS		3,062.6	1,477.2	826.2	337.6	2,659.4	1,347.2	3,310.5	1,578.5	3,739.8	3,576.4	1,713.2	4,042.3	3,934.0	1,884.6	4,446.6			

TBCP-A FULL LOAD CASE (LOAD SUMMARY)-CO_2 REMOVAL SYSTEM OPTION 1

	EQUIPMENT	**CONSUMED LOAD**											
		CONTINUOS		INTERMITTENT		STAND-BY		MAXIMUM			PEAK		
	DESCRIPTION	kW	kVAr	kW	kVAr	kW	kVAr	kW	kVAr	kVA	kW	kVAr	kVA
1	HV LOADS	4,269.53	2,419.66	0.00	0.00	2,455.21	1,391.43	4,269.53	2,419.66	4,907.51	4,515.05	2,558.80	5,189.72
2	LV LOADS	3,062.60	1,477.24	826.17	337.64	2,659.36	1,347.19	3,310.45	1,578.53	3,667.54	3,576.39	1,713.25	3,965.57
											①		
TOTAL LOADS		7,332.14	3,896.89	826.17	337.64	5,114.57	2,738.62	7,579.99	3,998.19	8,575.05	8,091.45	4,272.05	9,155.29
TOTAL LOADS (25% SPARE CAPACITY)		9,165.17	4,871.11	1,032.71	422.05	6,393.21	3,423.27	9,474.99	4,997.73	10,718.81	10,114.31	5,340.06	11,444.12

TBCP-A EMERGENCY LOAD CASE (LOAD SUMMARY)-SCENARIO 2

	EQUIPMENT	CONSUMED LOAD											
		CONTINUOS		INTERMITTENT		STAND-BY		MAXIMUM			PEAK		
	DESCRIPTION	kW	kVAr	kW	kVAr	kW	kVAr	kW	kVAr	kVA	kW	kVAr	kVA
1	HV LOADS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	LV LOADS	1,127.24	649.98	96.67	25.79	796.53	515.52	1,156.24	657.72	1,330.22	1,235.90	709.27	1,424.96
											③		
TOTAL LOADS		1,127.24	649.98	96.67	25.79	796.53	515.52	1,156.24	657.72	1,330.22	1,235.90	709.27	1,424.96
TOTAL LOADS (15% SPARE CAPACITY)		1,296.33	747.47	111.17	29.66	916.01	592.85	1,329.68	756.37	1,529.75	1,421.28	815.66	1,638.70

TBCP-A EMERGENCY CASE (LOAD SUMMARY) - FOR TRANSIENT STABILITY / MOTOR STARTING STUDY SCENARIO 2

	EQUIPMENT	**CONSUMED LOAD**											
		CONTINUOS		INTERMITTENT		STAND-BY		MAXIMUM			PEAK		
	DESCRIPTION	kW	kVAr	kW	kVAr	kW	kVAr	kW	kVAr	kVA	kW	kVAr	kVA
1	HV LOADS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	LV LOADS	1,127.24	649.98	96.67	25.79	617.37	409.21	1,156.24	657.72	1,330.22	1,217.98	698.64	1,404.13
TOTAL LOADS		1,127.24	649.98	96.67	25.79	617.37	409.21	1,156.24	657.72	1,330.22	1,217.98	698.64	1,404.13
TOTAL LOADS (15% SPARE CAPACITY)		1,296.33	747.47	111.17	29.66	709.97	470.59	1,329.68	756.37	1,529.75	1,400.68	803.43	1,614.74

P2000PG	GT-7510 GAS TURBINE GENERATOR	6500	F	0.80	1.00	6600	3	XLPE	50	0.72	3	240	2	710.8	1140.0	820.8	OK	0.098	0.089	0.007	0.800	0.600	4.07	0.06	OK	16000	0.34	58447	OK								
P2001PG	GT-7520 GAS TURBINE GENERATOR	6500	F	0.80	1.00	6600	3	XLPE	40	0.72	3	240	2	710.8	1140.0	820.8	OK	0.098	0.089	0.005	0.800	0.600	3.25	0.05	OK	16000	0.34	58447	OK								
P2002PG	GT-7530 GAS TURBINE GENERATOR	6500	F	0.80	1.00	6600	3	XLPE	75	0.72	3	240	2	710.8	1140.0	820.8	OK	0.098	0.089	0.010	0.800	0.600	6.10	0.09	OK	16000	0.34	58447	OK								
P1000PG	A-2500A REFRIGERANT COMPRESSOR A	970	M	0.87	0.97	6600	3	XLPE	100	0.72	3	35	1	101.0	175.0	126.0	OK	0.668	0.116	0.068	0.870	0.493	11.16	0.17	OK					5.5	555.31	0.30	0.95	29.87	0.5	OK	
P1001PG	A-2500B REFRIGERANT COMPRESSOR B	670	M	0.87	0.96	6600	3	XLPE	100	0.72	3	25	1	70.1	145.0	104.4	OK	0.927	0.124	0.094	0.870	0.493	10.53	0.16	OK					5.5	385.56	0.30	0.95	26.44	0.4	OK	
P1002PG	P-6940A COOLING WATER CIRC. PUMP A	670	M	0.87	0.96	6600	3	XLPE	90	0.72	3	25	1	70.1	145.0	104.4	OK	0.927	0.124	0.084	0.870	0.493	9.48	0.14	OK					5.5	385.56	0.30	0.95	23.79	0.4	OK	
P1003PG	P-6910A SEAWATER LIFT PUMP A	850	M	0.87	0.97	6600	3	XLPE	75	0.72	3	35	1	88.6	175.0	126.0	OK	0.668	0.116	0.051	0.870	0.493	7.34	0.11	OK					2.5	221.42	0.30	0.95	8.93	0.1	OK	
P1004PG	TF-7540	2500	F	1.00	1.00	6600	3	XLPE	55	0.72	3	120	1	218.7	375.0	270.0	OK	0.196	0.097	0.012	1.000	0.000	4.08	0.06	OK	16000	0.64	21300	OK								
P1005PG	TF-7550	2500	F	1.00	1.00	6600	3	XLPE	50	0.72	3	120	1	218.7	375.0	270.0	OK	0.196	0.097	0.011	1.000	0.000	3.71	0.06	OK	16000	0.64	21300	OK								
P1006PG	TF-7560	2500	F	1.00	1.00	6600	3	XLPE	40	0.72	3	120	1	218.7	375.0	270.0	OK	0.196	0.097	0.009	1.000	0.000	2.97	0.04	OK	16000	0.64	21300	OK								
P1007PG	TF-7570	2500	F	1.00	1.00	6600	3	XLPE	40	0.72	3	120	1	218.7	375.0	270.0	OK	0.196	0.097	0.009	1.000	0.000	2.97	0.04	OK	16000	0.64	21300	OK								
P1008PG	A-2500C REFRIGERANT COMPRESSOR C	970	M	0.87	0.97	6600	3	XLPE	100	0.72	3	35	1	101.0	175.0	126.0	OK	0.668	0.116	0.068	0.870	0.493	11.16	0.17	OK					5.5	555.31	0.30	0.95	29.87	0.5	OK	
P1009PG	P-6910B SEAWATER LIFT PUMP B	850	M	0.87	0.97	6600	3	XLPE	70	0.72	3	35	1	88.6	175.0	126.0	OK	0.668	0.116	0.047	0.870	0.493	6.85	0.10	OK					2.5	221.42	0.30	0.95	8.34	0.1	OK	
P1010PG	P-6940B COOLING WATER CIRC. PUMP B	670	M	0.87	0.96	6600	3	XLPE	80	0.72	3	25	1	70.1	145.0	104.4	OK	0.927	0.124	0.075	0.870	0.493	8.43	0.13	OK					5.5	385.56	0.30	0.95	21.15	0.3	OK	
P1011PG	PRODUCED WATER INJECTION PUMP	850	M	0.87	0.97	6600	3	XLPE	80	0.72	3	35	1	88.6	175.0	126.0	OK	0.668	0.116	0.054	0.870	0.493	7.83	0.12	OK					2.5	221.42	0.30	0.95	9.53	0.1	OK	
P1012PG	TF-7580	3150	F	1.00	1.00	6600	3	XLPE	40	0.72	3	150	1	275.6	430.0	309.6	OK	0.159	0.094	0.007	1.000	0.000	3.04	0.05	OK	16000	0.64	26625	OK								
P1013PG	TF-7585	3150	F	1.00	1.00	6600	3	XLPE	40	0.72	3	150	1	275.6	430.0	309.6	OK	0.159	0.094	0.007	1.000	0.000	3.04	0.05	OK	16000	0.64	26625	OK								
P1014PG	TF-7590	3150	F	1.00	1.00	6600	3	XLPE	40	0.72	3	150	1	275.6	430.0	309.6	OK	0.159	0.094	0.007	1.000	0.000	3.04	0.05	OK	16000	0.64	26625	OK								
P1015PG	TF-7595	3150	F	1.00	1.00	6600	3	XLPE	40	0.72	3	150	1	275.6	430.0	309.6	OK	0.159	0.094	0.007	1.000	0.000	3.04	0.05	OK	16000	0.64	26625	OK								
	SB-7710																																				
P3000PG	GD-7700 EMERGENCY DIESEL GENERATOR	1500	F	0.80	1.00	400	3	XLPE	50	0.68	1	630	4	2706.3	4108.0	2777.0	OK	0.042	0.086	0.005	0.800	0.600	4.99	1.25	OK	49000	1.00	89460	OK								
P5000PG	MCC-7810	45	F	0.95	0.91	400	3	XLPE	80	0.73	4	50	1	75.1	178.0	129.6	OK	0.494	0.074	0.040	0.950	0.312	5.13	1.28	OK	17000	0.05	31752	OK								
P5001PG	MCC-7820	276	F	0.95	0.91	400	3	XLPE	60	0.73	4	240	2	464.2	960.0	698.9	OK	0.099	0.070	0.007	0.950	0.312	2.79	0.70	OK	55000	1.00	68160	OK								
P5002PG	K-5510 AIR COMPRESSOR A	185	M	0.87	0.96	400	3	XLPE	50	0.73	3	240	1	319.7	480.0	349.4	OK	0.099	0.070	0.006	0.870	0.493	3.34	0.83	OK	29000	0.05	152410	OK	3.0	959.14	0.30	0.95	8.01	2.0	OK	
P5003PG	K-5530 AIR COMPRESSOR B	185	M	0.87	0.96	400	3	XLPE	50	0.73	3	240	1	319.7	480.0	349.4	OK	0.099	0.070	0.006	0.870	0.493	3.34	0.83	OK	29000	0.05	152410	OK	3.0	959.14	0.30	0.95	8.01	2.0	OK	
P5004PG	MCC-7840	538	F	0.95	0.91	400	3	XLPE	60	0.73	4	240	3	898.2	1440.0	1048.3	OK	0.099	0.070	0.007	0.950	0.312	3.60	0.90	OK	24000	1.00	102240	OK								
P5015PG	DB-7868 SMALL POWER DISTRIBUTION BOARD- SPACE HEATER	30.00	F	0.95	0.91	400	3	XLPE	30	0.73	4	25	1	50.1	115.0	83.7	OK	0.927	0.077	0.028	0.950	0.312	2.35	0.59	OK	4090	0.05	15876	OK								
	SB-7720																																				
P5005PG	MCC-7850	486	F	0.95	0.91	400	3	XLPE	30	0.73	4	240	3	811.4	1440.0	1048.3	OK	0.099	0.070	0.004	0.950	0.312	1.63	0.41	OK	34000	1.00	102240	OK								
P5006PG	MCC-7860	134	F	0.95	0.91	400	3	XLPE	30	0.73	4	240	1	223.7	480.0	349.4	OK	0.099	0.070	0.004	0.950	0.312	1.35	0.34	OK	32000	1.00	34080	OK								
P5007PG	P-2510A REGENERATION GAS BLOWER A	132	M	0.86	0.96	400	3	XLPE	65	0.73	3	150	1	230.8	350.0	254.8	OK	0.160	0.071	0.011	0.860	0.510	4.51	1.13	OK	19000	0.05	95256	OK	3.0	692.32	0.30	0.95	8.99	2.2	OK	
P5008PG	P-2510B REGENERATION GAS BLOWER B	132	M	0.86	0.96	400	3	XLPE	70	0.73	3	150	1	230.8	350.0	254.8	OK	0.160	0.071	0.012	0.860	0.510	4.86	1.22	OK	19000	0.05	95256	OK	3.0	692.32	0.30	0.95	9.68	2.4	OK	
P5009/01PG	HEATER CONTROL PANEL HCP-6040A	500	F	1.00	0.95	400	3	XLPE	25	0.73	4	240	3	759.7	1440.0	1048.3	OK	0.099	0.070	0.003	1.000	0.000	1.08	0.27	OK	43000	1.00	102240	OK								
P5009/04PG	E-6040A FUEL GAS SUPER HEATER #1	167	F	1.00	0.95	400	3	XLPE	85	0.73	4	185	1	253.7	409.0	297.8	OK	0.128	0.071	0.012	1.000	0.000	4.78	1.20	OK	30200	0.05	117483	OK								
P5010PG	HEATER CONTROL PANEL HCP-6010	173	F	1.00	0.95	400	3	XLPE	30	0.73	4	185	1	262.8	409.0	297.8	OK	0.128	0.071	0.004	1.000	0.000	1.75	0.44	OK	35000	0.05	117483	OK								
P5010/01PG	E-6010 FUEL GAS PRE-HEATER	58	F	1.00	0.95	400	3	XLPE	65	0.73	4	50	1	88.1	178.0	129.6	OK	0.494	0.074	0.042	1.000	0.000	6.41	1.60	OK	21100	0.05	31752	OK								
P5011PG	MCC-7870	232	F	0.95	0.91	400	3	XLPE	110	0.73	4	150	2	387.3	700.0	509.6	OK	0.160	0.071	0.019	0.950	0.312	6.43	1.61	OK	32000	1.00	42600	OK								
P5012PG	P-2510C REGENERATION GAS BLOWER C	132	F	0.95	0.91	400	3	XLPE	75	0.73	3	150	1	220.4	350.0	254.8	OK	0.160	0.071	0.013	0.950	0.312	4.99	1.25	OK	19000	0.05	95256	OK	7.2	1586.79	0.30	0.95	23.78	5.9	OK	
P5013/01PG	HEATER CONTROL PANEL HCP-6040B	500	F	1.00	0.95	400	3	XLPE	25	0.73	4	240	3	759.7	1440.0	1048.3	OK	0.099	0.070	0.003	1.000	0.000	1.08	0.27	OK	43000	1.00	102240	OK								
P5013/04PG	E-6040B FUEL GAS SUPER HEATER #2	167	F	1.00	0.95	400	3	XLPE	85	0.73	4	185	1	253.7	409.0	297.8	OK	0.128	0.071	0.012	1.000	0.000	4.78	1.20	OK	30200	0.05	117483	OK								
P5014PG	MCC-7880	232	F	0.95	0.91	400	3	XLPE	95	0.73	4	150	2	387.3	700.0	509.6	OK	0.160	0.071	0.017	0.950	0.312	5.55	1.39	OK	32000	1.00	42600	OK								

	SB-7730																																				
P5030PG	E-5660A HEATING MEDIUM HEATER 'A'	800	F	1.00	0.95	400	3	XLPE	60	0.73	4	240	4	1215.5	1920.0	1397.8	OK	0.099	0.070	0.007	1.000	0.000	3.12	0.78	OK	30400	1.00	136320	OK								
	SB-7740																																				
P5040PG	E-5660B HEATING MEDIUM HEATER 'B'	800	F	1.00	0.95	400	3	XLPE	60	0.73	4	240	4	1215.5	1920.0	1397.8	OK	0.099	0.070	0.007	1.000	0.000	3.12	0.78	OK	30400	1.00	136320	OK								
	SB-7760																																				
P5050PG	E-5660C HEATING MEDIUM HEATER 'C'	800	F	1.00	0.95	400	3	XLPE	60	0.73	4	240	4	1215.5	1920.0	1397.8	OK	0.099	0.070	0.007	1.000	0.000	3.12	0.78	OK	30400	1.00	136320	OK								
	SB-7760																																				
P5080PG	E-5660D HEATING MEDIUM HEATER 'D'	800	F	1.00	0.95	400	3	XLPE	60	0.73	4	240	4	1215.5	1920.0	1397.8	OK	0.099	0.070	0.007	1.000	0.000	3.12	0.78	OK	30400	1.00	136320	OK								
	MCC-7810 (TELECOM EQUIPMENT ROOM)																																				
P6000PG	HAH-5500A AIR HANDLING UNIT FAN A- TEL. EQUIP. ROOM	11.00	M	0.85	0.90	400	3	XLPE	25	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.098	0.850	0.527	3.06	0.76	OK	1180	0.05	3810	OK	7.2	115.16	0.30	0.95	9.21	2.3	OK	
P6001PG	HAH-5500B AIR HANDLING UNIT FAN B- TEL. EQUIP. ROOM	11.00	M	0.85	0.90	400	3	XLPE	25	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.098	0.850	0.527	3.06	0.76	OK	1190	0.05	3810	OK	7.2	115.16	0.30	0.95	9.21	2.3	OK	
P6002PG	HHW-5500 ELECTRIC DUCT HEATER- TEL. EQUIP. ROOM	4.00	F	1.00	0.95	400	3	XLPE	25	0.73	4	4	1	6.1	38.0	27.7	OK	5.880	0.088	0.147	1.000	0.000	1.55	0.39	OK	1130	0.05	2540	OK								
P6003PG	HPF-5500A PRESSURISATION FAN A- TEL. EQUIP. ROOM	5.50	M	0.80	0.87	400	3	XLPE	25	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.147	0.800	0.600	2.35	0.59	OK	1140	0.05	2540	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6004PG	HPF-5500B PRESSURISATION FAN B- TEL. EQUIP. ROOM	5.50	M	0.80	0.87	400	3	XLPE	25	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.147	0.800	0.600	2.35	0.59	OK	1140	0.05	2540	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6005PG	HEF-5500A EXHAUST FAN (BATTERY ROOM)- TEL. EQUIP. ROOM	0.25	M	0.80	0.66	400	3	XLPE	25	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.236	0.800	0.600	0.23	0.06	OK	1130	0.05	1588	OK	7.2	4.92	0.30	0.95	0.62	0.2	OK	
P6006PG	HEF-5500B EXHAUST FAN (BATTERY ROOM)- TEL. EQUIP ROOM	0.25	M	0.80	0.66	400	3	XLPE	25	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.236	0.800	0.600	0.23	0.06	OK	1130	0.05	1588	OK	7.2	4.92	0.30	0.95	0.62	0.2	OK	
P6007PG	CK-5500A-A COMPRESSOR A HVAC #1	18.50	M	0.85	0.91	400	3	XLPE	25	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.058	0.850	0.527	3.03	0.76	OK	1850	0.05	6350	OK	7.2	249.38	0.30	0.95	8.35	2.1	OK	
P6008PG	CF-5500A-A CONDENSING FAN A HVAC #1	5.50	M	0.80	0.87	400	3	XLPE	25	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.147	0.800	0.600	2.35	0.59	OK	1140	0.05	2540	OK	7.2	82.12	0.30	0.95	8.57	1.6	OK	
P6009PG	CK-5500B-A COMPRESSOR A HVAC #2	18.50	M	0.85	0.91	400	3	XLPE	25	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.058	0.850	0.527	3.03	0.76	OK	1850	0.05	6350	OK	7.2	249.38	0.30	0.95	8.35	2.1	OK	
P6010PG	CF-5500B-A CONDENSING FAN A HVAC #2	5.50	M	0.80	0.87	400	3	XLPE	25	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.147	0.800	0.600	2.35	0.59	OK	1170	0.05	2540	OK	7.2	82.12	0.30	0.95	6.57	1.6	OK	
	MCC-7830 (VITAL LOAD)																																				
P6200PG	P-5730A DIESEL TRANS. PUMP A	4.00	M	0.80	0.85	400	3	XLPE	75	0.73	3	4	1	8.5	38.0	27.7	OK	5.880	0.088	0.441	0.800	0.600	5.25	1.31	OK	670	0.05	2540	OK	7.2	61.13	0.30	0.95	14.67	3.7	OK	
P6201PG	P-5730B DIESEL TRANS. PUMP B	4.00	M	0.80	0.85	400	3	XLPE	75	0.73	3	4	1	8.5	38.0	27.7	OK	5.880	0.088	0.441	0.800	0.600	5.25	1.31	OK	670	0.05	2540	OK	7.2	61.13	0.30	0.95	14.67	3.7	OK	
P6202PG	P-5240A POTABLE WATER PUMP A	18.50	M	0.85	0.91	400	3	XLPE	50	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.117	0.850	0.527	6.06	1.52	OK	2530	0.05	6350	OK	7.2	249.38	0.30	0.95	16.71	4.2	OK	
P6203PG	P-5240B POTABLE WATER PUMP B	18.50	M	0.85	0.91	400	3	XLPE	50	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.117	0.850	0.527	6.06	1.52	OK	2530	0.05	6350	OK	7.2	249.38	0.30	0.95	16.71	4.2	OK	
P6204PG	A-5210A POTABLE WATER MAKER A	23.00	F	0.95	0.91	400	3	XLPE	55	0.73	4	10	1	38.4	66.0	48.0	OK	2.330	0.079	0.128	0.850	0.312	6.19	2.05	OK	5000	0.05	6350	OK	7.2	276.49	0.30	0.95	20.38	5.1	OK	
P6205PG	A-5210B POTABLE WATER MAKER B	23.00	M	0.85	0.91	400	3	XLPE	50	0.73	4	10	1	42.8	66.0	48.0	OK	2.330	0.079	0.117	0.850	0.527	7.49	1.87	OK	5000	0.05	6350	OK	7.2	308.00	0.30	0.95	20.63	5.2	OK	
P6206PG	P-5110A SERVICE PUMP A	55.00	M	0.86	0.94	400	3	XLPE	40	0.73	3	35	1	98.3	141.0	102.6	OK	0.669	0.074	0.027	0.860	0.510	4.18	1.04	OK	9450	0.05	22227	OK	7.2	707.80	0.30	0.95	13.30	3.3	OK	
P6207PG	P-5110B SERVICE PUMP B	55.00	M	0.86	0.94	400	3	XLPE	40	0.73	3	35	1	98.3	141.0	102.6	OK	0.669	0.074	0.027	0.860	0.510	4.18	1.04	OK	9450	0.05	22227	OK	7.2	707.80	0.30	0.95	13.30	3.3	OK	
P6208PG	E-5520/5525 AIR COMPRESSOR OIL/ AIR COOLER FAN	11.00	M	0.85	0.90	400	3	XLPE	50	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.197	0.850	0.527	6.12	1.53	OK	1510	0.05	3810	OK	7.2	150.27	0.30	0.95	16.38	4.1	OK	
P6209PG	E-5535/5540 AIR COMPRESSOR OIL/ AIR COOLER FAN	11.00	M	0.85	0.90	400	3	XLPE	55	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.216	0.850	0.527	6.73	1.68	OK	1380	0.05	3810	OK	7.2	150.27	0.30	0.95	18.02	4.5	OK	
P6210PG	UPS-7760A	40.00	F	0.95	0.91	400	3	XLPE	50	0.73	4	35	1	66.8	141.0	102.6	OK	0.669	0.074	0.034	0.950	0.312	3.81	0.95	OK	5810	0.05	22227	OK								
P6211PG	UPS-7760C	40.00	F	0.95	0.91	400	3	XLPE	50	0.73	4	35	1	66.8	141.0	102.6	OK	0.669	0.074	0.034	0.950	0.312	3.81	0.95	OK	5810	0.05	22227	OK								
P6212PG	UPS-7850A	100.00	F	0.95	0.91	400	3	XLPE	50	0.73	4	95	1	167.0	263.0	191.5	OK	0.247	0.071	0.013	0.950	0.312	3.71	0.93	OK	15960	0.05	60329	OK								
P6213PG	UPS-7850C	100.00	F	0.95	0.91	400	3	XLPE	50	0.73	4	95	1	167.0	263.0	191.5	OK	0.247	0.071	0.013	0.950	0.312	3.71	0.93	OK	15960	0.05	60329	OK								

P6215PG	NCCP-7825B AC UPS FOR NAVIGATIONAL AIDS	5.00	F	0.90	0.90	230	1	XLPE	50	0.73	4	6	1	15.5	48.0	34.9	OK	3.930	0.084	0.197	0.900	0.436	4.80	2.08	OK	2500	0.05	3810	OK								
P6216PG	DB-7812 EMER. LTG DIST. BOARD (MOD. 1)	1.60	F	0.90	0.90	400	3	XLPE	132	0.73	4	10	1	2.9	66.0	48.0	OK	2.330	0.079	0.308	0.900	0.436	1.39	0.35	OK	240	0.05	6350	OK								
P6217PG	DB-7822 EMER. LTG DIST. BOARD (MOD. 2)	0.70	F	0.90	0.90	400	3	XLPE	120	0.73	4	10	1	1.2	66.0	48.0	OK	2.330	0.079	0.260	0.900	0.436	0.55	0.14	OK	260	0.05	6350	OK								
P6218PG	DB-7832 EMER. LTG DIST. BOARD (MOD. 3)	1.50	F	0.90	0.90	400	3	XLPE	100	0.73	4	10	1	2.7	66.0	48.0	OK	2.330	0.079	0.233	0.900	0.436	0.99	0.25	OK	310	0.05	6350	OK								
P6219PG	DB-7842 EMER. LTG DIST. BOARD (MOD. 4)	0.70	F	0.90	0.90	400	3	XLPE	100	0.73	4	10	1	1.2	66.0	48.0	OK	2.330	0.079	0.233	0.900	0.436	0.46	0.12	OK	310	0.05	6350	OK								
P6220PG	DB-7852 EMER. LTG DIST. BOARD (MOD. 5)	0.50	F	0.90	0.90	400	3	XLPE	80	0.73	4	10	1	0.9	66.0	48.0	OK	2.330	0.079	0.187	0.900	0.436	0.26	0.07	OK	390	0.05	6350	OK								
P6221PG	DB-7862 EMER. LTG DIST. BOARD OUTDOOR (MOD. 6)	2.70	F	0.90	0.90	400	3	XLPE	30	0.73	4	10	1	4.8	66.0	48.0	OK	2.330	0.079	0.070	0.900	0.436	0.53	0.13	OK	1020	0.05	6350	OK								
P6222PG	DB-7882 EMER. LTG DIST. BOARD (MOD. 8, MSF NORTH)	2.00	F	0.90	0.90	400	3	XLPE	100	0.73	4	10	1	3.8	66.0	48.0	OK	2.330	0.079	0.233	0.900	0.436	1.32	0.33	OK	310	0.05	6350	OK								
P6224PG	P-5340 FIREWATER HYDRAULIC PUMP	3.70	M	0.80	0.84	400	3	XLPE	120	0.73	3	4	1	8.0	38.0	27.7	OK	5.880	0.088	0.706	0.800	0.600	7.88	1.97	OK	1250	0.05	2540	OK	7.2	57.36	0.30	0.95	22.02	5.5	OK	
P6225PG	P-5350 FIREWATER HYDRAULIC PUMP	3.70	M	0.80	0.84	400	3	XLPE	120	0.73	3	4	1	8.0	38.0	27.7	OK	5.880	0.088	0.706	0.800	0.600	7.88	1.97	OK	1250	0.05	2540	OK	7.2	57.36	0.30	0.95	22.02	5.5	OK	
P6226PG	P-7713 EMER. GEN HDYRAULIC PUMP	3.70	M	0.80	0.84	400	3	XLPE	60	0.73	3	4	1	8.0	38.0	27.7	OK	5.880	0.088	0.353	0.800	0.600	3.94	0.98	OK	1250	0.05	2540	OK	7.2	57.36	0.30	0.95	11.01	2.8	OK	
P6227/01PG	GT-7510 LINE REACTOR	251.00	M	0.86	0.95	400	3	XLPE	15	0.73	3	150	2	443.4	700.0	509.6	OK	0.160	0.071	0.003	0.860	0.510	1.00	0.25	OK	1000	0.05	95256	OK								
P6227/02PG	GT-7510 VARIBLE FREQUENCY DRIVE (VFD)	251.00	M	0.86	0.95	400	3	XLPE	5	0.73	3	150	2	443.4	700.0	509.6	OK	0.160	0.071	0.001	0.860	0.510	0.33	0.08	OK	1000	0.05	95256	OK								
P6227/03PG	B330A1 AC STARTER MOTOR FOR GT-7510	110.00	M	0.86	0.95	400	3	XLPE	60	0.73	3	120	1	194.3	300.0	218.4	OK	0.196	0.071	0.012	0.860	0.510	4.13	1.03	OK	1000	0.05	76205	OK	7.2	1399.21	0.30	0.95	18.29	4.6	OK	
P6228PG	B343A AC LIQUID FUEL PUMP (GTG 1)	30.00	M	0.85	0.92	400	3	XLPE	65	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.060	0.850	0.527	5.16	1.29	OK	4640	0.05	15876	OK	7.2	398.68	0.30	0.95	15.76	3.9	OK	
P6229PG	B588A BOOST PUMP DRIVER MOTOR (GTG 1)	1.10	M	0.80	0.77	400	3	XLPE	65	0.73	3	2.5	1	2.6	29.0	21.1	OK	9.450	0.093	0.614	0.800	0.600	2.21	0.55	OK	480	0.05	1588	OK	7.2	18.56	0.30	0.95	6.11	1.5	OK	
P6230PG	B321A PRE/POST LUBE OIL PUMP (GTG 1)	5.50	M	0.80	0.87	400	3	XLPE	65	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.382	0.800	0.600	6.11	1.53	OK	770	0.05	2540	OK	7.2	82.12	0.30	0.95	17.08	4.3	OK	
P6231PG	B598A-1 OIL COOLER FAN MOTOR (GTG 1)	7.50	M	0.80	0.88	400	3	XLPE	65	0.73	3	6	1	15.3	48.0	34.9	OK	3.930	0.084	0.256	0.800	0.600	5.52	1.38	OK	1160	0.05	3810	OK	7.2	110.46	0.30	0.95	15.65	3.9	OK	
P6232PG	H392A LUBE OIL TANK IMMERSION HEATER (GTG 1)	18.70	F	1.00	0.95	400	3	XLPE	65	0.73	4	10	1	28.4	66.0	48.0	OK	2.330	0.079	0.152	1.000	0.000	7.45	1.86	OK	3010	0.05	6350	OK								
P6233PG	B596A-1 ENCLOSURE VENT FAN A (GTG 1)	11.00	M	0.85	0.90	400	3	XLPE	60	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.236	0.850	0.527	7.34	1.84	OK	1260	0.05	3810	OK	7.2	150.27	0.30	0.95	19.65	4.9	OK	
P6234PG	B596A-2 ENCLOSURE VENT FAN/B (GTG 1)	11.00	M	0.85	0.90	400	3	XLPE	65	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.256	0.850	0.527	7.95	1.99	OK	1930	0.05	3810	OK	7.2	150.27	0.30	0.95	21.29	5.3	OK	
P6235/01PG	GT-7520 LINE REACTOR	251.00	M	0.86	0.95	400	3	XLPE	15	0.73	3	150	2	443.4	700.0	509.6	OK	0.160	0.071	0.003	0.860	0.510	1.00	0.25	OK	1000	0.05	95256	OK								
P6235/02PG	GT-7520 VARIBLE FREQUENCY DRIVE (VFD)	251.00	M	0.86	0.95	400	3	XLPE	5	0.73	3	150	2	443.4	700.0	509.6	OK	0.160	0.071	0.001	0.860	0.510	0.33	0.08	OK	1000	0.05	95256	OK								
P6235/03PG	B330A2 AC STARTER MOTOR FOR GT-7520	110.00	M	0.86	0.95	400	3	XLPE	60	0.73	3	120	1	194.3	300.0	218.4	OK	0.196	0.071	0.012	0.860	0.510	4.13	1.03	OK	1000	0.05	76205	OK	7.2	1399.21	0.30	0.95	18.29	4.6	OK	
P6236PG	B321B PRE/POST LUBE OIL PUMP (GTG 2)	5.50	M	0.80	0.87	400	3	XLPE	75	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.441	0.800	0.600	7.05	1.76	OK	670	0.05	2540	OK	7.2	82.12	0.30	0.95	19.71	4.9	OK	
P6237PG	B598B-1 OIL COOLER FAN MOTOR (GTG 2)	7.50	M	0.80	0.88	400	3	XLPE	75	0.73	3	6	1	15.3	48.0	34.9	OK	3.930	0.084	0.295	0.800	0.600	6.37	1.59	OK	1010	0.05	3810	OK	7.2	110.46	0.30	0.95	18.06	4.5	OK	
P6238PG	H392B LUBE OIL TANK IMMERSION HEATER (GTG 2)	18.70	F	1.00	0.95	400	3	XLPE	75	0.73	4	10	1	28.4	66.0	48.0	OK	2.330	0.079	0.175	1.000	0.000	8.60	2.15	OK	2630	0.05	6350	OK								
P6239PG	B596B-1 ENCLOSURE VENT FAN A (GTG 2)	11.00	M	0.85	0.90	400	3	XLPE	75	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.295	0.850	0.527	9.18	2.29	OK	1680	0.05	3810	OK	7.2	150.27	0.30	0.95	24.57	6.1	OK	
P6240PG	B596B-2 ENCLOSURE VENT FAN/B (GTG 2)	11.00	M	0.85	0.90	400	3	XLPE	80	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.314	0.850	0.527	9.79	2.45	OK	1580	0.05	3810	OK	7.2	150.27	0.30	0.95	26.20	6.6	OK	
P6241/01PG	GT-7530 LINE REACTOR	251.00	M	0.86	0.95	400	3	XLPE	15	0.73	3	150	2	443.4	700.0	509.6	OK	0.160	0.071	0.003	0.860	0.510	1.00	0.25	OK	1000	0.05	95256	OK								
P6242/02PG	GT-7530 VARIBLE FREQUENCY DRIVE (VFD)	251.00	M	0.86	0.95	400	3	XLPE	5	0.73	3	150	2	443.4	700.0	509.6	OK	0.160	0.071	0.001	0.860	0.510	0.33	0.08	OK	1000	0.05	95256	OK								
P6241/03PG	B330A3 AC STARTER MOTOR FOR GT-7530	110.00	M	0.86	0.95	400	3	XLPE	60	0.73	3	120	1	194.3	300.0	218.4	OK	0.196	0.071	0.012	0.860	0.510	4.13	1.03	OK	1000	0.05	76205	OK	7.2	1399.21	0.30	0.95	18.29	4.6	OK	
P6242PG	B343C AC LIQUID FUEL PUMP (GTG 3)	30.00	M	0.85	0.92	400	3	XLPE	75	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.070	0.850	0.527	5.98	1.49	OK	4070	0.05	15876	OK	7.2	398.68	0.30	0.95	18.18	4.5	OK	
P6243PG	B586C BOOST PUMP DRIVER MOTOR (GTG 3)	1.10	M	0.80	0.77	400	3	XLPE	75	0.73	3	2.5	1	2.6	29.0	21.1	OK	9.450	0.093	0.709	0.800	0.600	2.55	0.64	OK	410	0.05	1588	OK	7.2	18.56	0.30	0.95	7.05	1.0	OK	
P6244PG	B321C PRE/POST LUBE OIL PUMP (GTG 3)	5.50	M	0.80	0.87	400	3	XLPE	70	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.412	0.800	0.600	6.58	1.64	OK	720	0.05	2540	OK	7.2	82.12	0.30	0.95	18.39	4.6	OK	

	(GTG 3)																																				
P6246PG	H392C LUBE OIL TANK IMMERSION HEATER (GTG 3)	18.70	F	1.00	0.95	400	3	XLPE	75	0.73	4	10	1	28.4	66.0	48.0	OK	2.330	0.079	0.175	1.000	0.000	8.60	2.15	OK	2630	0.05	6350	OK								
P6247PG	B596C-1 ENCLOSURE VENT FAN A (GTG 3)	11.00	M	0.85	0.90	400	3	XLPE	65	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.256	0.850	0.527	7.95	1.99	OK	1930	0.05	3810	OK	7.2	150.27	0.30	0.95	21.29	5.3	OK	
P6248PG	B596C-2 ENCLOSURE VENT FAN B (GTG 3)	11.00	M	0.85	0.90	400	3	XLPE	65	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.256	0.850	0.527	7.95	1.99	OK	1930	0.05	3810	OK	7.2	150.27	0.30	0.95	21.29	5.3	OK	
P6249PG	HAH-5600A AIR HANDLING UNIT A (SWITCHGEAR ROOM)	30.00	M	0.85	0.92	400	3	XLPE	50	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	3.97	0.99	OK	3910	0.05	15876	OK	7.2	115.16	0.30	0.95	9.21	2.3	OK	
P6250PG	HAH-5600B AIR HANDLING UNIT B (SWITCHGEAR ROOM)	30.00	M	0.85	0.92	400	3	XLPE	50	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	3.97	0.99	OK	3910	0.05	15876	OK	7.2	115.16	0.30	0.95	9.21	2.3	OK	
P6251PG	HPF-5600A PRESSURIZATION FAN A (SWITCHGEAR ROOM)	2.20	M	0.80	0.81	400	3	XLPE	50	0.73	3	2.5	1	4.9	29.0	21.1	OK	9.450	0.093	0.473	0.800	0.600	3.23	0.81	OK	770	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6252PG	HPF-5600B PRESSURIZATION FAN B (SWITCHGEAR ROOM)	2.20	M	0.80	0.81	400	3	XLPE	50	0.73	3	2.5	1	4.9	29.0	21.1	OK	9.450	0.093	0.473	0.800	0.600	3.23	0.81	OK	770	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6253PG	HHW-5600 ELECTRIC DUCT HEATER	12.00	F	1.00	0.95	400	3	XLPE	50	0.73	4	6	1	18.2	48.0	34.9	OK	3.930	0.084	0.197	1.000	0.000	6.21	1.55	OK	1690	0.05	3810	OK								
P6254PG	CK-5600A-A COMPRESSOR A HVAC #1	37.00	M	0.85	0.93	400	3	XLPE	50	0.73	3	25	1	67.6	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	4.85	1.21	OK	6150	0.05	15876	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6255PG	CK-5600A-B COMPRESSOR B HVAC #1	37.00	M	0.85	0.93	400	3	XLPE	50	0.73	3	25	1	67.6	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	4.85	1.21	OK	6150	0.05	15876	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6256PG	CF-5600A-A CONDENSING FAN A HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	50	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.197	0.850	0.527	6.12	1.53	OK	1660	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6257PG	CF-5600A-B CONDENSING FAN B HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	50	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.197	0.850	0.527	6.12	1.53	OK	1660	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6258PG	CK-5600B-A COMPRESSOR A HVAC #1	37.00	M	0.85	0.93	400	3	XLPE	50	0.73	3	25	1	67.6	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	4.85	1.21	OK	6150	0.05	15876	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6259PG	CK-5600B-B COMPRESSOR B HVAC #1	37.00	M	0.85	0.93	400	3	XLPE	50	0.73	3	25	1	67.6	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	4.85	1.21	OK	6150	0.05	15876	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6260PG	CF-5600B-A CONDENSING FAN A HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	50	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.197	0.850	0.527	6.12	1.53	OK	1500	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6261PG	CF-5600B-B CONDENSING FAN B HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	50	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.197	0.850	0.527	6.12	1.53	OK	1500	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6262PG	HAH-5610A AIR HANDLING UNIT A (MCC/ UPS ROOM)	30.00	M	0.85	0.92	400	3	XLPE	40	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.037	0.850	0.527	3.18	0.79	OK	4790	0.05	15876	OK	7.2	115.16	0.30	0.95	9.21	2.3	OK	
P6263PG	HAH-5610B AIR HANDLING UNIT B (MCC/ UPS ROOM)	30.00	M	0.85	0.92	400	3	XLPE	40	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.037	0.850	0.527	3.18	0.79	OK	4790	0.05	15876	OK	7.2	115.16	0.30	0.95	9.21	2.3	OK	
P6264PG	HPF-5610A PRESSURIZATION FAN A (MCC/ UPS ROOM)	2.20	M	0.80	0.81	400	3	XLPE	40	0.73	3	2.5	1	4.9	29.0	21.1	OK	9.450	0.093	0.378	0.800	0.600	2.59	0.65	OK	770	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6265PG	HPF-5610B PRESSURIZATION FAN B (MCC/ UPS ROOM)	2.20	M	0.80	0.81	400	3	XLPE	40	0.73	3	2.5	1	4.9	29.0	21.1	OK	9.450	0.093	0.378	0.800	0.600	2.59	0.65	OK	770	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6266PG	HHW-5610 ELECTRIC DUCT HEATER	12.00	F	1.00	0.95	400	3	XLPE	40	0.73	4	6	1	18.2	48.0	34.9	OK	3.930	0.084	0.157	1.000	0.000	4.96	1.24	OK	1890	0.05	3810	OK								
P6267PG	HEF-5610A EXHAUST FAN A (BATTERY ROOM)	1.10	M	0.80	0.77	400	3	XLPE	50	0.73	3	2.5	1	2.6	29.0	21.1	OK	9.450	0.093	0.473	0.800	0.600	1.70	0.42	OK	620	0.05	1588	OK	7.2	18.56	0.30	0.95	4.70	1.2	OK	
P6268PG	HEF-5610B EXHAUST FAN B (BATTERY ROOM)	1.10	M	0.80	0.77	400	3	XLPE	50	0.73	3	2.5	1	2.6	29.0	21.1	OK	9.450	0.093	0.473	0.800	0.600	1.70	0.42	OK	620	0.05	1588	OK	7.2	18.56	0.30	0.95	4.70	1.2	OK	
P6269PG	CK-5610A-A COMPRESSOR A HVAC #1	37.00	M	0.85	0.93	400	3	XLPE	50	0.73	3	25	1	67.6	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	4.85	1.21	OK	6150	0.05	15876	OK	7.2	486.42	0.30	0.95	14.79	3.7	OK	
P6270PG	CK-5610A-B COMPRESSOR B HVAC #1	37.00	M	0.85	0.93	400	3	XLPE	50	0.73	3	25	1	67.6	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	4.85	1.21	OK	6150	0.05	15976	OK	7.2	486.42	0.30	0.95	14.79	3.7	OK	
P6271PG	CF-5610A-A CONDENSING FAN A HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	50	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.197	0.850	0.527	6.12	1.53	OK	1500	0.05	3810	OK	7.2	150.27	0.30	0.95	16.38	4.1	OK	
P6272PG	CF-5610A-B CONDENSING FAN B HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	50	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.197	0.850	0.527	6.12	1.53	OK	1500	0.05	3810	OK	7.2	150.27	0.30	0.95	16.38	4.1	OK	
P6273PG	CK-5610B-A COMPRESSOR A HVAC #1	37.00	M	0.85	0.93	400	3	XLPE	50	0.73	3	25	1	67.6	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	4.85	1.21	OK	5780	0.05	15876	OK	7.2	486.42	0.30	0.95	14.79	3.7	OK	
P6274PG	CK-5610B-B COMPRESSOR B HVAC #1	37.00	M	0.85	0.93	400	3	XLPE	50	0.73	3	25	1	67.6	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	4.85	1.21	OK	5780	0.05	15876	OK	7.2	486.42	0.30	0.95	14.79	3.7	OK	
P6275PG	CF-5610B-A CONDENSING FAN A HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	50	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.197	0.850	0.527	6.12	1.53	OK	1500	0.05	3810	OK	7.2	150.27	0.30	0.95	16.38	4.1	OK	
P6276PG	CF-5610B-B CONDENSING FAN B HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	50	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.197	0.850	0.527	6.12	1.53	OK	1500	0.05	3810	OK	7.2	150.27	0.30	0.95	16.38	4.1	OK	
P6277PG	DB-7891 TBDR-A PROCESS LOAD	36.00	F	0.95	0.91	400	3	XLPE	280	0.73	4	95	1	60.1	263.0	191.5	OK	0.247	0.071	0.072	0.950	0.312	7.48	1.87	OK	5810	0.05	60329	OK								
	MCC-7840 (LQ NORMAL LOAD)																																				
P6300PG	F-5295A WATER HEATER SYSTEM NO. 1	33.00	F	1.00	0.95	400	3	XLPE	45	0.73	4	25	1	50.1	115.0	83.7	OK	0.927	0.077	0.042	1.000	0.000	3.62	0.91	OK	4250	0.05	15876	OK								
P6301PG	F-5295B WATER HEATER SYSTEM NO. 2	33.00	F	1.00	0.95	400	3	XLPE	45	0.73	4	25	1	50.1	115.0	83.7	OK	0.927	0.077	0.042	1.000	0.000	3.62	0.91	OK	4250	0.05	15876	OK								
P6302PG	DB-7871A NORMAL LIGHTING DB MAIN DECK	3.30	F	0.90	0.90	400	3	XLPE	45	0.73	4	10	1	5.9	66.0	48.0	OK	2.330	0.079	0.105	0.900	0.436	0.98	0.24	OK	690	0.05	6350	OK								
P6303PG	DB-7871B NORMAL LIGHTING DB LEVEL 1	4.20	F	0.90	0.90	400	3	XLPE	30	0.73	4	10	1	7.5	86.0	48.0	OK	2.330	0.079	0.070	0.900	0.436	0.83	0.21	OK	1020	0.05	6350	OK								
P6304PG	DB-7871C NORMAL LIGHTING DB LEVEL 2	5.00	F	0.50	0.90	400	3	XLPE	45	0.73	4	10	1	8.9	66.0	48.0	OK	2.330	0.079	0.105	0.900	0.436	1.46	0.37	OK	1130	0.05	6350	OK								
P6305PG	DB-7871D NORMAL LIGHTING DB LEVEL 3	3.00	F	0.90	0.90	400	3	XLPE	45	0.73	4	10	1	5.3	66.0	48.0	OK	2.330	0.079	0.105	0.900	0.436	0.89	0.22	OK	690	0.05	6350	OK								

P6307PG	DB-7873A POWER DB MAIN DECK	9.50	F	0.95	0.91	400	3	XLPE	45	0.73	4	10	1	15.9	66.0	48.0	OK	2.330	0.079	0.105	0.950	0.312	2.77	0.69	OK	1700	0.05	6350	OK								
P6308PG	DB-7873B NORMAL LIGHTING DB LEVEL 1	9.20	F	0.90	0.90	400	3	XLPE	30	0.73	4	10	1	16.4	66.0	48.0	OK	2.330	0.079	0.070	0.900	0.436	1.82	0.45	OK	1680	0.05	6350	OK								
P6309PG	DB-7873C NORMAL LIGHTING DB LEVEL 2	18.00	F	0.90	0.90	400	3	XLPE	45	0.73	4	25	1	32.1	115.0	83.7	OK	0.927	0.077	0.042	0.900	0.436	2.17	0.54	OK	2780	0.05	15876	OK								
P6310PG	DB-7873D NORMAL LIGHTING DB LEVEL 3	27.00	F	0.90	0.90	400	3	XLPE	45	0.73	4	25	1	48.1	115.0	83.7	OK	0.927	0.077	0.042	0.900	0.436	3.25	0.81	OK	4250	0.05	15876	OK								
P6311PG	DB-7873E NORMAL LIGHTING DB LEVEL 4	20.00	F	0.90	0.90	400	3	XLPE	50	0.73	4	35	1	35.6	141.0	102.6	OK	0.669	0.074	0.034	0.900	0.436	1.96	0.49	OK	3850	0.05	22227	OK								
P6312PG	DB-7874A SMALL POWER DB	60.00	F	0.95	0.91	400	3	XLPE	45	0.73	4	50	1	100.2	178.0	129.6	OK	0.494	0.074	0.022	0.950	0.312	3.64	0.96	OK	11400	0.05	31752	OK								
P6313PG	DB-7874B SMALL POWER DB	118.00	F	0.95	0.91	400	3	XLPE	40	0.73	4	120	1	197.0	300.0	216.4	OK	0.196	0.071	0.008	0.950	0.312	2.84	0.71	OK	20590	0.05	76205	OK								
P6314PG	DB-7875C SMALL POWER DB-KITCHEN	170.00	F	0.95	0.91	400	3	XLPE	70	0.73	4	240	1	283.8	480.0	349.4	OK	0.099	0.070	0.009	0.950	0.312	3.98	1.00	OK	7450	0.05	152410	OK								
P6315PG	DB-7875D SMALL POWER DB-KITCHEN	43.00	F	0.95	0.91	400	3	XLPE	70	0.73	4	35	1	71.8	141.0	102.8	OK	0.669	0.074	0.047	0.950	0.312	5.73	1.43	OK	4910	0.05	22227	OK								
P6316PG	HAH-5030A AIR HANDLING UNIT FAN A- LEVEL 3	18.50	M	0.85	0.91	400	3	XLPE	45	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.105	0.850	0.527	5.46	1.36	OK	2810	0.05	6350	OK	7.2	115.16	0.30	0.95	9.21	2.3	OK	
P6317PG	HAH-5030B AIR HANDLING UNIT FAN B- LEVEL 3	18.50	M	0.85	0.91	400	3	XLPE	45	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.105	0.850	0.527	5.46	1.36	OK	2810	0.05	6350	OK	7.2	115.16	0.30	0.95	9.21	2.3	OK	
P6318PG	HHW-5030 ELECTRIC DUCT HEATER- LEVEL 3	10.00	F	1.00	0.95	400	3	XLPE	45	0.73	4	6	1	15.2	48.0	34.9	OK	3.930	0.084	0.177	1.000	0.000	4.65	1.16	OK	1720	0.05	3810	OK								
P6319PG	HEF-5030A EXHAUST FAN FOR TOILET- LEVEL 3	0.25	M	0.80	0.66	400	3	XLPE	45	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.425	0.800	0.600	0.41	0.10	OK	690	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6320PG	HEF-5030B EXHAUST FAN FOR TOILET- LEVEL 3	0.25	M	0.80	0.66	400	3	XLPE	45	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.425	0.800	0.600	0.41	0.10	OK	690	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6321PG	HEF-5030C EXHAUST FAN FOR TOILET- LEVEL 3	0.25	M	0.80	0.66	400	3	XLPE	45	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.425	0.800	0.600	0.41	0.10	OK	690	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6322PG	HEF-5030D EXHAUST FAN FOR TOILET- LEVEL 3	0.25	M	0.80	0.66	400	3	XLPE	45	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.425	0.800	0.600	0.41	0.10	OK	690	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6323PG	HEF-5030E EXHAUST FAN FOR TOILET- LEVEL 3	0.25	M	0.80	0.66	400	3	XLPE	45	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.425	0.800	0.600	0.41	0.10	OK	690	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6324PG	HEF-5030F EXHAUST FAN FOR TOILET- LEVEL 3	0.25	M	0.80	0.66	400	3	XLPE	45	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.425	0.800	0.600	0.41	0.10	OK	690	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6325PG	CK-5030A-A COMPRESSOR A HVAC #1	22.00	M	0.85	0.91	400	3	XLPE	45	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.105	0.850	0.527	6.45	1.61	OK	4450	0.05	6350	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6326PG	CK-5030A-B COMPRESSOR B HVAC #1	22.00	M	0.85	0.91	400	3	XLPE	45	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.105	0.850	0.527	6.45	1.61	OK	4450	0.05	6350	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6327PG	CF-5030A-A CONDENSING FAN A HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	45	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.177	0.850	0.527	5.51	1.38	OK	1660	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6328PG	CF-5030A-B CONDENSING FAN B HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	45	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.177	0.850	0.527	5.51	1.38	OK	1660	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6329PG	CK-5030B-A COMPRESSOR A HVAC #2	22.00	M	0.85	0.91	400	3	XLPE	45	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.105	0.850	0.527	6.45	1.61	OK	4450	0.05	6350	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6330PG	CK-5030B-B COMPRESSOR B HVAC #2	22.00	M	0.85	0.91	400	3	XLPE	45	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.105	0.850	0.527	6.45	1.61	OK	4450	0.05	6350	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6331PG	CF-5030B-A CONDENSING FAN A HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	45	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.177	0.850	0.527	5.51	1.38	OK	1660	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6332PG	CF-5030B-B CONDENSING FAN B HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	45	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.177	0.850	0.527	5.51	1.38	OK	1660	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6333PG	HAH-5040-A AIR HANDLING UNIT FAN A-LEVEL 4	22.00	M	0.85	0.91	400	3	XLPE	50	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.117	0.850	0.527	7.16	1.79	OK	3900	0.05	6350	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6334PG	HAH-5040-B AIR HANDLING UNIT FAN B-LEVEL 4	22.00	M	0.85	0.91	400	3	XLPE	50	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.117	0.850	0.527	7.16	1.79	OK	3900	0.05	6350	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6335PG	HHW-5040 ELECTRIC DUCT HEATER- LEVEL 4	12.00	F	1.00	0.95	400	3	XLPE	50	0.73	4	6	1	18.2	48.0	34.9	OK	3.930	0.084	0.197	1.000	0.000	6.21	1.55	OK	2500	0.05	3810	OK								
P6336PG	HEF-5040A EXHAUST FAN FOR TOILET- LEVEL 4	0.25	M	0.80	0.66	400	3	XLPE	50	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.473	0.800	0.600	0.45	0.11	OK	620	0.05	1568	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6337PG	HEF-5040B EXHAUST FAN FOR TOILET- LEVEL 4	0.25	M	0.80	0.66	400	3	XLPE	50	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.473	0.800	0.600	0.45	0.11	OK	620	0.05	1568	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6338PG	HEF-5040C EXHAUST FAN FOR TOILET- LEVEL 4	0.25	M	0.80	0.66	400	3	XLPE	50	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.473	0.800	0.600	0.45	0.11	OK	620	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6339PG	HEF-5040D EXHAUST FAN FOR TOILET- LEVEL 4	0.25	M	0.80	0.66	400	3	XLPE	50	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.473	0.800	0.600	0.45	0.11	OK	620	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6340PG	CK-5040A-A COMPRESSOR A HVAC #1	30.00	M	0.85	0.92	400	3	XLPE	50	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	3.97	0.99	OK	4030	0.05	15876	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6341PG	CK-5040A-B COMPRESSOR B HVAC #1	30.00	M	0.85	0.92	400	3	XLPE	50	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	3.97	0.99	OK	4030	0.05	15876	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6342PG	CF-5040A-A CONDENSING FAN A HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	50	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.197	0.850	0.527	6.12	1.53	OK	1500	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	

P6344PG	CK-5040B-A COMPRESSOR A HVAC #2	30.00	M	0.85	0.92	400	3	XLPE	50	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	3.97	0.99	OK	4030	0.05	15876	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6345PG	CK-5040B-B COMPRESSOR B HVAC #2	30.00	M	0.85	0.92	400	3	XLPE	50	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.047	0.850	0.527	3.97	0.99	OK	4030	0.05	15876	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6346PG	CF-5040B-A CONDENSING FAN A HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	50	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.197	0.850	0.527	6.12	1.53	OK	1500	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6347PG	CF-5040B-B CONDENSING FAN B HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	50	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.197	0.850	0.527	6.12	1.53	OK	1500	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6348PG	HAH-5000A AIR HANDLING UNIT FAN A- MAIN DECK	18.50	M	0.85	0.91	400	3	XLPE	75	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.175	0.850	0.527	9.10	2.27	OK	2680	0.05	6350	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6349PG	HAH-5000B AIR HANDLING UNIT FAN B- MAIN DECK	18.50	M	0.85	0.91	400	3	XLPE	75	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.175	0.850	0.527	9.10	2.27	OK	2680	0.05	6350	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6350PG	HHW-5000 ELECTRIC DUCT HEATER- MAIN DECK	10.00	F	1.00	0.95	400	3	XLPE	75	0.73	4	6	1	15.2	48.0	34.9	OK	3.930	0.084	0.295	1.000	0.000	7.76	1.94	OK	1690	0.05	3810	OK								
P6351PG	HEF-5000A EXHAUST FAN (MECH. WORKSHOP)- MAIN DECK	1.10	M	0.80	0.77	400	3	XLPE	75	0.73	3	2.5	1	2.6	29.0	21.1	OK	9.450	0.093	0.709	0.800	0.600	2.55	0.64	OK	410	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6352PG	HEF-5000B EXHAUST FAN (DARK ROOM)- MAIN DECK	0.25	M	0.80	0.66	400	3	XLPE	75	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.709	0.800	0.600	0.68	0.17	OK	410	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6353PG	HEF-5000C EXHAUST FAN (LAB)- MAIN DECK	0.25	M	0.80	0.66	400	3	XLPE	75	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.709	0.800	0.600	0.68	0.17	OK	410	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6354PG	HEF-5000D EXHAUST FAN (LAB)- MAIN DECK	0.25	M	0.80	0.66	400	3	XLPE	75	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.709	0.800	0.600	0.68	0.17	OK	410	0.05	1588	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6355PG	HSF-5000E SUPPLY FAN- PAINT ROOM- MAIN DECK	0.25	M	0.80	0.66	400	3	XLPE	75	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.709	0.800	0.600	0.68	0.17	OK	410	0.05	1588	OK	7.2	4.92	0.30	0.95	1.87	0.5	OK	
P6356PG	CK-5000A-A COMPRESSOR A HVAC #1	22.00	M	0.85	0.91	400	3	XLPE	75	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.175	0.850	0.527	10.75	2.69	OK	4210	0.05	6350	OK	7.2	294.61	0.30	0.95	29.61	7.4	OK	
P6357PG	CK-5000A-B COMPRESSOR B HVAC #1	22.00	M	0.85	0.91	400	3	XLPE	75	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.175	0.850	0.527	10.75	2.69	OK	4210	0.05	6350	OK	7.2	294.61	0.30	0.95	29.61	7.4	OK	
P6358PG	CF-5000A-A CONDENSING FAN A HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	75	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.295	0.850	0.527	9.18	2.29	OK	1680	0.05	3810	OK	7.2	150.27	0.30	0.95	24.57	6.1	OK	
P6359PG	CF-5000A-B CONDENSING FAN B HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	75	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.295	0.850	0.527	9.18	2.29	OK	1680	0.05	3810	OK	7.2	150.27	0.30	0.95	24.57	6.1	OK	
P6360PG	CK-5000B-A COMPRESSOR A HVAC #2	22.00	M	0.85	0.91	400	3	XLPE	75	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.175	0.850	0.527	10.75	2.69	OK	4210	0.05	6350	OK	7.2	294.61	0.30	0.95	29.61	7.4	OK	
P6361PG	CK-5000B-B COMPRESSOR B HVAC #2	22.00	M	0.85	0.91	400	3	XLPE	75	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.175	0.850	0.527	10.75	2.69	OK	4420	0.05	6350	OK	7.2	294.61	0.30	0.95	29.61	7.4	OK	
P6362PG	CF-5000B-A CONDENSING FAN A HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	75	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.295	0.850	0.527	9.18	2.29	OK	1680	0.05	3810	OK	7.2	150.27	0.30	0.95	24.57	6.1	OK	
P6363PG	CF-5000B-B CONDENSING FAN B HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	75	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.295	0.850	0.527	9.18	2.29	OK	1680	0.05	3810	OK	7.2	150.27	0.30	0.95	24.57	6.1	OK	
P6364PG	DB-7891 TBDR-A PROCESS LOAD	37.00	F	0.95	0.91	400	3	XLPE	280	0.73	4	95	1	81.8	263.0	191.5	OK	0.247	0.071	0.072	0.950	0.312	7.69	1.92	OK	5230	0.05	60329	OK								
	MCC-7860																																				
P6500PG	P-5610B HEATING MEDIUM CIRC PUMP B	110.00	M	0.86	0.95	400	3	XLPE	60	0.73	3	120	1	193.9	300.0	218.4	OK	0.196	0.071	0.012	0.860	0.510	4.12	1.03	OK	1010	0.05	76205	OK	7.2	1398.27	0.30	0.95	18.25	4.6	OK	
P6501PG	E-5680A HEATING MEDIUM BYPASS 1ST STAGE COOLER FAN	5.50	M	0.80	0.87	400	3	XLPE	75	0.73	3	6	1	11.4	48.0	34.9	OK	3.930	0.084	0.295	0.800	0.600	4.73	1.18	OK	120	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6502PG	E-5680B HEATING MEDIUM BYPASS 1ST STAGE COOLER FAN	5.50	M	0.80	0.87	400	3	XLPE	75	0.73	3	6	1	11.4	48.0	34.9	OK	3.930	0.084	0.295	0.800	0.600	4.73	1.18	OK	120	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6503PG	E-5680C HEATING MEDIUM BYPASS 2ND STAGE COOLER FAN	11.00	M	0.85	0.90	400	3	XLPE	75	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.295	0.850	0.527	9.18	2.29	OK	130	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6504PG	E-5680D HEATING MEDIUM BYPASS 2ND STAGE COOLER FAN	11.00	M	0.85	0.90	400	3	XLPE	75	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.295	0.850	0.527	9.18	2.29	OK	130	0.05	3810	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6505PG	P-3040A CONDENSATE PUMP A	37.00	M	0.85	0.93	400	3	XLPE	110	0.73	3	25	1	67.8	115.0	83.7	OK	0.927	0.077	0.102	0.850	0.527	10.66	2.67	OK	370	0.05	15876	OK	7.2	486.42	0.30	0.95	32.53	8.1	OK	
P6506PG	P-3040B CONDENSATE PUMP B	37.00	M	0.85	0.93	400	3	XLPE	110	0.73	3	25	1	67.6	115.0	83.7	OK	0.927	0.077	0.102	0.850	0.527	10.66	2.67	OK	370	0.05	15876	OK	7.2	486.42	0.30	0.95	32.53	8.1	OK	
P6507PG	P-3040C CONDENSATE PUMP C	37.00	M	0.85	0.93	400	3	XLPE	105	0.73	3	25	1	67.6	115.0	83.7	OK	0.927	0.077	0.098	0.850	0.527	10.18	2.54	OK	370	0.05	15876	OK	7.2	486.42	0.30	0.95	31.06	7.8	OK	
P6508PG	P-5280B WASH WATER PUMP	11.00	M	0.85	0.90	400	3	XLPE	70	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.275	0.850	0.527	8.58	2.14	OK	180	0.05	3810	OK	7.2	150.27	0.30	0.95	22.93	5.7	OK	
P6509PG	P-6430B CLOSED DRAIN TRANS. PUMP B	15.00	M	0.85	0.90	400	3	XLPE	95	0.73	3	10	1	28.3	66.0	48.0	OK	2.330	0.079	0.221	0.850	0.527	9.42	2.35	OK	100	0.05	6350	OK	7.2	203.77	0.30	0.95	25.94	6.5	OK	
P6510PG	P-8830B HYPO. DOSING PUMP B	11.00	M	0.85	0.90	400	3	XLPE	85	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.334	0.850	0.527	10.40	2.60	OK	150	0.05	3810	OK	7.2	150.27	0.30	0.95	27.84	7.0	OK	
P6511PG	K-8840B HYPO. AIR BLOWER	3.00	M	0.80	0.83	400	3	XLPE	95	0.73	3	2.5	1	8.6	29.0	21.1	OK	9.450	0.093	0.898	0.800	0.600	8.22	2.06	OK	130	0.05	1588	OK	7.2	47.24	0.30	0.95	22.72	5.7	OK	
P6512PG	CH-8810B TRANSFORMER RECTIFIER FOR HYPO CELL B	30.00	F	0.95	0.91	400	3	XLPE	85	0.73	4	25	1	50.1	115.0	83.7	OK	0.927	0.077	0.079	0.950	0.312	6.67	1.67	OK	220	0.05	15876	OK								
P6513PG	WSO-7861 WELDING SOCKET OUTLET	37.00	F	0.95	0.91	400	3	XLPE	40	0.73	4	25	1	61.8	115.0	83.7	OK	0.927	0.077	0.037	0.950	0.312	3.87	0.97	OK	290	0.05	15876	OK								

	OUTLET																																				
P6515PG	B-7361 ELECTRIC DRIVEN MONORAIL- 25 MT	18.50	F	0.95	0.91	400	3	XLPE	90	0.73	4	10	1	30.9	66.0	48.0	OK	2.330	0.079	0.210	0.950	0.312	10.78	2.69	OK	140	0.05	6350	OK								
	MCC-7870 (GAS TURBINE COMPRESSOR 1)																																				
P6600PG	88QGGP1B1 GG OIL PUMP MOTOR 1	22.00	M	0.85	0.91	400	3	XLPE	50	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.117	0.850	0.527	7.16	1.79	OK	250	0.05	6350	OK	7.2	294.61	0.30	0.95	19.74	4.9	OK	
P6601PG	88QGGP2B1 GG OIL PUMP MOTOR 2	22.00	M	0.85	0.91	400	3	XLPE	40	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.093	0.850	0.527	5.73	1.43	OK	250	0.05	6350	OK	7.2	294.61	0.30	0.95	15.79	3.9	OK	
P6602PG	88QP1B1 TC MAIN LUBE OIL PUMP 1	45.00	M	0.86	0.94	400	3	XLPE	40	0.73	3	25	1	80.8	115.0	83.7	OK	0.927	0.077	0.037	0.860	0.510	4.68	1.17	OK	430	0.05	15876	OK	7.2	581.59	0.30	0.95	14.15	3.5	OK	
P6603PG	88QP2B1 TC MAIN LUBE OIL PUMP 2	45.00	M	0.86	0.94	400	3	XLPE	40	0.73	3	25	1	80.8	115.0	83.7	OK	0.927	0.077	0.037	0.860	0.510	4.68	1.17	OK	430	0.05	15876	OK	7.2	581.59	0.30	0.95	14.15	3.5	OK	
P6604PG	88GTE1B1 GT ENCLOSURE VENT FAN 1	45.00	M	0.86	0.94	400	3	XLPE	40	0.73	3	25	1	80.8	115.0	83.7	OK	0.927	0.077	0.037	0.860	0.510	4.68	1.17	OK	430	0.05	15876	OK	7.2	581.59	0.30	0.95	14.15	3.5	OK	
P6605PG	88GTE2B1 GT ENCLOSURE VENT FAN 2	45.00	M	0.86	0.94	400	3	XLPE	40	0.73	3	25	1	80.8	115.0	83.7	OK	0.927	0.077	0.037	0.860	0.510	4.68	1.17	OK	430	0.05	15876	OK	7.2	581.59	0.30	0.95	14.15	3.5	OK	
P6606PG	95QSHB1 STARTER OIL TANK HEATER	2.50	F	1.00	0.95	400	3	XLPE	40	0.73	4	2.5	1	3.8	29.0	21.1	OK	9.450	0.093	0.378	1.000	0.000	2.49	0.62	OK	30	0.05	1588	OK								
P6607PG	95QGGHB1 GG OIL TANK HEATER	3.50	F	1.00	0.95	400	3	XLPE	40	0.73	4	2.5	1	5.3	29.0	21.1	OK	9.450	0.093	0.378	1.000	0.000	3.48	0.87	OK	30	0.05	1588	OK								
P6608PG	95QHB1 MAIN LUBE OIL HEATER	12.00	F	1.00	0.95	400	3	XLPE	30	0.73	4	6	1	18.2	48.0	34.9	OK	3.930	0.084	0.118	1.000	0.000	3.72	0.93	OK	60	0.05	3810	OK								
P6609PG	DB-7611 NORMAL LTG DIST. BOARD (MOD. 1)	3.40	F	0.90	0.90	400	3	XLPE	15	0.73	4	4	1	6.1	38.0	27.7	OK	5.880	0.088	0.088	0.900	0.436	0.84	0.21	OK	60	0.05	2540	OK								
P6610PG	WSO-7871 WELDING SOCKET OUTLET	37.00	F	0.95	0.91	400	3	XLPE	25	0.73	4	25	1	61.8	115.0	83.7	OK	0.927	0.077	0.023	0.950	0.312	2.42	0.60	OK	380	0.05	15876	OK								
P6611PG	WSO-7872 WELDING SOCKET OUTLET	37.00	F	0.95	0.91	400	3	XLPE	25	0.73	4	25	1	61.8	115.0	83.7	OK	0.927	0.077	0.023	0.950	0.312	2.42	0.60	OK	380	0.05	15876	OK								
P6612PG	B-7311 ELECTRIC DRIVEN MONORAIL- 20 MT	18.50	F	0.95	0.91	400	3	XLPE	40	0.73	4	10	1	30.9	66.0	48.0	OK	2.330	0.079	0.093	0.950	0.312	4.79	1.20	OK	80	0.05	6350	OK								
P6613PG	B-7312 ELECTRIC DRIVEN MONORAIL- 20 MT	18.50	F	0.95	0.91	400	3	XLPE	40	0.73	4	10	1	30.9	66.0	48.0	OK	2.330	0.079	0.093	0.950	0.312	4.79	1.20	OK	80	0.05	6350	OK								
P6614PG	HAH-5100A AIR HANDLING UNIT A- COMP. CONTROL ROOM	18.50	M	0.85	0.91	400	3	XLPE	20	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.047	0.850	0.527	2.43	0.61	OK	200	0.05	6350	OK	7.2	115.16	0.30	0.95	9.21	2.3	OK	
P6615PG	HAH-5100B AIR HANDLING UNIT B- COMP. CONTROL ROOM	18.50	M	0.85	0.91	400	3	XLPE	20	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.047	0.850	0.527	2.43	0.61	OK	200	0.05	6350	OK	7.2	115.16	0.30	0.95	9.21	2.3	OK	
P6616PG	HHW-5100 ELECTRIC DUCT HEATER- COMP. CONTROL ROOM	10.00	F	1.00	0.95	400	3	XLPE	15	0.73	4	6	1	15.2	48.0	34.9	OK	3.930	0.084	0.059	1.000	0.000	1.55	0.39	OK	60	0.05	3810	OK								
P6617PG	HPF-5100A PRESSURIZATION FAN A- COMP. CONTROL ROOM	5.50	M	0.80	0.87	400	3	XLPE	20	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.118	0.800	0.600	1.88	0.47	OK	90	0.05	2540	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6618PG	HPF-5100B PRESSURIZATION FAN B- COMP. CONTROL ROOM	5.50	M	0.80	0.87	400	3	XLPE	20	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.118	0.800	0.600	1.88	0.47	OK	90	0.05	2540	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6619PG	HEF-5100A EXHAUST FAN A (BATTERY ROOM)- COMP CONTROL ROOM	0.25	M	0.80	0.66	400	3	XLPE	20	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.189	0.800	0.600	0.18	0.05	OK	50	0.05	1588	OK	7.2	4.92	0.30	0.95	0.50	0.1	OK	
P6620PG	HEF-5100B EXHAUST FAN B (BATTERY ROOM)- COMP CONTROL ROOM	0.25	M	0.80	0.66	400	3	XLPE	20	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.189	0.800	0.600	0.18	0.05	OK	50	0.05	1588	OK	7.2	4.92	0.30	0.95	0.50	0.1	OK	
P6621PG	CK-5100A-A COMPRESSOR A ACCU #1	18.50	M	0.85	0.91	400	3	XLPE	20	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.047	0.850	0.527	2.43	0.61	OK	210	0.05	6350	OK	7.2	249.38	0.30	0.95	6.68	1.7	OK	
P6622PG	CF-5100A-A CONDENSING FAN A ACCU #1	11.00	M	0.85	0.90	400	3	XLPE	20	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.079	0.850	0.527	2.45	0.61	OK	110	0.05	3810	OK	7.2	150.27	0.30	0.95	6.55	1.6	OK	
P6623PG	CK-5100B-A COMPRESSOR A ACCU #2	18.50	M	0.85	0.91	400	3	XLPE	20	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.047	0.850	0.527	2.43	0.61	OK	210	0.05	6350	OK	7.2	249.38	0.30	0.95	6.68	1.7	OK	
P6624PG	CF-5100B-A CONDENSING FAN A ACCU #2	11.00	M	0.85	0.90	400	3	XLPE	20	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.079	0.850	0.527	2.45	0.61	OK	110	0.05	3810	OK	7.2	150.27	0.30	0.95	6.55	1.6	OK	
	MCC-7880 (GAS TURBINE COMPRESOR 2)																																				
P6700PG	88QGGP1B2 GG OIL PUMP MOTOR 1	22.00	M	0.85	0.91	400	3	XLPE	40	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.093	0.850	0.527	5.73	1.43	OK	250	0.05	6350	OK	7.2	294.61	0.30	0.95	15.79	3.9	OK	
P6701PG	88QGGP2B2 GG OIL PUMP MOTOR 2	22.00	M	0.85	0.91	400	3	XLPE	40	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.093	0.850	0.527	5.73	1.43	OK	250	0.05	6350	OK	7.2	294.61	0.30	0.95	15.79	3.9	OK	
P6702PG	88QP1B2 TC MAIN LUBE OIL PUMP 1	45.00	M	0.86	0.94	400	3	XLPE	40	0.73	3	25	1	80.8	115.0	83.7	OK	0.927	0.077	0.037	0.860	0.510	4.68	1.17	OK	430	0.05	15876	OK	7.2	581.59	0.30	0.95	14.15	3.5	OK	
P6703PG	88QP2B2 TC MAIN LUBE OIL PUMP 2	45.00	M	0.86	0.94	400	3	XLPE	40	0.73	3	25	1	80.8	115.0	83.7	OK	0.927	0.077	0.037	0.860	0.510	4.68	1.17	OK	430	0.05	15876	OK	7.2	581.59	0.30	0.95	14.15	3.5	OK	
P6704PG	88GTE1B2 GT ENCLOSURE VENT FAN 1	45.00	M	0.86	0.94	400	3	XLPE	40	0.73	3	25	1	80.8	115.0	83.7	OK	0.927	0.077	0.037	0.860	0.510	4.68	1.17	OK	430	0.05	15876	OK	7.2	581.59	0.30	0.95	14.15	3.5	OK	
P6705PG	88GTE2B2 GT ENCLOSURE VENT FAN 2	45.00	M	0.86	0.94	400	3	XLPE	40	0.73	3	25	1	80.8	115.0	83.7	OK	0.927	0.077	0.037	0.860	0.510	4.68	1.17	OK	430	0.05	15876	OK	7.2	581.59	0.30	0.95	14.15	3.5	OK	
P6706PG	95QSHB2 STARTER OIL TANK HEATER	2.50	F	1.00	0.95	400	3	XLPE	40	0.73	4	2.5	1	3.8	29.0	21.1	OK	9.450	0.093	0.378	1.000	0.000	2.49	0.62	OK	30	0.05	1588	OK								
P6707PG	95QGGHB GG OIL TANK HEATER	3.50	F	1.00	0.95	400	3	XLPE	40	0.73	4	2.5	1	5.3	29.0	21.1	OK	9.450	0.093	0.378	1.000	0.000	3.48	0.87	OK	30	0.05	1588	OK								

P6709PG	DB-7821 NORMAL LIGHTING DISTRIBUTION BOARD (MOD 2)	2.40	F	0.90	0.90	400	3	XLPE	60	0.73	4	2.5	1	4.3	29.0	21.1	OK	9.450	0.093	0.567	0.900	0.436	3.80	0.95	OK	60	0.05	1588	OK								
P6710PG	WSO 7881 WELDING SOCKET OUTLET	37.00	F	0.95	0.91	400	3	XLPE	45	0.73	4	25	1	61.8	115.0	83.7	OK	0.927	0.077	0.042	0.950	0.312	4.36	1.09	OK	360	0.05	15876	OK								
P6711PG	WSO 7882 WELDING SOCKET OUTLET	37.00	F	0.95	0.91	400	3	XLPE	45	0.73	4	25	1	61.8	115.0	83.7	OK	0.927	0.077	0.042	0.950	0.312	4.36	1.09	OK	360	0.05	15876	OK								
P6712PG	B-7311 ELECTRIC DRIVEN MONORAIL- 20 MT	18.50	F	0.95	0.91	400	3	XLPE	45	0.73	4	10	1	30.9	66.0	48.0	OK	2.330	0.079	0.105	0.950	0.312	5.39	1.35	OK	80	0.05	6350	OK								
P6713PG	B-7312 ELECTRIC DRIVEN MONORAIL- 20 MT	18.50	F	0.95	0.91	400	3	XLPE	45	0.73	4	10	1	30.9	66.0	48.0	OK	2.330	0.079	0.105	0.950	0.312	5.39	1.35	OK	80	0.05	6350	OK								
P6714PG	HAH-5200A AIR HANDLING UNIT FAN A- COMP. CONTROL ROOM	18.50	M	0.85	0.91	400	3	XLPE	20	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.047	0.850	0.527	2.43	0.61	OK	200	0.05	6350	OK	7.2	115.16	0.30	0.95	9.21	2.3	OK	
P6715PG	HAH-5200B AIR HANDLING UNIT FAN B- COMP CONTROL ROOM	18.50	M	0.85	0.91	400	3	XLPE	20	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.047	0.850	0.527	2.43	0.61	OK	200	0.05	6350	OK	7.2	115.16	0.30	0.95	9.21	2.3	OK	
P6716PG	HHW-5200 ELECTRIC DUCT HEATER- COMP CONTROL ROOM	10.00	F	1.00	0.95	400	3	XLPE	15	0.73	4	6	1	15.2	48.0	34.9	OK	3.930	0.084	0.059	1.000	0.000	1.55	0.39	OK	60	0.05	3810	OK								
P6717PG	HPF-5200A PRESSURIZATION FAN A- COMP. CONTROL ROOM	5.50	M	0.80	0.87	400	3	XLPE	20	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.118	0.800	0.600	1.88	0.47	OK	90	0.05	2540	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6718PG	HPF-5200B PRESSURIZATION FAN B- COMP CONTROL ROOM	5.50	M	0.80	0.87	400	3	XLPE	20	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.118	0.800	0.600	1.88	0.47	OK	90	0.05	2540	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6719PG	HEF-5200A EXHAUST FAN (BATTERY ROOM)- COMP CONTROL ROOM	0.25	M	0.80	0.66	400	3	XLPE	20	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.189	0.800	0.600	0.18	0.05	OK	50	0.05	1588	OK	7.2	4.92	0.30	0.95	0.50	0.1	OK	
P6720PG	HEF-5200B EXHAUST FAN (BATTERY ROOM)- COMP. CONTROL ROOM	0.25	M	0.80	0.66	400	3	XLPE	20	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.189	0.800	0.600	0.18	0.05	OK	50	0.05	1588	OK	7.2	4.92	0.30	0.95	0.50	0.1	OK	
P6721PG	CK-5200A-A COMPRESSOR A HVAC #1	18.50	M	0.85	0.91	400	3	XLPE	20	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.047	0.850	0.527	2.43	0.61	OK	210	0.05	6350	OK								
P6722PG	CF-5200A-A CONDENSING FAN A HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	20	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.079	0.850	0.527	2.45	0.61	OK	110	0.05	3810	OK								
P6723PG	CK-5200B-A COMPRESSOR A HVAC #2	18.50	M	0.85	0.91	400	3	XLPE	20	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.047	0.850	0.527	2.43	0.61	OK	210	0.05	6350	OK								
P6724PG	CF-5200B-A CONDENSING FAN A HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	20	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.079	0.850	0.527	2.45	0.61	OK	110	0.05	3810	OK								
	MCC-7820 (LQ LOAD)																																				
P6100PG	HSS-7866 HELICOPTER STARTER SOCKET OUTLET	10.00	F	0.95	0.91	400	3	XLPE	55	0.73	4	6	1	16.7	48.0	34.9	OK	3.930	0.084	0.216	0.950	0.312	5.98	1.49	OK	1370	0.05	3810	OK								
P6101PG	NLV-8200 SURVIVAL CRAFT NO.1	11.00	F	0.95	0.91	400	3	XLPE	40	0.73	4	6	1	18.4	48.0	34.9	OK	3.930	0.084	0.157	0.950	0.312	4.78	1.20	OK	1260	0.05	3810	OK								
P6102PG	NLV-8210 SURVIVAL CRAFT NO.2	11.00	F	0.95	0.91	400	3	XLPE	40	0.73	4	6	1	18.4	48.0	34.9	OK	3.930	0.084	0.157	0.950	0.312	4.78	1.20	OK	1260	0.05	3810	OK								
P6103PG	NLV-8220 SURVIVAL CRAFT NO.3	11.00	F	0.95	0.91	400	3	XLPE	50	0.73	4	6	1	18.4	48.0	34.9	OK	3.930	0.084	0.197	0.950	0.312	5.98	1.49	OK	1260	0.05	3810	OK								
P6104PG	DB-7872A EMERGENCY LIGHTING DB MAIN DECK	3.00	F	0.90	0.90	400	3	XLPE	45	0.73	4	10	1	5.3	66.0	48.0	OK	2.330	0.079	0.105	0.900	0.436	0.89	0.22	OK	680	0.05	6350	OK								
P6105PG	DB-7872B EMERGENCY LIGHTING DB LEVEL 1	3.60	F	0.90	0.90	400	3	XLPE	30	0.73	4	10	1	6.4	66.0	48.0	OK	2.330	0.079	0.070	0.900	0.436	0.71	0.18	OK	1020	0.05	6350	OK								
P6106PG	DB-7872C EMERGENCY LIGHTING DB LEVEL 2	3.70	F	0.90	0.90	400	3	XLPE	45	0.73	4	10	1	6.6	66.0	48.0	OK	2.330	0.079	0.105	0.900	0.436	1.10	0.27	OK	680	0.05	6350	OK								
P6107PG	DB-7872D EMERGENCY LIGHTING DB LEVEL 3	2.20	F	0.90	0.90	400	3	XLPE	45	0.73	4	10	1	3.9	66.0	48.0	OK	2.330	0.079	0.105	0.900	0.436	0.65	0.16	OK	680	0.05	6350	OK								
P6108PG	DB-7872E EMERGENCY LIGHTING DB LEVEL 4	3.30	F	0.90	0.90	400	3	XLPE	50	0.73	4	10	1	5.9	66.0	48.0	OK	2.330	0.079	0.117	0.900	0.436	1.09	0.27	OK	770	0.05	6350	OK								
P6109PG	DB-7875A SMALL POWER DB-KITCHEN	9.50	F	0.95	0.91	400	3	XLPE	45	0.73	4	16	1	15.9	88.0	64.1	OK	1.470	0.076	0.066	0.950	0.312	1.76	0.44	OK	8390	0.05	10161	OK								
P6110PG	HAH-5020A AIR HANDLING UNIT FAN A - LEVEL2	18.50	M	0.85	0.91	400	3	XLPE	40	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.093	0.850	0.527	4.85	1.21	OK	3090	0.05	6350	OK	7.2	249.38	0.30	0.95	13.37	3.3	OK	
P6111PG	HAH-5020B AIR HANDLING UNIT FAN B - LEVEL2	18.50	M	0.85	0.91	400	3	XLPE	40	0.73	3	10	1	34.6	66.0	48.0	OK	2.330	0.079	0.093	0.850	0.527	4.85	1.21	OK	3090	0.05	6350	OK	7.2	249.38	0.30	0.95	13.37	3.3	OK	
P6112PG	HHW-5020 ELECTRIC DUCT HEATER- LEVEL 2	12.00	F	1.00	0.95	400	3	XLPE	40	0.73	4	6	1	18.2	48.0	34.9	OK	3.930	0.084	0.157	1.000	0.000	4.96	1.24	OK	1870	0.05	3810	OK								
P6113PG	HPF-5020A PRESSURIZATION FAN A- LEVEL 2	5.50	M	0.80	0.87	400	3	XLPE	40	0.73	3	2.5	1	11.4	29.0	21.1	OK	9.450	0.093	0.378	0.800	0.600	6.02	1.50	OK	780	0.05	1588	OK	7.2	82.12	0.30	0.95	16.63	4.2	OK	
P6114PG	HPF-5020B PRESSURIZATION FAN B- LEVEL 2	5.50	M	0.80	0.87	400	3	XLPE	40	0.73	3	2.5	1	11.4	29.0	21.1	OK	9.450	0.093	0.378	0.800	0.600	6.02	1.50	OK	780	0.05	1588	OK	7.2	82.12	0.30	0.95	16.63	4.2	OK	
P6115PG	HEF-5020A EXHAUST FAN A-LEVEL 2	0.25	M	0.80	0.66	400	3	XLPE	40	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.378	0.800	0.600	0.36	0.09	OK	770	0.05	1588	OK	7.2	4.92	0.30	0.95	1.00	0.2	OK	
P6116PG	HEF-5020B EXHAUST FAN B-LEVEL 2	0.25	M	0.80	0.66	400	3	XLPE	40	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.378	0.800	0.600	0.36	0.09	OK	770	0.05	1588	OK	7.2	4.92	0.30	0.95	1.00	0.2	OK	
P6117PG	CK-5020A-A COMPRESSOR A HVAC #1	22.00	M	0.85	0.91	400	3	XLPE	40	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.093	0.850	0.527	5.73	1.43	OK	3180	0.05	6350	OK	7.2	294.61	0.30	0.95	15.79	3.9	OK	
P6118PG	CK-5020A-B COMPRESSOR B HVAC #1	22.00	M	0.85	0.91	400	3	XLPE	40	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.093	0.850	0.527	5.73	1.43	OK	3180	0.05	6350	OK	7.2	294.61	0.30	0.95	15.79	3.9	OK	
P6119PG	CF-5020A-A CONDENSING FAN A HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	40	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.157	0.850	0.527	4.89	1.22	OK	1240	0.05	3810	OK	7.2	150.27	0.30	0.95	13.10	3.3	OK	
P6120PG	CF-5020A-B CONDENSING FAN B HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	40	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.157	0.850	0.527	4.89	1.22	OK	1240	0.05	3810	OK	7.2	150.27	0.30	0.95	13.10	3.3	OK	
P6121PG	CK-5020B-A COMPRESSOR A HVAC #2	22.00	M	0.85	0.91	400	3	XLPE	40	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.093	0.850	0.527	5.73	1.43	OK	3180	0.05	6350	OK	7.2	294.61	0.30	0.95	15.79	3.9	OK	

P6123PG	CF-5020B-A CONDENSING FAN A HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	40	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.157	0.850	0.527	4.89	1.22	OK	1240	0.05	3810	OK	7.2	150.27	0.30	0.95	13.10	3.3	OK	
P6124PG	CF-5020B-B CONDENSING FAN B HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	40	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.157	0.850	0.527	4.89	1.22	OK	1240	0.05	3810	OK	7.2	150.27	0.30	0.95	13.10	3.3	OK	
P6125PG	HAH-5010-A AIR HANDLING UNIT FAN A-LEVEL 1	22.00	M	0.85	0.91	400	3	XLPE	45	0.73	3	10	1	40.9	66.0	48.0	OK	2.330	0.079	0.105	0.850	0.527	6.45	1.61	OK	2780	0.05	6350	OK	7.2	294.61	0.30	0.95	17.76	4.4	OK	
P6126PG	HAH-5010-B AIR HANDLING UNIT FAN B-LEVEL 1	22.00	M	0.85	0.91	400	3	XLPE	45	0.73	3	10	1	40.9	68.0	48.0	OK	2.330	0.079	0.105	0.850	0.527	6.45	1.61	OK	2780	0.05	6350	OK	7.2	294.61	0.30	0.95	17.76	4.4	OK	
P6127PG	HHW-5010 ELECTRIC DUCT HEATER- LEVEL 1	12.00	F	1.00	0.95	400	3	XLPE	45	0.73	4	6	1	18.2	48.0	34.9	OK	3.930	0.084	0.177	1.000	0.000	5.58	1.40	OK	1670	0.05	3810	OK								
P6128PG	HPF-5010A PRESSURIZATION FAN A- LEVEL 1	2.20	M	0.80	0.81	400	3	XLPE	70	0.73	3	2.5	1	4.9	29.0	21.1	OK	9.450	0.093	0.662	0.800	0.600	4.52	1.13	OK	450	0.05	1588	OK	7.2	35.28	0.30	0.95	12.51	3.1	OK	
P6129PG	HPF-5010B PRESSURIZATION FAN B- LEVEL 1	2.20	M	0.80	0.81	400	3	XLPE	90	0.73	3	2.5	1	4.9	29.0	21.1	OK	9.450	0.093	0.851	0.800	0.600	5.82	1.45	OK	450	0.05	1588	OK	7.2	35.28	0.30	0.95	16.08	4.0	OK	
P6130PG	HEF-5010A KITCHEN HOOD EXHAUST- LEVEL 1	1.10	M	0.80	0.77	400	3	XLPE	45	0.73	3	2.5	1	2.6	29.0	21.1	OK	9.450	0.093	0.425	0.800	0.600	1.53	0.38	OK	690	0.05	1588	OK	7.2	18.56	0.30	0.95	4.23	1.1	OK	
P6131PG	HSF-5010B DRYER SUPPLY FAN (LAUNDRY)- LEVEL 1	0.37	M	0.80	0.68	400	3	XLPE	45	0.73	3	2.5	1	1.0	29.0	21.1	OK	9.450	0.093	0.425	0.800	0.600	0.58	0.15	OK	680	0.05	1588	OK	7.2	7.07	0.30	0.95	1.61	0.4	OK	
P6132PG	HEF-5010C LAUNDRY ROOM EXHAUST FAN- LEVEL 1	0.55	M	0.80	0.73	400	3	XLPE	45	0.73	3	2.5	1	1.4	29.0	21.1	OK	9.450	0.093	0.425	0.800	0.600	0.81	0.20	OK	680	0.05	1588	OK	7.2	9.79	0.30	0.95	2.23	0.6	OK	
P6133PG	HEF-5010D DRYER EXHAUST FAN (ALUNDRY)- LEVEL 1	0.25	M	0.80	0.66	400	3	XLPE	45	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.425	0.800	0.600	0.41	0.10	OK	680	0.05	1588	OK	7.2	4.92	0.30	0.95	1.12	0.3	OK	
P6134PG	HEF-5010E SMOKE ROOM EXHAUST FAN- LEVEL 1	0.25	M	0.80	0.66	400	3	XLPE	45	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.425	0.800	0.600	0.41	0.10	OK	680	0.05	1588	OK	7.2	4.92	0.30	0.95	1.12	0.3	OK	
P6135PG	CK-5010A-A COMPRESSOR A HVAC #1	30.00	M	0.85	0.92	400	3	XLPE	45	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.042	0.850	0.527	3.58	0.89	OK	4330	0.05	15876	OK	7.2	398.68	0.30	0.95	10.91	2.7	OK	
P6136PG	CK-5010A-B COMPRESSOR B HVAC #1	30.00	M	0.85	0.92	400	3	XLPE	45	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.042	0.850	0.527	3.58	0.89	OK	4330	0.05	15876	OK	7.2	398.68	0.30	0.95	10.91	2.7	OK	
P6137PG	CF-5010A-A CONDENSING FAN A HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	45	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.177	0.850	0.527	5.51	1.38	OK	1650	0.05	3810	OK	7.2	150.27	0.30	0.95	14.74	3.7	OK	
P6138PG	CF-5010A-B CONDENSING FAN B HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	45	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.177	0.850	0.527	5.51	1.38	OK	1650	0.05	3810	OK	7.2	150.27	0.30	0.95	14.74	3.7	OK	
P6139PG	CK-5010B-A COMPRESSOR A HVAC #1	30.00	M	0.85	0.92	400	3	XLPE	45	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.042	0.850	0.527	3.58	0.89	OK	4330	0.05	15876	OK	7.2	398.68	0.30	0.95	10.91	2.7	OK	
P6140PG	CK-5010B-B COMPRESSOR B HVAC #1	30.00	M	0.85	0.92	400	3	XLPE	45	0.73	3	25	1	55.4	115.0	83.7	OK	0.927	0.077	0.042	0.850	0.527	3.58	0.89	OK	4330	0.05	15876	OK	7.2	398.68	0.30	0.95	10.91	2.7	OK	
P6141PG	CF-5010B-A CONDENSING FAN A HVAC #1	11.00	M	0.85	0.90	400	3	XLPE	45	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.177	0.850	0.527	5.51	1.38	OK	1650	0.05	3810	OK	7.2	150.27	0.30	0.95	14.74	3.7	OK	
P6142PG	CF-5010B-B CONDENSING FAN B HVAC #2	11.00	M	0.85	0.90	400	3	XLPE	45	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.177	0.850	0.527	5.51	1.38	OK	1650	0.05	3810	OK	7.2	150.27	0.30	0.95	14.74	3.7	OK	
P6143PG	HPF-5030A PRESSURISATION FAN A- LEVEL 3	5.50	M	0.80	0.87	400	3	XLPE	45	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.265	0.800	0.600	4.23	1.06	OK	1100	0.05	2540	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6144PG	HPF-5030B PRESSURISATION FAN B- LEVEL 3	5.50	M	0.80	0.87	400	3	XLPE	45	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.265	0.800	0.600	4.23	1.06	OK	1100	0.05	2540	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6145PG	HPF-5040A PRESSURIZATION FAN A- LEVEL 4	5.50	M	0.80	0.87	400	3	XLPE	50	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.294	0.800	0.600	4.70	1.17	OK	1000	0.05	2540	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6146PG	HPF-5040B PRESSURIZATION FAN B- LEVEL 4	5.50	M	0.80	0.87	400	3	XLPE	50	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.294	0.800	0.600	4.70	1.17	OK	1000	0.05	2540	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6147PG	HPF-5000A PRESSURISATION FAN A- MAIN DECK	5.50	M	0.80	0.87	400	3	XLPE	75	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.441	0.800	0.600	7.05	1.76	OK	670	0.05	2540	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6148PG	HPF-5000B PRESSURISATION FAN B- MAIN DECK	5.50	M	0.80	0.87	400	3	XLPE	75	0.73	3	4	1	11.4	38.0	27.7	OK	5.880	0.088	0.441	0.800	0.600	7.05	1.76	OK	670	0.05	2540	OK	7.2	23.03	0.30	0.95	5.77	1.4	OK	
P6149PG	DB-7875B SMALL POWER DB-KITCHEN	17.07	F	0.95	0.91	400	3	XLPE	45	0.73	4	16	1	28.5	88.0	64.1	OK	1.470	0.076	0.068	0.950	0.312	3.15	0.79	OK	8390	0.05	10161	OK								
	MCC-7660																																				
P6400PG	P-6870 COOLING WATER SYS. BATCH COR. INHIBITOR INJECTION PUMP	0.25	M	0.80	0.66	400	3	XLPE	85	0.73	3	2.5	1	0.7	29.0	21.1	OK	9.450	0.093	0.803	0.800	0.600	0.77	0.19	OK	370	0.05	1588	OK	7.2	4.92	0.30	0.95	2.12	0.5	OK	
P6401PG	P-5610A HEATING MEDIUM CIRC PUMP A	110.00	M	0.86	0.95	400	3	XLPE	70	0.73	3	120	1	193.9	300.0	218.4	OK	0.196	0.071	0.015	0.860	0.510	4.81	1.20	OK	14490	0.05	76205	OK	7.2	1396.27	0.30	0.95	21.29	5.3	OK	
P6402PG	P-5280A WASH WATER PUMP A	11.00	M	0.85	0.90	400	3	XLPE	60	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.236	0.850	0.527	7.34	1.84	OK	1260	0.05	3810	OK	7.2	150.27	0.30	0.95	19.65	4.9	OK	
P6403PG	P-8830A HYPO. DOSING PUMP A	11.00	M	0.85	0.90	400	3	XLPE	60	0.73	3	6	1	20.9	48.0	34.9	OK	3.930	0.084	0.236	0.850	0.527	7.34	1.84	OK	1270	0.05	3810	OK	7.2	150.27	0.30	0.95	19.65	4.9	OK	
P6404PG	K-8840A HYPO. AIR BLOWER	3.00	M	0.80	0.83	400	3	XLPE	60	0.73	3	2.5	1	6.6	29.0	21.1	OK	9.450	0.093	0.587	0.800	0.600	5.19	1.30	OK	520	0.05	1588	OK	7.2	47.24	0.30	0.95	14.35	3.6	OK	
P6405PG	P-6430A CLOSED DRAIN TRANS PUMP A	15.00	M	0.85	0.90	400	3	XLPE	100	0.73	3	10	1	28.3	66.0	48.0	OK	2.330	0.079	0.233	0.850	0.527	9.91	2.48	OK	1260	0.05	6350	OK	7.2	205.77	0.30	0.95	27.30	6.8	OK	
P6406PG	P-6460 CLOSED DRAIN CAISSON PUMP	0.75	M	0.80	0.75	400	3	XLPE	155	0.73	3	2.5	1	1.8	29.0	21.1	OK	9.450	0.093	1.465	0.800	0.600	3.69	0.92	OK	200	0.05	1588	OK	7.2	12.99	0.30	0.95	10.20	2.5	OK	
P6407PG	P-6520 OPEN DRAIN CAISSON PUMP	0.75	M	0.80	0.75	400	3	XLPE	140	0.73	3	2.5	1	1.8	29.0	21.1	OK	9.450	0.093	1.323	0.800	0.600	3.33	0.83	OK	220	0.05	1588	OK	7.2	12.99	0.30	0.95	9.21	2.3	OK	
P6408PG	E-6300 HP FLARE K.O DRUM HEATER	50.00	F	1.00	0.95	400	3	XLPE	110	0.73	4	35	1	76.0	141.0	102.6	OK	0.669	0.074	0.074	1.000	0.000	9.68	2.42	OK	4810	0.05	22227	OK								
P6409PG	UPS-7850B AC UPS BYPASS SUPPLY ISOLATION TRANSFORMER	100.00	F	0.95	0.91	400	3	XLPE	65	0.73	4	95	1	167.0	263.0	191.5	OK	0.247	0.071	0.017	0.950	0.312	4.83	1.21	OK	14400	0.05	60329	OK								

P6410PG	BYPASS SUPPLY ISOLATION TRANSFORMER																																				
P6411PG	DB-7831 NORMAL LTG DIST. BOARD (MOD. 3)	9.40	F	0.90	0.90	400	3	XLPE	80	0.73	4	10	1	16.8	66.0	48.0	OK	2.330	0.079	0.187	0.900	0.436	4.95	1.24	OK	640	0.05	6350	OK								
P6412PG	DB-7841 NORMAL LTG DIST. BOARD (MOD. 4)	10.00	F	0.90	0.90	400	3	XLPE	75	0.73	4	10	1	17.8	66.0	48.0	OK	2.330	0.079	0.175	0.900	0.436	4.93	1.23	OK	680	0.05	6350	OK								
P6413PG	DB-7851 NORMAL LTG DIST. BOARD (MOD. 5)	10.40	F	0.90	0.90	400	3	XLPE	65	0.73	4	10	1	18.5	66.0	48.0	OK	2.330	0.079	0.152	0.900	0.436	4.45	1.11	OK	760	0.05	6350	OK								
P6414PG	DB-7861 OUTDOOR NORMAL LTG DIST. BOARD (MOD. 6)	6.80	F	0.90	0.90	400	3	XLPE	30	0.73	4	10	1	12.1	66.0	48.0	OK	2.330	0.079	0.070	0.900	0.436	1.34	0.34	OK	1020	0.05	6350	OK								
P6415PG	DB-7863 INDOOR NORMAL LTG DIST. BOARD (MOD. 6)	8.70	F	0.90	0.90	400	3	XLPE	30	0.73	4	10	1	15.5	66.0	48.0	OK	2.330	0.079	0.070	0.900	0.436	1.72	0.43	OK	1020	0.05	6350	OK								
P6416PG	DB-7881A NORMAL LTG DIST. BOARD (MSF)	11.50	F	0.90	0.90	400	3	XLPE	75	0.73	4	10	1	20.5	66.0	48.0	OK	2.330	0.079	0.175	0.900	0.436	5.67	1.42	OK	1020	0.05	6350	OK								
P6417PG	DB-7881B NORMAL LTG DIST. BOARD (MSF)	15.00	F	0.80	0.90	400	3	XLPE	80	0.73	4	10	1	26.7	66.0	48.0	OK	2.330	0.079	0.187	0.900	0.436	7.89	1.97	OK	1580	0.05	6350	OK								
P6418PG	WSO-7841 WELDING SOCKET OUTLET	37.00	F	0.95	0.91	400	3	XLPE	80	0.73	4	25	2	61.8	230.0	167.4	OK	0.927	0.077	0.074	0.950	0.312	3.87	0.97	OK	1580	0.05	15876	OK								
P6419PG	WSO-7842 WELDING SOCKET OUTLET	37.00	F	0.95	0.91	400	3	XLPE	80	0.73	4	25	2	61.8	230.0	167.4	OK	0.927	0.077	0.074	0.950	0.312	3.87	0.97	OK	1580	0.05	15876	OK								
P6420PG	CH-8810A TRANSFORMER RECTIFIER FOR HYPO. CELL A	30.00	F	0.95	0.91	400	3	XLPE	60	0.73	4	25	1	50.1	115.0	83.7	OK	0.927	0.077	0.056	0.950	0.312	4.71	1.18	OK	3240	0.05	15876	OK								

		Prepared By	Checked By	Approved By
Project Title TBCP-A	Initial	SMD	MRAB	MRAR
	Date	06/07/07		
	Revision	B		

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VOLTAGE DROP AND CABLE SIZING CALCULATIONS

APPENDIX 2 : CURRENT CARRYING CAPACITY OF XLPE CABLE

Fujikura XLPE Cables

Current Carrying Capacity
XLPE Insulated 600/1000V

50 Hz

Cable	In air at 40°C			In ground at 25°C			SC kA	R	X
Size	1-core	2-core	3 / 4 core	1-core	2-core	3 / 4 core	(1 s)	ohm/km	ohm/km
	A	A	A	A	A	A			
2.5	36	34	29	44	46	37	0.36	9.45	0.0932
4	47	45	38	56	58	49	0.57	5.88	0.0875
6	61	57	48	70	75	61	0.85	3.93	0.0837
10	85	79	66	94	98	81	1.42	2.33	0.0785
16	113	105	88	120	125	100	2.27	1.47	0.0761
25	150	140	115	155	165	135	3.55	0.927	0.0758
35	181	168	141	190	197	162	4.97	0.669	0.0743
50	265	215	178	250	240	200	7.10	0.494	0.0729
70	290	265	220	270	290	240	9.94	0.342	0.0726
95	347	316	263	320	345	285	13.50	0.247	0.0708
120	410	370	300	370	380	325	17.00	0.196	0.0705
150	470	430	350	420	450	370	21.30	0.160	0.0709
185	530	485	409	465	500	410	26.30	0.128	0.0712
240	640	570	480	550	580	480	34.10	0.0987	0.0703
300	725	680	574	615	650	536	42.60	0.0799	0.0697
400	845	780	670	740	780	640	56.80	0.0640	0.0694
500	980	-	-	810	-	-	71.00	0.0525	0.0290
630	1150	-	-	945	-	-	89.5	0.0420	0.0860

Fujikura XLPE Cables

Current Carrying Capacity
XLPE Insulated 6/10KV

50 Hz

Cable	In air at 40°C			In ground at 25°C			SC kA	R	X
Size	1-core (trefoil)	1-core(flat)	3 core	1-core	2-core	3 / 4 core	(1 s)	ohm/km	ohm/km
	A	A	A	A	A	A			
25			145				3.58	0.927	0.1240
35			175				4.97	0.668	0.1160
50	235	295	220				7.10	0.493	0.1110
70	285	370	270				9.94	0.342	0.1060
95	360	455	330				13.59	0.247	0.1000
120	415	520	375				17.00	0.196	0.0970
150	470	600	430				21.30	0.159	0.0940
185	540	690	490				26.30	0.128	0.0920
240	640	820	570				34.10	0.0984	0.0890
300	740	940	650				42.60	0.0797	0.0860
400	840	1100	740				56.20	0.0639	0.0830
500	940	1280	-				71.00		
630	1110	1500	-				89.5		

TED GENERATOR PERFORMANCE VALUES

7-5000 SOLID ROTOR								
	KVA	PF	TAMB	TRISE	POLES	RPM	SLOTS	HZ
0.	8125.	0.8	40	80	4	1500	60	50
-PH	VOLTS-LL	AMPS-PH	AMPS-LN	BASE Z	025	026	PHASE/CONNECTION	
11	6600	710.8	710.8	5.361	00033SR1	00022	3 PHASE WYE	

PER UNIT PITCH

ANCES		SAT	UNSAT		HI POT VALUES	VOLTS	
HRONOUS					STATOR	14200	
ECT AXIS	Xd	138.9	176.5		ROTOR	1500	
DRATURE AXIS	Xq	76.3	102.7		EXCITER FIELD	1500	
SIENT					EXCITER ARM	1500	
ECT AXIS	X'd	22.3	25.4				
DRATURE AXIS	X'q	76.3	102.7		MOTOR STARTING	0 P.F.	
RANSIENT						INRUSH	%VOLT
ECT AXIS	X"d	14.6	17.2		SKVA AT GENERATOR	SKVA	DIP
DRATURE AXIS	X"q	14.0	16.5		TERMINALS	3560.3	10
TIVE SEQUENCE	X2	14.3	16.8			5654.6	15
SEQUENCE	X0	1.7	2.0			8010.7	20
AGE REACTANCE	XL	7.527	8.553			10681.0	25
						13732.7	30
TANCES @ 25C -	RDCa	0.01463					
	RDCf	0.4410					

VOLTAGE DIP AT RATED P.F. = 14.7%
XID= 25.4% FOR DIP CALCULATION.

CONSTANTS (SECONDS)		
IS 3-PH S.C. TRANSIENT	T'd3	0.946
IS O.C. TRANSIENT	T'd0	5.609
IS 3-PH S.C. SUB-TRANS	T"d3	0.037
IS O.C. SUB-TRANS	T"d0	0.056
CKT (ASYMMETRICAL S.C.)	TA	0.555

TRANSIENT TORQUES				KW		HEAT REJ
	TORQUE	MAX TORQUE		@0.8P.F.	%EFF	BTU/HR
ITION	P.U.	FT-LBS				
S.C.	6.9	261389	FL	6500.0	97.4	587847
S.C.	9.0	342961	3/4L	4875.0	97.2	485076
			1/2L	3250.0	96.4	408905
			1/4L	1625.0	93.9	358618

IENCY CALCULATED AT 95.0C

ORT CUIT RENT	INSTANTANEOUS SYMMETRICAL FAULT CURRENT		INSTANTANEOUS ASYMMETRICAL FAULT CURRENT	
	P.U.	AMPS	P.U.	AMPS
	6.86	4875	11.88	8445
	6.00	4265	10.39	7387
	9.80	6968	16.98	12070

PEED: 1875.0 RPM FOR 1 MINUTE. MINIMUM 3 PHASE MOTORING POWER: 650.00 KW

	FULL LOAD	NO LOAD
H COEFF	14680KW/RAD	7730KW/RAD

LACEMENT ANGLE: 27.3 DEGREES

BY____________________

ATA CAN BE TRANSFERRED TO CUSTOMER DATA SHEETS WHEN APPLICABLE

TED GENERATOR PERFORMANCE VALUES

7-5000 SOLID ROTOR								
	KVA	**PF**	**TAMB**	**TRISE**	**POLES**	**RPM**	**SLOTS**	**HZ**
0.	8125.	0.8	40	80	4	1500	60	50
-PH	**VOLTS-LL**	**AMPS-PH**	**AMPS-LN**	**BASE Z**	**025**	**026**	**PHASE/CONNECTION**	
.1	6600	710.8	710.8	5.361	00033SR1	00022	3 PHASE WYE	

IG: DEV

ONSTANTS (SECONDS)

S L-N S.C. TRANSIENT	TID2	1.068
S L-L S.C. TRANSIENT	TID1	1.108
S 3-PH S.C. TRANSIENT	TIQ3	1.122
S O.C. TRANSIENT	TIQ0	1.122
S L-N S.C. SUB-TRANS	TIID2	0.044
S L-L S.C. SUB-TRANS	TIID1	0.045
S 3-PH S.C. SUB-TRANS	TIIQ3	0.004
S O.C. SUB-TRANS	TIIQ0	0.028

LLANEOUS CALCULATIONS

CAPACITANCE-GRD	0.214	MICRO-FARAD
	25103	VOLTS
ATION FACTOR	1.20	
00064 * WK**2		KW-SEC/KVA
ATIO	42.7	
CIRCUIT RATIO	0.720	

TANCES	OHMS	PERCENT
SEQUENCE R0	0.0439	0.818
IVE SEQUENCE R1	0.0183	0.341

GATED LOSSES (KW)

	6500.0	**NO LOAD**
	28.6	28.6
	61.7	61.7
R A	31.0	0.0
Y	9.3	0.0
R F	36.1	6.4
TER	5.4	1.0
L	172.1	97.7

IENT TORQUES

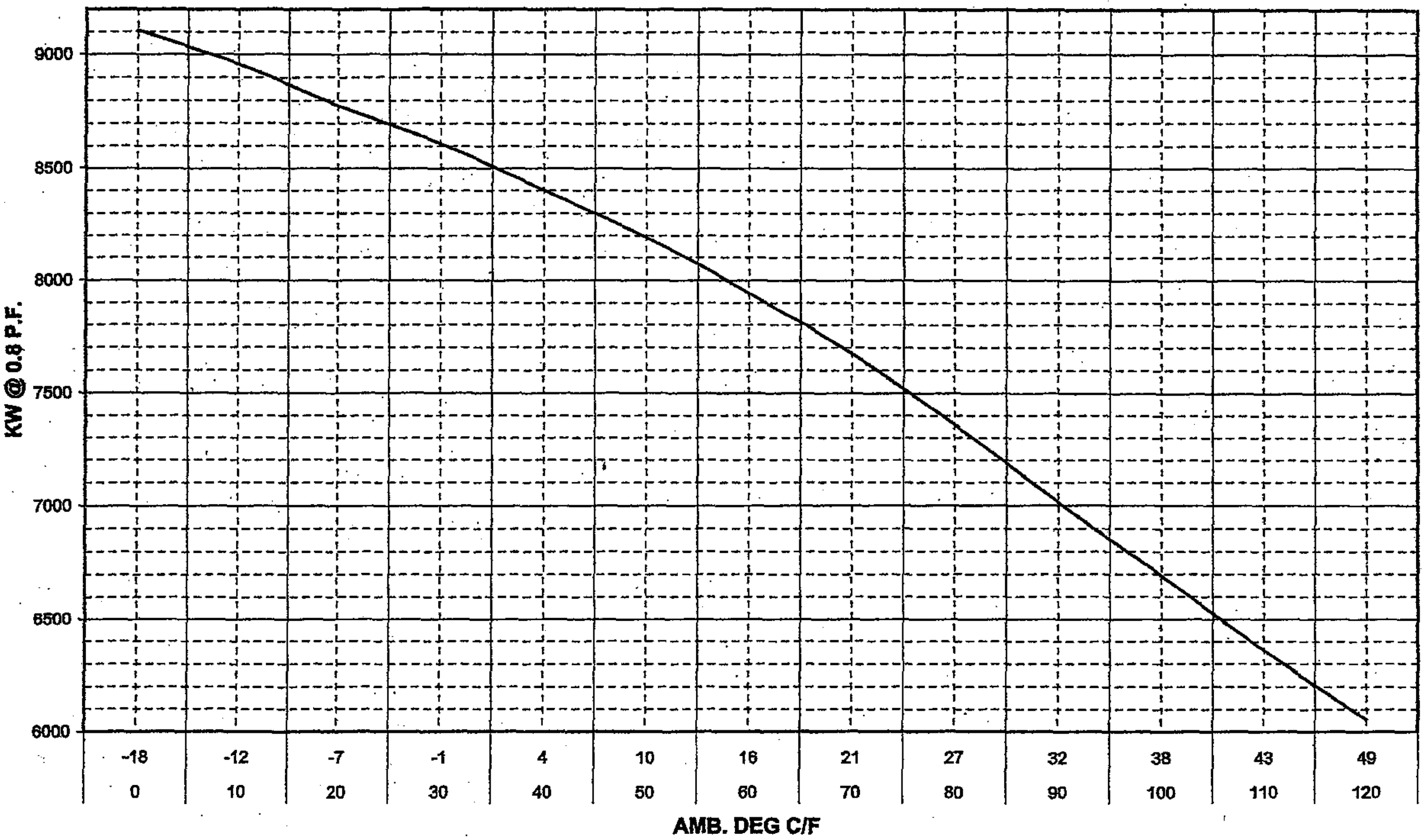
ITION	TORQUE	MAX TORQUE
	P.U.	FT-LBS
OUT OF PH		
NCH W/INF BUS	17.8	679107.7
OUT OF PH		
NCH W/INF BUS	19.4	738977.9

```
3 148.7                          VOLTS  0.0
  246.7                          AMPS   0.0
```

NEUTRAL GROUNDING REACTOR (XR) IS REQUIRED TO LIMIT THE L-N CURRENT
HE 3-PH FAULT CURRENT, THEN THE PROPER VALUE OF REACTANCE IS 0.23 OHMS (XR)

```
ECOND CURRENT RATING =        4143 AMPS
ECOND CURRENT RATING =        1029 AMPS
```

PROPRIETARY DATA FOR ENGINEERING
TECHNICAL INFORMATION



4P10.7-5000 CLASS B RISE 50 HZ ODP DESIGN
< 3000 FT. ALT

1/19/2006

KATO ENGINEERING

Kato Engineering Generator Design Program

THIS DATA CAN BE TRANSFERRED TO CUSTOMER DATA SHEETS WHEN APPLICABLE

PREDICTED GENERATOR PERFORMANCE VALUES

4P7-2950TEFC IP56 EDG #GD-7700 - TBCP-A -								
KW	KVA	PF	TAMB	TRISE	POLES	RPM	SLOTS	HZ
1500.	1875.	0.8	40	80	4	1500	72	50
VOLTS-PH	VOLTS-LL	AMPS-PH	AMPS-LN	BASE Z	025	026	PHASE/CONNECTION	
231	400	2706.3	2706.3	0.085	70036	70024	3 PHASE WYE	

VENTING: DEV

TIME CONSTANTS (SECONDS)

D-AXIS L-N S.C. TRANSIENT	TID2	1.082
D-AXIS L-L S.C. TRANSIENT	TID1	1.132
Q-AXIS 3-PH S.C. TRANSIENT	TIQ3	1.099
Q-AXIS O.C. TRANSIENT	TIQ0	1.099
D-AXIS L-N S.C. SUB-TRANS	TIID2	0.049
D-AXIS L-L S.C. SUB-TRANS	TIID1	0.049
Q-AXIS 3-PH S.C. SUB-TRANS	TIIQ3	0.005
Q-AXIS O.C. SUB-TRANS	TIIQ0	0.027

MISCELLANEOUS CALCULATIONS

3-PH CAPACITANCE-GRD	0.244	MICRO-FARAD
BIL	3182	VOLTS
SATURATION FACTOR	1.06	
H=0.000277 * WK**2		KW-SEC/KVA
X/R RATIO	27.9	
SHORT CIRCUIT RATIO	0.823	

RESISTANCES	OHMS	PERCENT
ZERO SEQUENCE R0	0.0008	0.996
POSITIVE SEQUENCE R1	0.0004	0.415

SEGREGATED LOSSES (KW)

KW	1500.0	NO LOAD
F&W	43.9	43.9
CORE	15.1	15.1
I**2R A	8.7	0.0
STRAY	14.2	0.0
I**2R F	5.9	1.4
EXCITER	0.9	0.2
TOTAL	88.6	60.6

TRANSIENT TORQUES

CONDITION	TORQUE * P.U.	MAX TORQUE FT-LBS
3-PH OUT OF PH		
SYNCH W/INF BUS	22.4	197059.7
1-PH OUT OF PH		
SYNCH W/INF BUS	23.3	204485.3

* NOTE: PU torque based on rated kVA, not rated kw.

VOLTS	66.0	VOLTS	0.0
AMPS	111.9	AMPS	0.0

IF A NEUTRAL GROUNDING REACTOR (XR) IS REQUIRED TO LIMIT THE L-N CURRENT TO THE 3-PH FAULT CURRENT, THEN THE PROPER VALUE OF REACTANCE IS 0.00 OHMS (XR)

10 SECOND CURRENT RATING =	21457 AMPS
60 SECOND CURRENT RATING =	5467 AMPS

PROPRIETARY DATA FOR ENGINEERING
TECHNICAL INFORMATION

hengqg GH-9470 E203*74052 7/27/2007 12:26:22 PM - Program Version 1.1.38

Kato Engineering Generator Design Program

4P7-2950TEFC IP56 EDG #GD-7700 - TBCP-A -								
KW	KVA	PF	TAMB	TRISE	POLES	RPM	SLOTS	HZ
1500.	1875.	0.8	40	80	4	1500	72	50
VOLTS-PH	VOLTS-LL	AMPS-PH	AMPS-LN	BASE Z	025	026	PHASE/CONNECTION	
231	400	2706.3	2706.3	0.085	70036	70024	3 PHASE WYE	

SATURATION DATA

VOLTS		CALCULATED FIELD AMPS			EXPECTED FIELD AMPS		
P.U.	LINE	O.C.	0.8 P.F.	ZERO P.F.	O.C.	0.8 P.F.	ZERO P.F.
0.00	0	0.35	58.52	58.52	0.00	58.52	58.55
0.25	100	13.29	67.17	71.49	10.25	65.32	68.91
0.50	200	26.39	77.18	84.63	20.90	73.45	79.89
0.75	300	39.71	88.26	98.03	32.78	83.75	92.71
1.00	400	56.49	105.51	118.44	48.16	98.97	110.75
1.10	440	69.74	122.01	138.05	56.44	107.87	121.11
1.20	480	97.37	162.10	188.21	66.90	119.57	134.66
1.30	520	183.15	324.60	425.42	80.58	135.39	152.94
1.40	560	657.84	1065.12	1298.27	99.05	157.31	178.23

REACTANCES AND TIME CONSTANTS AT 1875 KVA BASE

		CALCULATED	EXPECTED
SYNCHRONOUS REACTANCES (UNSATURATED)			
DIRECT AXIS	Xdu	126.599	125.333
QUADRATURE AXIS	Xqu	75.015	74.265
TRANSIENT REACTANCES			
UNSATURATED	X'du	23.406	16.649
SATURATED	X'd	20.598	14.651
SUBTRANSIENT REACTANCES (SATURATED)			
DIRECT AXIS	X"d	11.693	11.594
QUADRATURE AXIS	X"q	10.814	13.367
NEGATIVE SEQUENCE REACTANCE(SATURATED)	X2	11.254	12.480
ZERO SEQUENCE REACTANCE	X0	1.192	1.585
TIME CONSTANTS			
FLD CKT WITH ARM CKT OPEN	T'do	5.495	5.495(s)
FLD CKT WITH ARM CKT SHORTED	T'd	0.894	
ARM CKT (ASYMMETRICAL SHORT CKT)	TA	0.079	
ARMATURE LEAKAGE REACTANCE (SATURATED)	XL(xA)	5.730	5.730
FIELD LEAKAGE REACTANCE (UNSATURATED)	XF		11.084
MAGNETIZING REACTANCE (P.U.)			
DIRECT AXIS	Xmd	120.870	
QUADRATURE AXIS	Xmq	69.286	
DIRECT AXIS MAGNETIZING INDUCTANCE	Lad		
QUADRATURE AXIS MAGNETIZING INDUCTANCE	Laq		
DAMPER VALUES (P.U.)			
DIRECT AXIS LEAKAGE REACTANCE	Xlkd	9.000	
QUADRATURE AXIS LEAKAGE REACTANCE	Xlkq	5.084	
DIRECT AXIS RESISTANCE	Rkd		
QUADRATURE AXIS RESISTANCE	Rkq		

OTHER CONSTANTS

		FULL LOAD	NO LOAD
SYNCHRONIZING COEFFICIENT (kW/RAD)		4110.5	2499.5

DISPLACEMENT ANGLE (DEGREES)		22.5	
REACTANCE FACTOR (KILGORE)	X	1.280	
ARMATURE LEAKAGE (KUHLMAN)	XL	5.845	
ARMATURE LEAKAGE (KILGORE)	XL	5.730	

Kato Engineering Generator Design Program

PREDICTED GENERATOR PERFORMANCE VALUES

4P7-2950TEFC IP56 EDG #GD-7700 - TBCP-A -								
KW	KVA	PF	TAMB	TRISE	POLES	RPM	SLOTS	HZ
1500.	1875.	0.8	40	80	4	1500	72	50
VOLTS-PH	VOLTS-LL	AMPS-PH	AMPS-LN	BASE Z	025	026	PHASE/CONNECTION	
231	400	2706.3	2706.3	0.085	70036	70024	3 PHASE WYE	

0.6667 PER UNIT PITCH

REACTANCES		SAT	UNSAT		HI POT VALUES	VOLTS	
SYNCHRONOUS					STATOR	1800	
DIRECT AXIS	Xd	121.5	142.7		ROTOR	1500	
QUADRATURE AXIS	Xq	61.0	74.3		EXCITER FIELD	1500	
TRANSIENT					EXCITER ARM	1500	
DIRECT AXIS	X'd	14.7	16.6				
QUADRATURE AXIS	X'q	61.0	74.3		MOTOR STARTING	0 P.F.	
SUBTRANSIENT						INRUSH	%VOLT
DIRECT AXIS	X"d	11.6	13.6		SKVA AT GENERATOR	SKVA	DIP
QUADRATURE AXIS	X"q	13.4	15.7		TERMINALS	1251.3	10
NEGATIVE SEQUENCE	X2	12.5	14.7			1987.4	15
ZERO SEQUENCE	X0	1.6	1.9			2815.5	20
LEAKAGE REACTANCE	XL	5.73	6.511			3754.0	25
						4826.5	30
RESISTANCES @ 25C -	RDCa	0.00028					
	RDCf	0.4322					

NL-FL VOLTAGE DIP AT RATED P.F. = 10.4%
USED XID= 16.6% FOR DIP CALCULATION.

TIME CONSTANTS (SECONDS)		
D-AXIS 3-PH S.C. TRANSIENT	T'd3	0.782
D-AXIS O.C. TRANSIENT	T'd0	5.495
D-AXIS 3-PH S.C. SUB-TRANS	T"d3	0.043
D-AXIS O.C. SUB-TRANS	T"d0	0.055
ARM CKT (ASYMMETRICAL S.C.)	TA	0.079

TRANSIENT TORQUES				KW		HEAT REJ
	TORQUE	MAX TORQUE		@0.8P.F.	%EFF	BTU/HR
CONDITION	P.U.	FT-LBS				
3-PH S.C.	8.6	75848	FL	1500.0	94.4	302671
L-L S.C.	10.8	94902	3/4L	1125.0	93.6	262328
			1/2L	750.0	91.7	232905
			1/4L	375.0	85.7	214399

EFFICIENCY CALCULATED AT 95.0C

SHORT CIRCUIT CURRENT	INSTANTANEOUS SYMMETRICAL FAULT CURRENT		INSTANTANEOUS ASYMMETRICAL FAULT CURRENT	
TYPE	P.U.	AMPS	P.U.	AMPS
3-PH	8.63	23343	14.94	40432
L-L	7.19	19471	12.46	33726
L-N	11.69	31642	20.25	54807

OVERSPEED: 1875.0 RPM FOR 1 MINUTE. MINIMUM 3 PHASE MOTORING POWER: 150.00 KW

	FULL LOAD	NO LOAD
SYNCH COEFF	4110KW/RAD	2499KW/RAD

DISPLACEMENT ANGLE: 22.5 DEGREES

BY______________________________

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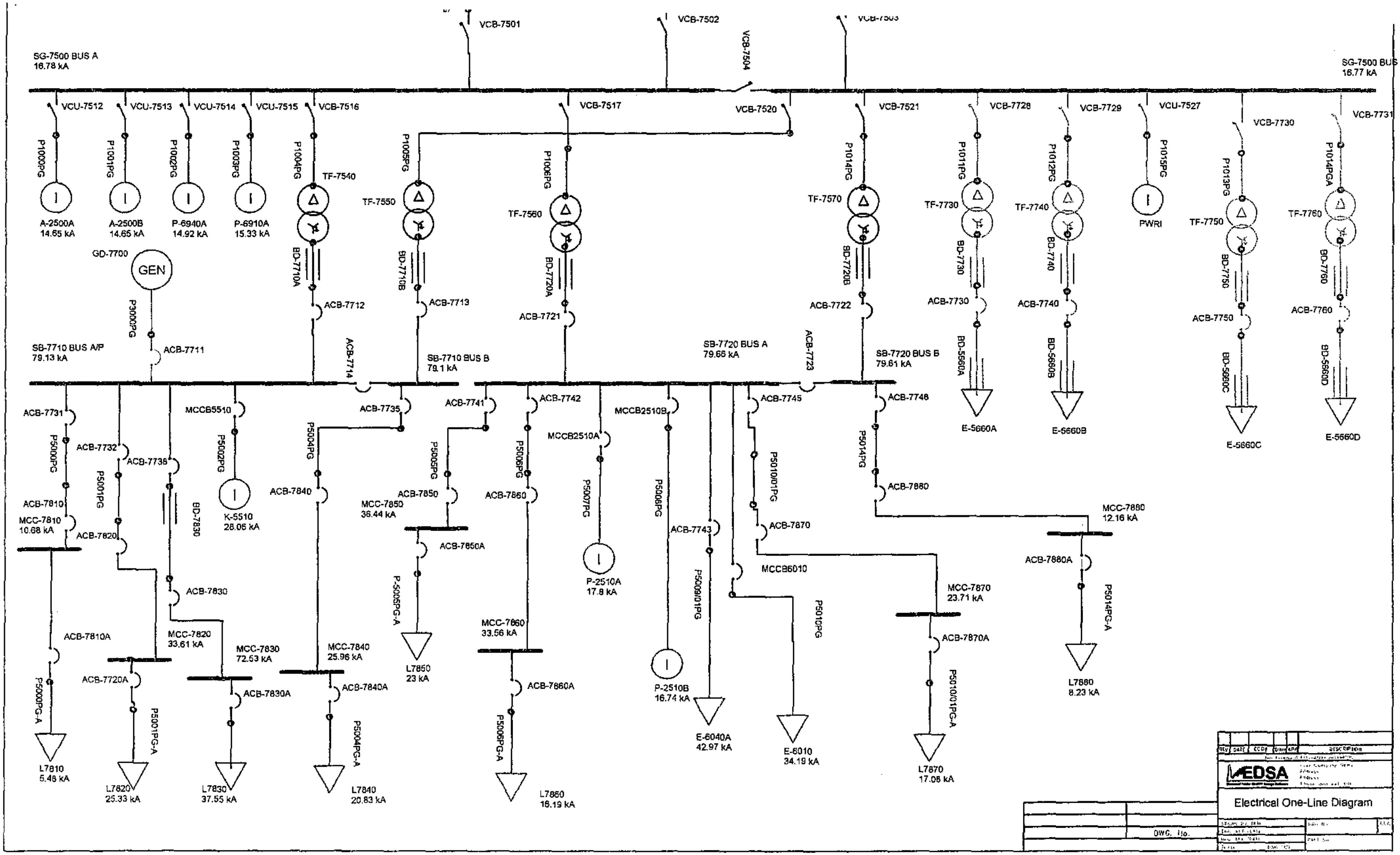

Electrical One-Line Diagram

```
                         EDSA

          3-Phase Short Circuit v5.50.00

                                  Page      :  1
                                  Date      :  02/25/2008
                                  Time      :  12:58:00PM
                                  Company   :
                                  Engineer  :
  SHORT CIRCUIT FINAL             Check by  :
  1:                              CheckDate:
   100.00                         Cyc/Sec   :  50
-----------------------------------------------------------------
.ectrical One-Line 3-Phase to Single-Phase IEC project


                     -------------
                     System Summary
                     -------------

E Activate Nodes       :    86
E Branches             :    87

ve Sources             :    3
ve Motors              :    8
ag Busses              :    0
sformers               :    8
ve Islands             :    1
erature (°C)           :    25.0

                    -------------------
                    Calculation Options
                    -------------------

ults :  at All Buses or Mult-Buses
idard :  1988 Version
twork:  3 Phases 3 Wires system

fined:  by Standard

r to Generators
Method: B

ages   : Use System Voltage
ages   : Adjusted by Tap/Turn Ratio
```

```
                     EDSA

          3-Phase Short Circuit v5.50.00

                                   Page      :  2
                                   Date      :  02/25/2008
                                   Time      :  12:58:00PM
                                   Company   :
                                   Engineer  :
  SHORT CIRCUIT FINAL              Check by  :
  1:                               CheckDate:
   100.00                          Cyc/Sec   :  50
-------------------------------------------------------------------
lectrical One-Line 3-Phase to Single-Phase IEC project

--------------------------------------------------------
Results: 0.5 Cycle--Symmetrical--3P, LL,LG,& LLG Faults
--------------------------------------------------------

                                                       Thevenin Imped. Complex
           Pre-Flt 3P Flt. LL Flt. LG Flt. LLG Flt --------------- ------
             kV      KA      KA      KA      KA    Z+(pu)   Zo(pu) 3P X/R
---------- ------- ------- ------- ------- ------- ------- ------- ------
                 7      15      13      14      14    0.60    0.66   2.37
                 7      15      13      14      14    0.60    0.66   2.37
                 0      34      30      35      36    4.22    4.13   1.20
                 0      43      37      44      46    3.36    3.04   3.80
                 7      17      14      16      16    0.52    0.58  21.43
                 7      17      14      16      16    0.53    0.59  20.86
                 7      17      14      16      16    0.53    0.59  18.34
                 0      28      24      28      29    5.14    5.28   1.28
                 0       5       5       5       6   26.35   26.63   0.22
                 0      25      22      25      26    5.70    5.61   1.17
                 0      38      33      25      36    3.84    9.98   2.66
                 0      21      18      21      22    6.93    6.62   2.65
                 0      23      20      23      24    6.27    6.18   1.15
                 0      16      14      16      16    8.91    8.91   0.83
                 0      17      15      17      17    8.45    8.44   0.84
                 0       8       7       8       8   17.54   17.63   0.56
                 0      11       9      11      11   13.51   13.75   0.29
                 0      34      29      34      35    4.29    4.20   1.23
                 0      73      63      72      84    1.99    2.41   6.34
                 0      26      22      26      27    5.56    5.25   2.98
                 0      36      32      37      38    3.96    3.81   1.54
                 0      34      29      34      35    4.30    4.20   1.24
                 0      24      21      24      24    6.09    6.05   0.97
                 0      12      11      12      12   11.87   11.94   0.62
                 0      18      15      18      18    8.11    8.51   0.77
                 0      17      14      16      17    8.62    9.08   0.75
                 7      15      13      15      15    0.57    0.63   3.06
                 7      15      13      14      15    0.59    0.65   2.59
/P               0      79      69      86      89    1.82    1.46   8.82
```

```
                        EDSA

           3-Phase Short Circuit v5.50.00

                                Page     : 3
                                Date     : 02/25/2008
                                Time     : 12:58:00PM
                                Company  :
                                Engineer :
  SHORT CIRCUIT FINAL           Check by :
  1:                            CheckDate:
   100.00                       Cyc/Sec  : 50
------------------------------------------------------------------
lectrical One-Line 3-Phase to Single-Phase IEC project

-------------------------------------------------------
Results: 0.5 Cycle--Symmetrical--3P, LL,LG,& LLG Faults
-------------------------------------------------------

                                                   Thevenin Imped. Complex
           Pre-Flt 3P Flt. LL Flt. LG Flt. LLG Flt --------------- ------
            kV       KA      KA      KA      KA    Z+(pu)   Zo(pu) 3P X/R
----------- ------- ------- ------- ------- ------- ------- ------- ------
                 0      79      69      86      89    1.82    1.46   8.82
                 0      80      69      86      90    1.81    1.45   8.82
                 0      80      69      86      90    1.81    1.45   8.83
                 7      17      15      16      17    0.52    0.58  24.83
                 7      17      15      16      17    0.52    0.58  24.84
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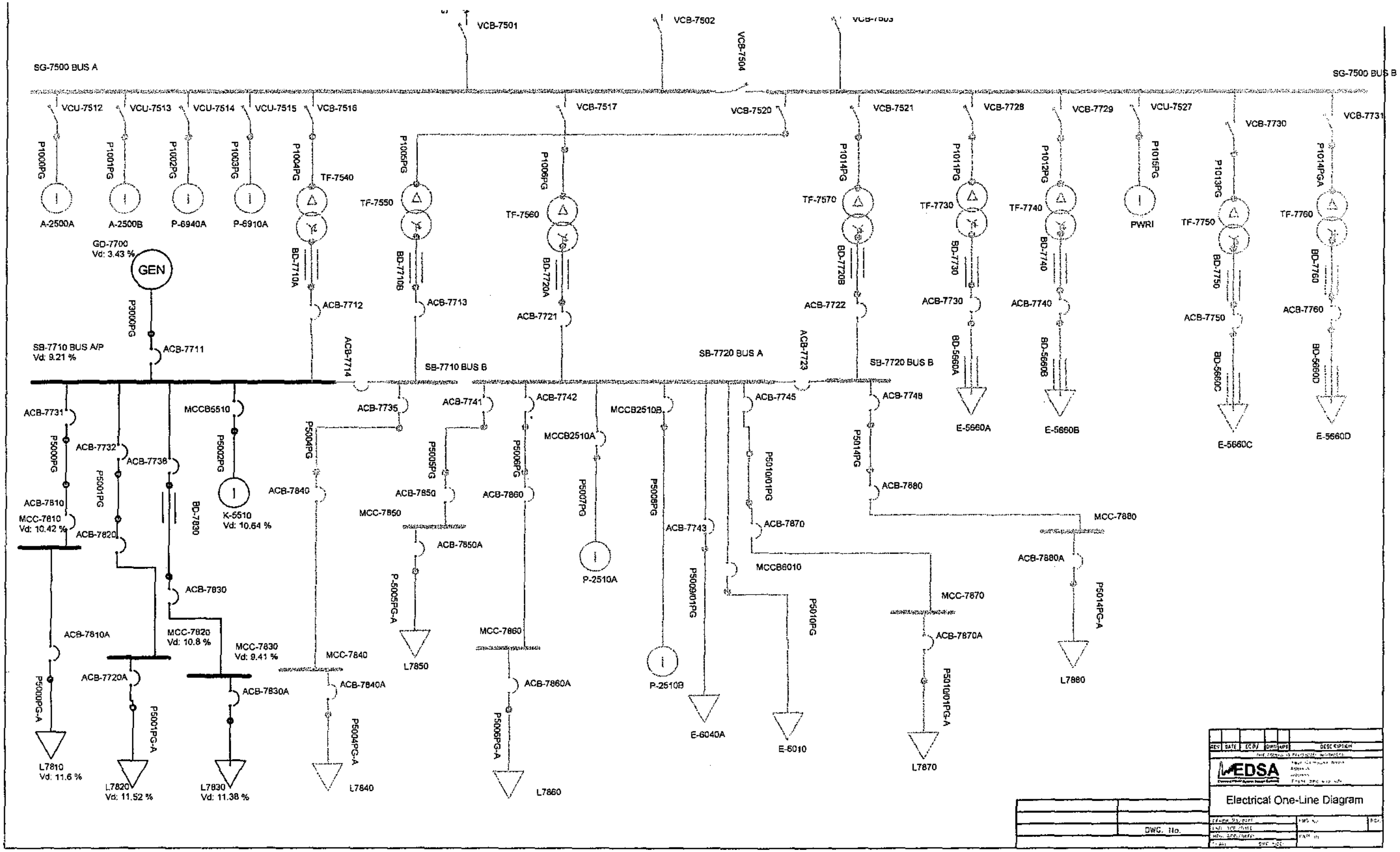
VCB-7501
VCB-7502
VCB-7503
VCB-7504
SG-7500 BUS A
SG-7500 BUS B
VCU-7512
VCU-7513
VCU-7514
VCU-7515
VCB-7516
VCB-7517
VCB-7520
VCB-7521
VCB-7728
VCB-7729
VCU-7527
VCB-7730
VCB-7731
P1000PG
P1001PG
P1002PG
P1003PG
P1004PG
P1005PG
P1006PG
P1014PG
P1011PG
P1012PG
P1015PG
P1013PG
P1014PGA
A-2500A
A-2500B
P-6940A
P-6910A
TF-7540
TF-7550
TF-7560
TF-7570
TF-7730
TF-7740
PWRI
TF-7750
TF-7760
GD-7700
Vd: 3.43 %
GEN
P3000PG
BD-7710A
BD-7710B
BD-7720A
BD-7720B
BD-7730
BD-7740
BD-7750
BD-7760
ACB-7712
ACB-7713
ACB-7721
ACB-7722
ACB-7730
ACB-7740
ACB-7750
ACB-7760
ACB-7711
ACB-7714
ACB-7723
BD-5660A
BD-5660B
BD-5660C
BD-5660D
SB-7710 BUS A/P
Vd: 9.21 %
SB-7710 BUS B
SB-7720 BUS A
SB-7720 BUS B
E-5660A
E-5660B
E-5660C
E-5660D
ACB-7731
ACB-7732
ACB-7736
MCCB5510
P5002PG
ACB-7735
ACB-7741
ACB-7742
MCCB2510B
ACB-7745
ACB-7748
P5000PG
P5001PG
BD-7830
K-5510
Vd: 10.64 %
P5004PG
P5005PG
P5006PG
MCCB2510A
P5007PG
P5008PG
P5010/01PG
P5014PG
ACB-7810
MCC-7810
Vd: 10.42 %
ACB-7820
ACB-7840
ACB-7850
MCC-7850
ACB-7860
ACB-7743
ACB-7870
ACB-7880
MCC-7880
ACB-7850A
ACB-7880A
P-2510A
ACB-7830
P-5005PG-A
P5009/01PG
MCCB6010
P5010PG
P5014PG-A
MCC-7870
ACB-7810A
MCC-7820
Vd: 10.8 %
MCC-7830
Vd: 9.41 %
MCC-7840
MCC-7860
L7850
ACB-7870A
P-2510B
ACB-7720A
ACB-7830A
ACB-7840A
ACB-7860A
L7880
P5000PG-A
P5001PG-A
P5004PG-A
P5006PG-A
P5010/01PG-A
E-6040A
E-6010
L7810
Vd: 11.6 %
L7820
Vd: 11.52 %
L7830
Vd: 11.38 %
L7840
L7860
L7870
REV
DATE
ECO/
DWN
APP
DESCRIPTION
EDSA
Electrical One-Line Diagram
DWG. No.

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ıotor starting final                          Check by   :
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·Line 3-Phase to Single-Phase IEC project


                     Starting Motor Info
                     ===================

                     System     Running Load      Start    LRA
ne             Type   Volts      kVA      PF(%)   PF(%)    Amps      MF    StartMethod
---------- ------ ------- --------- ------ ------ -------- ----- ------------
              Z_Load    6600     802.20   87.00   25.00    210.52   3.00 FullVoltage
              Z_Load     400     224.08   86.00   25.00    646.86   2.00 FullVoltage
              Z_Load    6600    1017.72   87.00   25.00    512.14   5.75 FullVoltage


               Power Source Internal Impedance
               ===============================

me             Type   R (Ohm)  X (Ohm)
---------- ------ -------- --------
              Gen       0.0034   0.1460


                      Bus Voltage Result
                      ==================

                      System   V (PU)   V (PU)   VDip   V (PU)
ıme            Type    Volts    Before   During    %     After    StartMethod
----------- ------ ------- -------- -------- ----- -------- ------------
              Gen       400   1.0000   0.9657  3.43   1.0000
              None     6600   1.0000   1.0000  0.00   1.0000
              None     6600   1.0000   1.0000  0.00   1.0000
              None     6600   1.0000   1.0000  0.00   1.0000
              None      400   1.0000   1.0000  0.00   1.0000
              None      400   1.0000   1.0000  0.00   1.0000
              None      400   1.0000   1.0000  0.00   1.0000
              None      400   1.0000   1.0000  0.00   1.0000
              None      400   1.0000   1.0000  0.00   1.0000
              None     6600   1.0000   1.0000  0.00   1.0000
              None     6600   1.0000   1.0000  0.00   1.0000
              None     6600   1.0000   1.0000  0.00   1.0000
              None     6600   1.0000   1.0000  0.00   1.0000
              None     6600   1.0000   1.0000  0.00   1.0000
              None     6600   1.0000   1.0000  0.00   1.0000
              None      400   1.0000   1.0000  0.00   1.0000
              None      400   1.0000   1.0000  0.00   1.0000
              None      400   0.9569   0.9084  5.06   0.9510
              None      400   0.9565   0.9079  5.08   0.9507
              None      400   0.9563   0.9076  5.08   0.9504
              None      400   0.9544   0.9057  5.11   0.9486
              None      400   0.9489   0.8959  5.59   0.9431
              None      400   0.9422   0.8923  5.30   0.9366
```

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EDSA Advanced Motor Starting Program v4.10.00
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                                    Engineer :
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Line 3-Phase to Single-Phase IEC project


                  System  V (PU)   V (PU)   VDip  V (PU)
ne         Type   Volts   Before   During    %    After    StartMethod
---------- ------ ------- -------- -------- ----- -------- -----------
          None      400   0.9565   0.9075  5.12  0.9506
          None      400   0.9488   0.8958  5.59  0.9430
          None     6600   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   0.9563   0.9077  5.08  0.9505
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   0.9549   0.9062  5.10  0.9491
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None     6600   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
          None      400   1.0000   1.0000  0.00  1.0000
```

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    EDSA Advanced Motor Starting Program v4.10.00
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-Line 3-Phase to Single-Phase IEC project


                      System  V (PU)   V (PU)   VDip   V (PU)
me              Type   Volts   Before   During   %      After   StartMethod
----------  ------ -------  -------- -------- -----  -------- -----------
            None       400   1.0000   1.0000  0.00   1.0000
            None       400   1.0000   1.0000  0.00   1.0000
            None       400   1.0000   1.0000  0.00   1.0000
            None       400   1.0000   1.0000  0.00   1.0000
            None       400   1.0000   1.0000  0.00   1.0000
            None       400   0.9417   0.8917  5.31   0.9360
            None       400   1.0000   1.0000  0.00   1.0000
            None       400   1.0000   1.0000  0.00   1.0000
            Z_Load    6600   1.0000   1.0000  0.00   1.0000 FullVoltage
            P_Load    6600   1.0000   1.0000  0.00   1.0000
            P_Load     400   1.0000   1.0000  0.00   1.0000
            P_Load     400   1.0000   1.0000  0.00   1.0000
            P_Load     400   1.0000   1.0000  0.00   1.0000
            P_Load     400   1.0000   1.0000  0.00   1.0000
            P_Load     400   1.0000   1.0000  0.00   1.0000
            P_Load     400   1.0000   1.0000  0.00   1.0000
            None      6600   1.0000   1.0000  0.00   1.0000
            None      6600   1.0000   1.0000  0.00   1.0000
            None      6600   1.0000   1.0000  0.00   1.0000
            Z_Load     400   0.9565   0.8936  6.58   0.9377 FullVoltage
            P_Load     400   0.9415   0.8840  6.11   0.9364
            P_Load     400   0.9351   0.8848  5.38   0.9295
            P_Load     400   0.9358   0.8862  5.30   0.9301
            P_Load     400   1.0000   1.0000  0.00   1.0000
            P_Load     400   1.0000   1.0000  0.00   1.0000
            P_Load     400   1.0000   1.0000  0.00   1.0000
            P_Load     400   1.0000   1.0000  0.00   1.0000
            P_Load     400   1.0000   1.0000  0.00   1.0000
            None       400   0.9489   0.8958  5.59   0.9431
            None       400   0.9419   0.8920  5.30   0.9363
            None       400   0.9546   0.9059  5.11   0.9488
            None       400   1.0000   1.0000  0.00   1.0000
            None       400   1.0000   1.0000  0.00   1.0000
            None       400   1.0000   1.0000  0.00   1.0000
            None       400   1.0000   1.0000  0.00   1.0000
            None       400   1.0000   1.0000  0.00   1.0000
            P_Load     400   1.0000   1.0000  0.00   1.0000
            P_Load     400   1.0000   1.0000  0.00   1.0000
            Z_Load    6600   1.0000   1.0000  0.00   1.0000 FullVoltage
            P_Load    6600   1.0000   1.0000  0.00   1.0000
            P_Load    6600   1.0000   1.0000  0.00   1.0000
\/P         None       400   0.9565   0.9079  5.08   0.9507
3           None       400   1.0000   1.0000  0.00   1.0000
\           None       400   1.0000   1.0000  0.00   1.0000
```

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    EDSA Advanced Motor Starting Program v4.10.00
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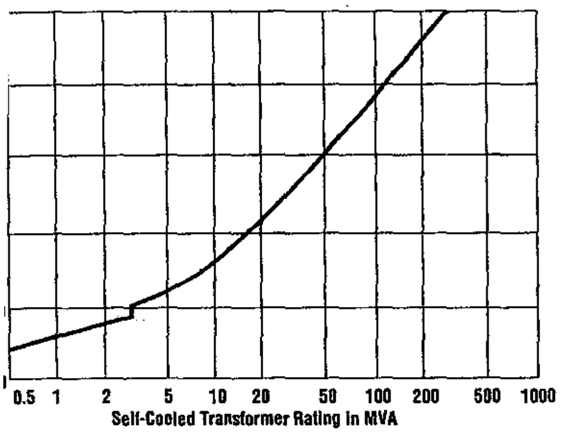
-Line 3-Phase to Single-Phase IBC project


                           System  V (PU)   V (PU)   VDip   V (PU)
me                Type     Volts   Before   During    %     After    StartMethod
----------       ------   ------- -------- -------- ----- -------- -----------
                 None       400    1.0000   1.0000  0.00   1.0000
                 None      6600    1.0000   1.0000  0.00   1.0000
                 None      6600    1.0000   1.0000  0.00   1.0000
```

Section

pedance and Reactance Data–Transformers and Switches

1.1. Transformer Impedance Data
atio of Transformers – Based on ANSI/IEEE C37.010-1979)



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e 1.2. Impedance Data for Three Phase Transformers

	%R	%X	%Z	X/R
	3.7600	1.0000	3.8907	0.265
	2.7200	1.7200	3.2182	0.632
	2.3100	1.1600	2.5849	0.502
	2.1000	1.8200	2.7789	0.867
	0.8876	1.3312	1.6000	1.5
	0.9429	1.4145	1.7000	1.5
	0.8876	1.3312	1.6000	1.5
5	0.5547	0.8321	1.0000	1.5
0	0.6657	0.9985	1.2000	1.5
0	0.6657	0.9985	1.2000	1.5
.0	0.6657	0.9985	1.2000	1.5
.0	0.7211	1.0816	1.3000	1.5
.0	0.6317	3.4425	3.5000	5.45
0.0	0.6048	3.4474	3.5000	5.70
0.0	0.5617	3.4546	3.5000	6.15
0.0	0.7457	4.9441	5.0000	6.63
0.0	0.7457	4.9441	5.0000	6.63

e: UL Listed transformers 25KVA and greater have a ±10% tolerance on r nameplate impedance.

le 1.3. Impedance Data for Single Phase Transformers

A	Suggested X/R Ratio for Calculation	Normal Range of Percent Impedance (%Z)*	Impedance Multipliers** For Line-to-Neutral Faults for %X	for%R
0	1.1	1.2–6.0	0.6	0.75
5	1.4	1.2–6.5	0.6	0.75
0	1.6	1.2–6.4	0.6	0.75
0	1.8	1.2–6.6	0.6	0.75
.0	2.0	1.3–5.7	0.6	0.75
7.0	2.5	1.4–6.1	1.0	0.75
0.0	3.6	1.9–6.8	1.0	0.75
3.0	4.7	2.4–6.0	1.0	0.75
0.0	5.5	2.2–5.4	1.0	0.75

tional standards do not specify %Z for single-phase transformers. Consult anufacturer for values to use in calculation.

sed on rated current of the winding (one–half nameplate kVA divided by condary line-to-neutral voltage).

te: UL Listed transformers 25 KVA and greater have a ± 10% tolerance on ir impedance nameplate.

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Table 1.4. Impedance Data for Single Phase and Three Phase Transformers-Supplement†

KVA 1Ø	3Ø	%Z	Suggested X/R Ratio for Calculation
10		1.2	1.1
15		1.3	1.1
	75	1.11	1.5
	150	1.07	1.5
	225	1.12	1.5
	300	1.11	1.5
333		1.9	4.7
500		2.1	5.5

†These represent actual transformer nameplate ratings taken from field installations.

Note: UL Listed transformers 25KVA and greater have a ±10% tolerance on their impedance nameplate.

Table 2. Current Transformer Reactance Data
Approximate Reactance of Current Transformers*

Primary Current Ratings - Amperes	Reactance in Ohms for Various Voltage Ratings 600-5000V	7500V	15,000V
100 - 200	0.0022	0.0040	—
250 - 400	0.0005	0.0008	0.0002
500 - 800	0.00019	0.00031	0.00007
1000 - 4000	0.00007	0.00007	0.00007

Note: Values given are in ohms per phase. For actual values, refer to manufacturers' data.

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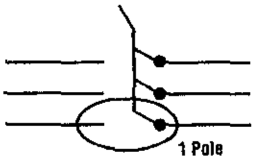
Table 3. Disconnecting Switch Reactance Data
(Disconnecting-Switch Approximate Reactance Data, in Ohms*)

Switch Size (Amperes)	Reactance (Ohms)
200	0.0001
400	0.00008
600	0.00008
800	0.00007
1200	0.00007
1600	0.00005
2000	0.00005
3000	0.00004
4000	0.00004



Note: The reactance of disconnecting switches for low-voltage circuits (600V and below) is in the order of magnitude of 0.00008 - 0.00005 ohm/pole at 60 Hz for switches rated 400 - 4000 A, respectively.

*For actual values, refer to manufacturers' data.

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ıpedance & Reactance Data-Circuit Breakers and Conductors

4. Circuit Breaker Reactance Data

actance of Low-Voltage Power Circuit Breakers

lt-Breaker upting g eres)	Circuit-Breaker Rating (amperes)	Reactance (ohms)
0	15 - 35	0.04
	50 - 100	0.004
0	125 - 225	0.001
	250 - 600	0.0002
0	200 - 800	0.0002
	1000 - 1600	0.00007
0	2000 - 3000	0.00008
00	4000	0.00008

pical Molded Case Circuit Breaker Impedances

ed-Case lt-Breaker g eres)	Resistance (ohms)	Reactance (ohms)
	0.00700	Negligible
	0.00240	Negligible
	0.00200	0.00070
	0.00035	0.00020
	0.00031	0.00039
	0.00007	0.00017

s:

ue to the method of rating low-voltage power it breakers, the reactance of the circuit breaker h is to interrupt the fault is not included in lating fault current.

bove 600 amperes the reactance of molded case it breakers are similar to those given in (a)

ctual values, refer to manufacturers' data.

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Table 5. Impedance Data - Insulated Conductors (Ohms/1000 ft. each conductor - 60Hz)

Size	Resistance (25C)				Reactance - 600V - THHN			
AWG or	Copper		Aluminum		Single Conductors		1 Multiconductor	
kcM	Metal	NonMet	Metal	Nonmet	Mag.	Nonmag.	Mag	Nonmag.
14	2.5700	2.5700	4.2200	4.2200	.0493	.0394	.0351	.0305
12	1.6200	1.6200	2.6600	2.6600	.0468	.0374	.0333	.0290
10	1.0180	1.0180	1.6700	1.6700	.0463	.0371	.0337	.0293
8	.6404	.6404	1.0500	1.0500	.0475	.0380	.0351	.0305
6	.4100	.4100	.6740	.6740	.0437	.0349	.0324	.0282
4	.2590	.2590	.4240	.4240	.0441	.0353	.0328	.0235
2	.1640	.1620	.2660	.2660	.0420	.0336	.0313	.0273
1	.1303	.1290	.2110	.2110	.0427	.0342	.0319	.0277
1/0	.1040	.1020	.1680	.1680	.0417	.0334	.0312	.0272
2/0	.0835	.0812	.1330	.1330	.0409	.0327	.0306	.0266
3/0	.0668	.0643	.1060	.1050	.0400	.0320	.0300	.0261
4/0	.0534	.0511	.0844	.0838	.0393	.0314	.0295	.0257
250	.0457	.0433	.0722	.0709	.0399	.0319	.0299	.0261
300	.0385	.0362	.0602	.0592	.0393	.0314	.0295	.0257
350	.0333	.0311	.0520	.0507	.0383	.0311	.0290	.0254
400	.0297	.0273	.0460	.0444	.0385	.0308	.0286	.0252
500	.0244	.0220	.0375	.0356	.0379	.0303	.0279	.0249
600	.0209	.0185	.0319	.0298	.0382	.0305	.0278	.0250
750	.0174	.0185	.0264	.0240	.0376	.0301	.0271	.0247
1000	.0140	.0115	.0211	.0182	.0370	.0296	.0260	.0243

Note: Increased resistance of conductors in magnetic raceway is due to the effect of hysteresis losses. The increased resistance of conductors in metal non-magnetic raceway is due to the effect of eddy current losses. The effect is essentially equal for steel and aluminum raceway. Resistance values are acceptable for 600 volt, 5KV and 15 KV insulated Conductors.

Size	Reactance - 5KV				Reactance - 15KV			
AWG or	Single Conductors		1 Multiconductor		Single Conductors		1 Multiconductor	
kcM	Mag.	Nonmag.	Mag.	Nonmag.	Mag.	Nonmag.	Mag.	Nonmag.
8	.0733	.0586	.0479	.0417	–	–	–	–
6	.0681	.0545	.0447	.0389	.0842	.0674	.0584	.0508
4	.0633	.0507	.0418	.0364	.0783	.0626	.0543	.0472
2	.0591	.0472	.0393	.0364	.0727	.0582	.0505	.0439
1	.0571	.0457	.0382	.0332	.0701	.0561	.0487	.0424
1/0	.0537	.0430	.0360	.0313	.0701	.0561	.0487	.0424
2/0	.0539	.0431	.0350	.0305	.0661	.0561	.0458	.0399
3/0	.0521	.0417	.0341	.0297	.0614	.0529	.0427	.0372
4/0	.0505	.0404	.0333	.0290	.0592	.0491	.0413	.0359
250	.0490	.0392	.0323	.0282	.0573	.0474	.0400	.0348
300	.0478	.0383	.0317	.0277	.0557	.0458	.0387	.0339
350	.0469	.0375	.0312	.0274	.0544	.0446	.0379	.0332
400	.0461	.0369	.0308	.0270	.0534	.0436	.0371	.0326
500	.0461	.0369	.0308	.0270	.0517	.0414	.0357	.0317
600	.0439	.0351	.0296	.0261	.0516	.0414	.0343	.0309
750	.0434	.0347	.0284	.0260	.0500	.0413	.0328	.0301
1000	.0421	.0337	.0272	.0255	.0487	.0385	.0311	.0291

These are only representative figures. Reactance is affected by cable insulation type, shielding, conductor outside diameter, conductor spacing in 3 conductor cable, etc. In commercial buildings meduim voltage impedances normally do not affect the short circuit calculations significantly.

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" Values for Conductors and Busway

6. " C" Values for Conductors and Busway

	Three Single Conductors						Three-Conductor Cable					
	Conduit						Conduit					
	Steel			Nonmagnetic			Steel			Nonmagnetic		
	600V	5KV	15KV	600V	5KV	15KV	600V	5KV	15KV	600V	5KV	15KV
er												
	389	389	389	389	389	389	389	389	389	389	389	389
	617	617	617	617	617	617	617	617	617	617	617	617
	981	981	981	981	981	981	981	981	981	981	981	981
	1557	1551	1557	1558	1555	1558	1559	1557	1559	1559	1558	1559
	2425	2406	2389	2430	2417	2406	2431	2424	2414	2433	2428	2420
	3806	3750	3695	3825	3789	3752	3830	3811	3778	3837	3823	3798
	4760	4760	4760	4802	4802	4802	4760	4790	4760	4802	4802	4802
	5906	5736	5574	6044	5926	5809	5989	5929	5827	6087	6022	5957
	7292	7029	6758	7493	7306	7108	7454	7364	7188	7579	7507	7364
	8924	8543	7973	9317	9033	8590	9209	9086	8707	9472	9372	9052
	10755	10061	9389	11423	10877	10318	11244	11045	10500	11703	11528	11052
	12843	11804	11021	13923	13048	12360	13656	13333	12613	14410	14118	13461
	15082	13605	12542	16673	15351	14347	16391	15890	14813	17482	17019	16012
	16483	14924	13643	18593	17120	15865	18310	17850	16465	19779	19352	18001
	18176	16292	14768	20867	18975	17408	20617	20051	18318	22524	21938	20163
	19703	17385	15678	22736	20526	18672	19557	21914	19821	22736	24126	21982
	20565	18235	16365	24296	21786	19731	24253	23371	21042	26915	26044	23517
	22185	19172	17492	26706	23277	21329	26980	25449	23125	30028	28712	25916
	22965	20567	47962	28033	25203	22097	28752	27974	24896	32236	31258	27766
	24136	21386	18888	28303	25430	22690	31050	30024	26932	32404	31338	28303
	25278	22539	19923	31490	28083	24887	33864	32688	29320	37197	35748	31959
ıinum												
	236	236	236	236	236	236	236	236	236	236	236	236
	375	375	375	375	375	375	375	375	375	375	375	375
	598	598	598	598	598	598	598	598	598	598	598	598
	951	950	951	951	950	951	951	951	951	951	951	951
	1480	1476	1472	1481	1478	1476	1481	1480	1478	1482	1481	1479
	2345	2332	2319	2350	2341	2333	2351	2347	2339	2353	2349	2344
	2948	2948	2948	2958	2958	2958	2948	2956	2948	2958	2958	2958
	3713	3669	3626	3729	3701	3672	3733	3719	3693	3739	3724	3709
	4645	4574	4497	4678	4631	4580	4686	4663	4617	4699	4681	4646
	5777	5669	5493	5838	5766	5645	5852	5820	5717	5875	5851	5771
	7186	6968	6733	7301	7152	6986	7327	7271	7109	7372	7328	7201
	8826	8466	8163	9110	8851	8627	9077	8980	8750	9242	9164	8977
	10740	10167	9700	11174	10749	10386	11184	11021	10642	11408	11277	10968
	12122	11460	10848	12862	12343	11847	12796	12636	12115	13236	13105	12661
	13909	13009	12192	14922	14182	13491	14916	14698	13973	15494	15299	14658
	15484	14280	13288	16812	15857	14954	15413	16490	15540	16812	17351	16500
	16670	15355	14188	18505	17321	16233	18461	18063	16921	19587	19243	18154
	18755	16827	15657	21390	19503	18314	21394	20606	19314	22987	22381	20978
	20093	18427	16484	23451	21718	19635	23633	23195	21348	25750	25243	23294
	21766	19685	17686	23491	21769	19976	26431	25789	23750	25682	25141	23491
0	23477	21235	19005	28778	26109	23482	29864	29049	26608	32938	31919	29135

e: These values are equal to one over the impedance per foot for impedances found in Table 5, Page 26.

pacity	**Busway**				
	Plug-In	**Feeder**		**High Impedance**	
	Copper	**Aluminum**	**Copper**	**Aluminum**	**Copper**
	28700	23000	18700	12000	—
	38900	34700	23900	21300	—
	41000	38300	36500	31300	—
	46100	57500	49300	44100	—
0	69400	89300	62900	56200	15600
0	94300	97100	76900	69900	16100
0	119000	104200	90100	84000	17500
0	129900	120500	101000	90900	19200
0	142900	135100	134200	125000	20400
0	143800	156300	180500	166700	21700
0	144900	175400	204100	188700	23800
0	—	—	277800	256400	—

te: These values are equal to one over the impedance per foot for ɔedances in Table 7, Page 28.

usway Impedance Data

7. Busway Impedance Data (Ohms per 1000 Feet – Line-to-Neutral, 60 Cycles)

In Busway						
	Copper Bus Bars			**Aluminum Bus Bars**		
re Rating	**Resistance**	**Reactance**	**Impedance**	**Resistance**	**Reactance**	**Impedance**
	0.0262	0.0229	0.0348	0.0398	0.0173	0.0434
	0.0136	0.0218	0.0257	0.0189	0.0216	0.0288
	0.0113	0.0216	0.0244	0.0179	0.0190	0.0261
	0.0105	0.0190	0.0217	0.0120	0.0126	0.0174
	0.0071	0.0126	0.0144	0.0080	0.0080	0.0112
	0.0055	0.0091	0.0106	0.0072	0.0074	0.0103
	0.0040	0.0072	0.0084	0.0065	0.0070	0.0096
	0.0036	0.0068	0.0077	0.0055	0.0062	0.0083
	0.0033	0.0062	0.0070	0.0054	0.0049	0.0074
	0.0032	0.0062	0.0070	0.0054	0.0034	0.0064
	0.0031	0.0062	0.0069	0.0054	0.0018	0.0057
	0.0030	0.0062	0.0069	—	—	—
	0.0020	0.0039	0.0044	—	—	—
Impedance Feeder Busway						
	0.0425	0.0323	0.0534	0.0767	0.0323	0.0832
	0.0291	0.0301	0.0419	0.0378	0.0280	0.0470
	0.0215	0.0170	0.0274	0.0305	0.0099	0.0320
	0.0178	0.0099	0.0203	0.0212	0.0081	0.0227
	0.0136	0.0082	0.0159	0.0166	0.0065	0.0178
	0.0110	0.0070	0.0130	0.0133	0.0053	0.0143
	0.0090	0.0065	0.0111	0.0110	0.0045	0.0119
	0.0083	0.0053	0.0099	0.0105	0.0034	0.0110
	0.0067	0.0032	0.0074	0.0075	0.0031	0.0080
	0.0045	0.0032	0.0055	0.0055	0.0023	0.0060
	0.0041	0.0027	0.0049	0.0049	0.0020	0.0053
	0.0030	0.0020	0.0036	0.0036	0.0015	0.0039
	0.0023	0.0015	0.0027	—	—	—

above data represents values which are a composite of those obtained by a survey of industry; values tend to be on the low side.

symmetrical Factors

ble 8. Asymmetrical Factors

ort Circuit ower Factor, ercent*	Short Circuit X/R Ratio	Ratio to Symmetrical RMS Amperes Maximum 1 phase Instantaneous Peak Amperes Mp	 Maximum 1 phase RMS Amperes at 1/2 Cycle M_m (Asym.Factor)*	 Average 3 phase RMS Amperes at 1/2 Cycle M_a*
	∞	2.828	1.732	1.394
	100.00	2.785	1.697	1.374
	49.993	2.743	1.662	1.354
	33.322	2.702	1.630	1.336
	24.979	2.663	1.599	1.318
	19.974	2.625	1.569	1.302
	16.623	2.589	1.540	1.286
	14.251	2.554	1.512	1.271
	13.460	2.520	1.486	1.256
	11.066	2.487	1.461	1.242
	9.9301	2.455	1.437	1.229
	9.0354	2.424	1.413	1.216
	8.2733	2.394	1.391	1.204
	7.6271	2.364	1.370	1.193
	7.0721	2.336	1.350	1.182
	6.5912	2.309	1.331	1.172
	6.1695	2.282	1.312	1.162
	5.7947	2.256	1.295	1.152
	5.4649	2.231	1.278	1.144
	5.16672	2.207	1.278	1.135
	4.8990	2.183	1.247	1.127
	4.6557	2.160	1.232	1.119
	4.4341	2.138	1.219	1.112
	4.2313	2.110	1.205	1.105
	4.0450	2.095	1.193	1.099
	3.8730	2.074	1.181	1.092
	3.7138	2.054	1.170	1.087
	3.5661	2.034	1.159	1.081
	3.4286	2.015	1.149	1.076
	3.3001	1.996	1.139	1.071
	3.1798	1.978	1.130	1.064
	3.0669	1.960	1.122	1.062
	2.9608	1.943	1.113	1.057
	2.8606	1.926	1.106	1.057
	2.7660	1.910	1.098	1.050
	2.6764	1.894	1.091	1.046
	2.5916	1.878	1.085	1.043
	2.5109	1.863	1.079	1.040
	2.4341	1.848	1.073	1.037
	2.3611	1.833	1.068	1.034
	2.2913	1.819	1.062	1.031
	2.2246	1.805	1.058	1.029
	2.1608	1.791	1.053	1.027
	2.0996	1.778	1.049	1.024
	2.0409	1.765	1.045	1.023
	1.9845	1.753	1.041	1.021
	1.9303	1.740	1.038	1.019
	1.8780	1.728	1.035	1.017
	1.8277	1.716	1.032	1.016
	1.7791	1.705	1.029	1.014
	1.7321	1.694	1.026	1.013
	1.5185	1.641	1.016	1.008
	1.3333	1.594	1.009	1.004
	1.1691	1.517	1.005	1.001
	1.0202	1.517	1.002	1.001
	0.8819	1.486	1.0008	1.0004
	0.7500	1.460	1.0002	1.0001
	0.6198	1.439	1.00004	1.00002
0	0.0000	1.414	1.00000	1.00000

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Selective Coordination (Blackout Prevention)

Having determined the faults that must be interrupted, the next step is to specify Protective Devices that will provide a Selectively Coordinated System with proper Interrupting Ratings.

Such a system assures safety and reliability under all service conditions and prevents needless interruption of service on circuits other than the one on which a fault occurs.

The topic of Selectivity will be Discussed in the next Handbook, EDP II.

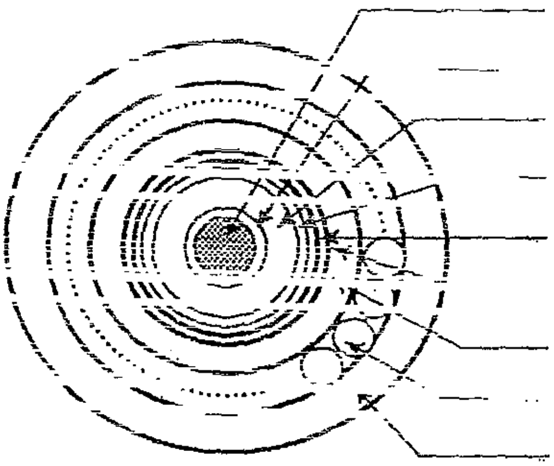
Component Protection (Equipment Damage Prevention)

Proper protection of electrical equipment requires that fault current levels be known. The characteristics and let-through values of the overcurrent device must be known, and compared to the equipment withstand ratings. This topic of Component Protection is discussed in the third Handbook, EDP III.

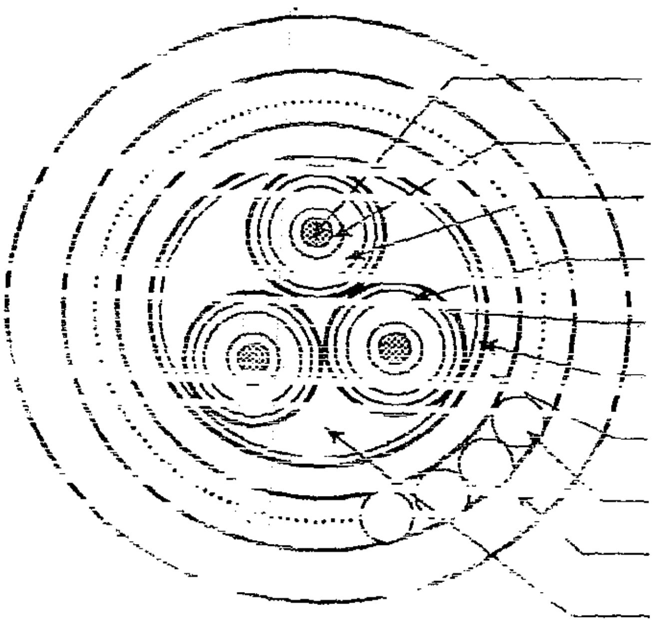
Cross-sectional views

rmoured

Cross-sectional view of 3.8/6 - 18/30 kV XLPE/AWA/PVC & XLPE/SWA/PVC **power cables (ref. to IEC 60502 - 1997)**



Single core



Three-core

Note: Not to scale

oltage (Duration: 5 minutes)

d voltage /U(KV)	0.6/1	1.8/3	3.6/6	6/10	8.7/15	12/20	18/30
st voltage m.s.(KV)	3.5	6.5	12.5	21	30.5	42	63

ection Factor for Various Basic ient Temperatures

perature °C	Correction factor In air	 In ground
10		1.03
15		1.00
20	1.05	0.97
25	1.00	0.93
30	0.95	0.89
35	0.91	0.85
40	0.86	0.81
45	0.80	0.77
50	0.75	
55	0.69	

Correction Factor for Depth of Laying

Laying depth (m)	3.6/6KV — 18/30KV up to 300mm²	 above 300mm²
0.80	1.00	1.00
1.00	0.98	0.97
1.25	0.96	0.95
1.50	0.95	0.94
1.75	0.94	0.92
2.00	0.92	0.90
2.50	0.91	0.89
≥3.0	0.90	0.88

rrection Factor for Thermal Resistivity of Soil

	Conductor size mm²	Thermal resistivity (°Cm/W) 0.8	 0.9	 1.0	 1.5	 2.0	 2.5	 3.0
Single-core	up to 150	1.16	1.11	1.07	0.91	0.81	0.73	0.67
	185 — 400	1.17	1.12	1.07	0.90	0.80	0.72	0.66
	500 — 1000	1.18	1.13	1.08	0.90	0.79	0.71	0.65
Multicore	up to 16	1.09	1.06	1.04	0.95	0.85	0.79	0.74
	25 — 150	1.14	1.10	1.07	0.93	0.84	0.76	0.70
	185 — 400	[illegible]	1.11	1.07	0.92	0.82	0.74	0.68

ting Factor of Current Carrying Capacity for Group Installation Multicore es in Horizontal Formation

Voltage (KV)	Number of cables in group	Spacing of circuits (between centres of cable group)				
		Touching	0.15m*	0.3m	0.45m	0.6m
kV - 12/20kV	2	0.80	0.85	0.89	0.90	0.92
	3	0.69	0.75	0.80	0.84	0.86
	4	0.63	0.70	0.77	0.80	0.84
	5	0.57	0.66	0.73	0.78	0.81
	6	0.55	0.63	0.71	0.76	0.80
18/30kV	2	0.80	0.85	0.87	[illegible]	0.94
	3	0.70	0.73	0.78	0.82	0.85
	4	0.64	0.68	0.74	0.78	0.82
	5	0.59	0.63	0.70	0.75	0.79
	6	0.56	0.60	0.66	0.74	[illegible]

s spacing is not applicable for some larger diameter cables.

ting Factor of Current Carrying Capacity for Group Installation of 3 Single-core es, in Trefoil and Laid Flat Touching, Horizontal Formation

Voltage (kV)	Number of circuits	Spacing of circuits (between centres of cable group)					
		Touching					
		Trefoil	Flat	0.15m*	0.3m	0.45m	0.6m
	2	0.76	0.80	[illegible]	[illegible]	[illegible]	0.90
	3	0.66	0.69	0.71	[illegible]	0.80	0.83
6kV - 12/20kV	4	0.60	0.63	0.65	0.72	0.76	0.80
	5	0.55	0.58	0.61	0.68	0.73	0.77
	6	0.52	0.55	[illegible]	[illegible]	[illegible]	[illegible]
	2	0.79	0.81	0.81	0.85	0.88	0.90
	3	0.67	0.70	0.71	0.76	0.80	0.83
18/30kV	4	0.62	0.65	0.65	0.72	[illegible]	[illegible]
	5	0.57	0.60	0.60	0.68	[illegible]	0.77
	6	0.54	0.57	0.57	0.66	0.72	0.76

is spacing is not applicable for some larger diameter cables.

rrent Ratings for 12/20kV - 18/30kV Armoured XLPE Cables

	Nominal size mm²	In Air			In Ground		
		Single-core		3-core	Single-core		3-core
		Trefoil (A)	Flat (A)	(A)	Trefoil (A)	Flat (A)	(A)
Copper conductor	35			180			[illegible]
	50	245	295	225	220	[illegible]	[illegible]
	70	300	365	275	270	280	255
	95	[illegible]	450	330	320	335	295
	120	425	520	380	360	[illegible]	[illegible]
	150	485	590	430	410	430	370
	185	550	670	490	460	485	420
	240	[illegible]	[illegible]	570	530	550	[illegible]
	300	740	920	650	600	640	[illegible]
	400	850	1070	740	690	730	590
	500	980	1250		760	830	
	630	[illegible]	[illegible]		850	950	
Aluminium conductor	35			145			135
	50	190	230	175	170	175	160
	70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	95	280	340	[illegible]	250	260	230
	120	330	400	300	280	295	260
	150	375	455	335	320	330	290
	185	430	520	[illegible]	[illegible]	[illegible]	[illegible]
	240	510	620	400	410	440	380
	300	580	710	520	475	495	425
	400	680	840	600	550	570	480
	500	790	980		[illegible]	[illegible]	
	630	920	1060		[illegible]	[illegible]	

Single-core unarmoured cable with copper wire screen.

ctrical Characteristics for 3.6/6kV and 6/10kV Armoured Cables

	Conductor size	A.C. resistance @ 90°C		Reactance (50 Hz)		Capacitance	A.C. resistance @ 90°C		Reactance	Capacitance
		Copper	[illegible]	[illegible]	Flat		Copper	Aluminium	(50 Hz)	
	mm²	Ω/km	Ω/km	Ω/km	Ω/km	μF/km	Ω/km	Ω/km	Ω/km	μF/km
3.6/6kV cable	25						0.927	1.54	0.117	0.30
	35						0.668	1.11	0.109	0.33
	50	0.494	0.822	0.121	0.181	0.34	0.493	0.822	0.105	0.36
	70	0.342	0.568	0.113	[illegible]	[illegible]	0.342	0.568	0.100	0.41
	95	0.247	0.411	0.109	0.167	[illegible]	0.247	0.411	0.095	0.46
	120	0.196	0.325	0.105	0.162	0.47	0.196	0.325	0.092	0.50
	150	0.159	0.265	0.102	0.159	0.51	0.159	0.265	0.090	[illegible]
	185	0.128	0.211	0.099	0.156	[illegible]	[illegible]	[illegible]	0.087	[illegible]
	240	0.0982	0.162	0.096	0.153	[illegible]	[illegible]	0.162	0.085	[illegible]
	300	0.0791	0.130	0.094	0.151	0.62	0.0798	0.130	0.084	[illegible]
	400	[illegible]	0.102	0.092	0.149	0.65	0.0641	0.102	0.082	0.70
	500	0.0510	0.804	0.089	0.147	[illegible]				
	630	0.0417	0.0639	0.086	0.144	0.78				
6/10kV cables	25						0.927	1.54	0.124	[illegible]
	35						0.668	1.11	[illegible]	[illegible]
	50	0.494	0.822	0.127	0.185	0.26	0.493	0.822	0.111	[illegible]
	70	0.342	0.568	0.120	0.177	0.30	0.342	0.568	0.106	0.32
	95	0.247	0.410	0.114	0.171	0.33	0.247	0.410	0.100	0.36
	120	0.196	0.325	0.109	0.166	0.36	0.196	0.325	0.097	[illegible]
	150	0.159	0.265	0.106	0.163	0.39	0.159	0.265	0.094	0.42
	185	0.128	0.211	0.103	0.160	0.43	0.128	0.211	0.092	0.46
	240	0.0981	[illegible]	[illegible]	0.155	0.48	0.0984	0.161	0.089	[illegible]
	300	0.0791	0.130	0.096	0.153	0.52	0.0797	0.130	0.086	[illegible]
	400	0.0632	0.102	0.093	0.150	0.58	0.0639	0.102	0.083	[illegible]
	500	0.0510	0.0804	0.090	0.147	0.66				
	630	0.0417	[illegible]	[illegible]	[illegible]	[illegible]				

*Single-core unarmoured cable with copper wire screen

Table 4

CURRENT RATINGS FOR 3.8 / 6.6 (7.2) kV TO 8.7 / 15 (17.5) ARMOURED XLPE CABLE

Conductor Size	In Air			In Ground		
	Single Core[a]		3 Core	Single Core[a]		3 Core
	Trefoil (A)	Flat (A)	(A)			
[illegible]			[illegible]	-	-	[illegible]
35[b]	-	-	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]			
[illegible]	285	370	270	270	280	255
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	335	300
[illegible]	[illegible]	520	375	360	380	340
150	470	600	430	410	430	380
185	540	690	490	460	485	430
240	640	820	570	530	[illegible]	[illegible]
300	740	940	650	600	640	540
400	840	1100	740	680	730	600
500	[illegible]	[illegible]		[illegible]	[illegible]	
630	1110	1500	-	830	940	-
800	1270	1720	-	920	1070	-
Aluminium Conductor						
25[b]	-	-	115	-	-	115
[illegible]			140	-	-	135
50	180	230	170	170	175	[illegible]
70	225	290	210	210	215	195
95	280	350	250	250	260	[illegible]
120	320	410	[illegible]	[illegible]	[illegible]	[illegible]
150	365	465	330	320	330	300
185	425	530	385	360	375	335
[illegible]	[illegible]	[illegible]	[illegible]	415	440	380
300	580	730	510	475	495	
400	670	860	590	540	570	435
[illegible]	[illegible]	1010		610	650	[illegible]
630	910	1190	-	[illegible]	[illegible]	
800	1060	1330	-	770	860	-

[a] Copper wire screened, unarmoured

[b] Not applicable to all voltages. See dimension tables for availability