ESCOM
ELECTRICAL SAFETY COMMITTEE

GUIDELINES AND BEST PRACTICES FOR CONSTRUCTION POWER PART 2: STANDALONE/ MOBILE GENERATOR > 10KVA TO 1250KVA

DOCUMENT NO: ESCOM/2024/05, REVISION 1.0

What is ESCOM?

The Safety, Health and Environment National Authority (SHENA) and Autoriti Elektrik Negara Brunei Darussalam (AENBD) established the Electrical Safety Committee or "ESCOM" in January 2023; with the objectives of promoting regulatory compliance and raising electrical safety standards within Brunei Darussalam.

Who are the ESCOM members?

Members of the ESCOM comprised of industry experts from both government institutions and private organisations with decades of collective experience and a shared passion to drive improvements and promote electrical safety in Brunei Darussalam. The committee is co-chaired by both SHENA and AENBD.

ELECTRICAL SAFETY BEST PRACTICES			
DOCUMENT TITLE	**GUIDELINES AND BEST PRACTICES FOR CONSTRUCTION POWER PART 2: STANDALONE MOBILE GENERATOR > 10KVA TO 1250KVA**		
REFERENCE NUMBER	**ESCOM/2024/05**	**REVISION NO.**	**1.0**
AUTHORS			
Dk Roselawati Pg Hj Halus	Chairperson	IET Brunei Darussalam Network	
Soo Kok Ping	Author	Brunei Shell Petroleum Company Sdn Bhd	
Simon Leong KA	Contributor	LKA Konsult Sdn Bhd	
Zephyrin Aurelia Ioh	Contributor	Hengyi Industries Sdn Bhd	
Phang Yun-Seng	Contributor	Brunei Methanol Company Sdn Bhd	

ISSUE DATE	16 OCTOBER 2024		
ESCOM CO-CHAIRPERSON			
NAME	Ir. Hj Noryasmin bin Hj Mohd Noor	SIGNATURE	

Disclaimer:

This document was developed as a recommendation and as an industry reference of best practices to improve electrical safety practices.

This document should not be construed as implying any liability nor should it be taken to encapsulate all the responsibilities and obligations of the law.

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Background

Numerous fatalities and electrical incidents resulting from electrocution that occurred in the last decade demonstrated shortcomings with regards to employee and personal safety in Construction Sites resulting from contact with live electrical installation (direct /or indirect). The common causes are:

1.1.1 unsafe situation, unsafe equipment, and unsafe system of work or work practices;

1.1.2 inadequate isolation and information;

1.1.3 poor control of work activities;

1.1.4 improper use of electrical appliance, extension cords, 2 and 3-pin plugs and socket outlet; and

1.1.5 lack of knowledge, person not trained / competent and many others.

1.2 Validity

This document is valid for five (5) years from the last revision date. Within this period, this document shall be assessed for relevance and re-validated in accordance with the review cycle and review process. Any suggestions for further improvement to this document can be sent to the Document Owner.

1.3 General

This document and associated parts, EIR (Electrical Installation Requirement, DES), Safe Use of Electricity at Construction Sites and SHENA Industry Guidance Note provide the basic and foundation on the requirement for any electrical installations and use of electrical tools serve as guidance reference /or minimum safety.

1.4 Purpose

1.4.1 The purpose of this document is to provide guidance on the minimum electrical standard when setting up mobile equipment and/or temporary power to be used in the period of construction or demolitions work which is intended to be taken out of service upon completion of the works on mobile or portable electrical tools /or equipment.

1.4.2 Compliance with relevant safety standards and requirements will enable the task to be properly carried out so as to avoid poor quality, and damage to equipment, and facility and endanger people from suffering

from electric shock & burns when they use unsafe equipment and in contacting overhead power lines & buried cables.

1.4.3 The requirements apply to fixed or moveable installations. This document deals with selection and application in the installation throughout the construction duration until it is removed. This document is not intended for the design, manufacturing, assemblies and testing of electrical equipment nor to instruct untrained persons.

1.5 Scope

1.5.1 The scope of this Guidance and Best Practices document covers on-site installations for one single source of power on local generation, distribution of electricity where electricity is used to facilitate various activities during the building or infrastructure development process, for electric operated tools, equipment, lighting, and other electrical devices as follows:

1.5.1.1 Part 1:- Temporary Construction Power

1.5.1.1.1 Circuit from ACS, i.e., site distribution board to sub-distribution board

1.5.1.1.2 from sub-distribution board to extension box.

1.5.1.1.3 from sub-distribution board to tools/equipment.

1.5.1.2 Part 2:- Standalone / Mobile Generator > 10kVA to 1250kVA

1.5.1.2.1 from local diesel genset to site distribution board.

1.5.1.2.2 LV single & 3 phases non-paralleling generator set from 10kVA to 1250kVA.

1.5.2 The following are NOT inclusive in this scope:

1.5.2.1 setup and installation of HV equipment i.e., RMU (Ring Main Unit),

1.5.2.2 HV switchboard /switchgear both indoor and outdoor.

1.5.2.3 Installation of Main feeder pillar, service pillar, distribution feeder panel of greater,

1.5.2.4 Synchronising of generator to grid,

1.5.2.5 Paralleling of electrical distribution,

1.5.2.6 Microgrids i.e., Solar Panel/Array,

1.5.2.7 Modification of existing system either extension, alteration of any installation,

1.5.2.8 *Equipment* with self-contained battery supplies,

1.5.3 This document consists of the following parts, under the general title Guideline to Construction Power:

1.5.3.1 Part 1: Temporary Construction Power

1.5.3.2 Part 2: Standalone Mobile Generator >10kVA to 1250kVA

1.5.3.3 Part 3: Electrical Safety at Construction Site

1.5.4 Words that are in italic font *shall* be make reference to respective definition.

2 DEFINITIONS

2.1 "Shall": indicates a requirement strictly to be followed in order to conform to the standard and from which no deviation is permitted, unless accepted by all involved parties.

2.2 Should: make a recommendation to indicate that among several possibilities one is recommended as particularly suitable without mentoring or excluding others, or that a certain course of action is preferred but not necessarily required.

2.3 Can: used for statements of possibility and capability, whether, physical or causal

2.4 Could: used to indicate an allowable course of action within the limits in this standard

2.5 Conductor: of material aluminium or copper metal forming a wire, cable or other designed for carrying electric current.

2.6 Dead: electrically discharged by being disconnected from any electrical supply and not having any charge retained by capacitance.

2.7 Earth electrode: A conductor or group of conductors in intimate contact with, and providing an electrical connection to, earth.

2.8 Earth Resistance: The resistance of the earth between the earth electrode and remote reference earth.

2.9 Mean ground level: average ground level

2.10 Low voltage: voltage that does not exceed 1000Vac or 1500Vdc

2.11 Live (1): electrically charged by connected to low/high voltage electricity supply or having charge retained by capacitance.

2.12 Live (2): in all circumstances, all electrical equipment is considered electrically charged until it is demonstrated, isolated, proved to be dead and earthed.

2.13 High voltage: voltages exceed low voltage U>1000V

2.14 Insulation: means separated from adjoining conducting material by a non-conducting substance which provides resistance to the passage of current, or to disruptive discharges through or over the surface of the substance at the operating voltage, and to mitigate the danger of shock or injurious leakage of current.

2.15 Sag: the distance measured vertically from a conductor to the straight line joining its two points of support. Unless otherwise stated in the rule, the sag referred to is the sag at the midpoint of the span.

2.16 Clearance: the clear distance between two objects measured surface to surface, and usually filled with a gas such as air.

2.17 Span: the horizontal distance between two adjacent supporting points of a conductor.

2.18 Wayleave: cleared swath of land / area under power overhead line.

2.19 Standalone: able to function independently.

2.20 In addition to the following may or can be taken as the same meanings

2.20.1 Right-of-Way: - also known as Wayleave.

2.20.2 Temporally equipment neither fixed nor stationary equipment.

2.20.3 Termination: - make connection.

2.20.4 Tie-in(s): - make connection.

2.20.5 Transportable / moveable: - as per "mobile."

2.21 Extracted from IEC 60050-212

2.21.1 Clause 212-11-18 "DC (electrification current)" – current after electrification by constant voltage between two electrodes in contact with an insulating material.

2.22 Extracted from IEC 60050-141

2.22.1 Clause 141-02-06 "star connection" – in a polyphase element, connection in which all phase elements have a common node.

2.23 Extracted from IEC 60050-151

2.23.1 Clause 151-11-25 "equipment" - single apparatus or set of devices or apparatuses, or the set of main devices of an installation, or all devices necessary to perform a specific task.

2.23.2 Clause 151-12-01 "electric circuit" - arrangement of devices, media, or both, forming one or more conductive paths and where these devices and media can have capacitive and inductive coupling.

2.23.3 Clause 151-12-07 "connection (1)" - intentional electric contact between conductors or intentional junction between waveguides including optical fibres.

2.23.4 Clause 151-12-08 "connection (2)" - conductor or electric circuit for joining terminals or other conductors.

2.23.5 Clause 151-12-09 "connecting" - the action of establishing a connection.

2.23.6 Clause 151-15-41 "insulation" – all the materials and parts used to insulate conductive elements of a device.

2.23.7 Clause 151-16-44 "fixed" - fastened to a support or otherwise secured in a specified location.

2.23.8 Clause 151-16-46 "mobile" - capable of operating while being moved.

2.24 Extracted from IEC 60050-601

2.24.1 Clause 601-01-10 "distribution of electricity" – the transfer of electricity to consumers within an area of consumption.

2.24.2 Clause 601-03-04 "overhead line" – An electric line whose conductors are supported above ground, generally by means of insulators and appropriate supports.

2.25 Extracted from IEC 60050-602-02-01

2.25.1 Clause 601-01-10 "generator set" – a group of rotating machines transforming mechanical or thermal energy into electricity.

2.26 Extracted from IEC 60050-826

2.26.1 Clause 826-16-04 "mobile equipment" - electrical equipment which can move or can be moved while in operation or which can be moved from one place to another while connected to the supply.

2.26.2 Clause 826-16-06 "stationary equipment" - fixed equipment or equipment that cannot be easily moved.

2.26.3 Clause 826-16-07 "fixed equipment" - electric equipment fastened to a support or otherwise secured in a specific location.

2.27 Extracted from IEC 61439-1

2.27.1 Clause 3.1.2 "assembly system" – a full range of mechanical and electrical components (enclosures, busbars, functional units, auxiliary circuits and associated controls, etc.), as defined by the original manufacturer, which can be assembled in accordance with the original manufacturer's instructions in order to produce various assemblies.

2.27.2 Clause 3.1.8 "functional unit" – part of an Assembly comprising all the electrical and mechanical elements that contribute to the fulfilment of the same function.

2.27.3 Clause 3.1.9 "incoming unit" – function through which energy is normally fed into the assembly.

2.27.4 Clause 3.3.2 "dead front assembly" – open-type assembly with front cover, the live parts possibly being accessible from directions other than the front.

2.27.5 Clause 3.3.3 "enclosed assembly" – assembly which is enclosed on all sides with the possible exception of its mounting surface in such a manner as to provide a defined degree of protection.

2.27.6 Clause 3.7.24 "class 1 assembly" – assembly with at least one provision for a basic protection and a connection to a protective conductor as a provision for fault protection.

2.27.7 Clause 3.7.25 "class II assembly" – assembly which is provided with the following;.

2.27.7.1 Basic insulation as provision for basic protection and Supplementary insulation as provision for fault protection, or in which;

2.27.7.2 Basic protection and fault protection are reinforced insulation.

2.27.8 Clause 3.7.7 "fault current" - current resulting from an insulation failure, the bridging of insulation or incorrect connection in an electrical circuit.

2.27.9 Clause 3.8.6 "short-circuit current Ic " - overcurrent resulting from a short-circuit due to a fault or an incorrect connection in an electric circuit

2.27.10 Clause 3.8.9.1 "rated voltage Un" - highest nominal voltage of the electrical system, declared by the assembly manufacturer, to which the main circuit(s) of the assembly is (are) designed to be connected

2.27.11 Clause 3.8.10.1 "rated current" - the value of uninterrupted current, declared by the assembly manufacturer which can be carried without the temperature-rise of various parts of the assembly exceeding specified limits under specified conditions

2.27.12 Clause 3.8.10.7 "rated current of an assembly InA" rated current which can be distributed by an assembly without the temperature-rise of any of the parts exceeding specified limits.

3 Acronyms and Abbreviations

For the purpose of this document, the following abbreviation shall apply:

AC	alternating current
DC	direct current
OHL	overhead line
HV	high voltage
LV	low voltage
RLV	reduce Low Voltage
PE	protective earth

4 Applicable standards and industry guidance

This standard is prepared for local generation using diesel fuel, it cannot be used for the purpose of determining conformity NEITHER apply to individual devices and self-contained components, such as circuit breakers, fuse switches, electronic equipment, etc., Assemblies *shall* comply with associated IEC & British standard but not limited to following:

4.1 The Electricity Safety, Quality and Continuity Regulations UK Statutory Instruments.

4.2 BS4363, Specification for distribution assemblies for reduced low voltage electricity supplies for construction and building sites.

4.3 BS7375, Distribution of electricity on construction and demolition sites – Code of Practice.

4.4 IEC 60245-4, Rubber insulated cables – Rated voltages up to and including 450/750 V –Part 4: Cords and flexible cables.

4.5 IEC 60309-1, Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements.

4.6 IEC 60309-2, Plugs, socket-outlets and couplers for industrial purposes – Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories.

4.7 IEC 60364 (all parts), Low voltage electrical installations.

4.8 IEC 60364-4-41, Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock.

4.9 IEC 60364-5-52, Electrical installations of buildings – Part 5-52: Wiring system equipment.

4.10 IEC 60364-5-53, Electrical installations of buildings – Part 5-53: Selection and erection of electrical equipment – Isolation, switching and control.

4.11 IEC 60364-7-704, Low voltage electrical installations — Part 7-704: Requirements for special installations or locations – Construction and demolition site installations.

4.12 IEC 60364-7-717, Low voltage electrical installations — Part 7-717: Requirements for special installations or locations – Mobile or Transportable units.

4.13 IEC 61439-1, Low voltage switchgear and control gear assemblies- Part 1: General Rule.

4.14 IEC 61439-3, Low voltage switchgear and control gear assemblies- Part 3: Distribution boards intended to be operated by an ordinary person (DBO).

4.15 IEC 61439-4, Low voltage switchgear and control gear assemblies- Part 4: Particular requirements for assemblies for construction sites (ACS)

4.15.1 EIR "Electrical Installation Requirements" published by Department of Electrical Services, Prime Minister's Office Brunei Darussalam.

4.15.2 ESCOM document No. ESCOM/2024/01, Title:- Guidelines and Best Practices for Public Lighting.

4.15.3 ESCOM document No. ESCOM/2024/02, Title:- Guidelines and Best Practices for Portable Appliance Testing.

5 Technical Requirement for Temporary Power

Please refer to Clause 5: Technical Requirement for Temporary Power under the document "Guidelines and Best Practices for Construction Power Part 1: Temporary Construction Power" (ESCOM/2024/04).

~~6~~ PART 2: Standalone portable/mobile >10kVA to 1250kVA

6.1 Local Diesel Generator Set

6.1.1 Technical Requirement for Local Diesel Generator Set Standalone Mobile Generator Set >10kVA to 1250kVA

In this document, generator set refers to a self-contained engine-driven generator consisting of a synchronous AC generator, generator Prime mover (typically diesel engine), skid control panel (i.e., inclusive engine & generator) and all associated auxiliary equipment complete with batteries and batteries chargers mounted on a common skid.

6.1.2 General Requirements

6.1.2.1 When temporary *Low Voltage* is provided by a local mobile generator set, the following *shall* be made available and certified by a competent qualified person before any connection is to be made:

6.1.2.1.1 A block diagram of the generator set and electrical equipment installation, indicating an estimated list / tabulated with electrical loads showing rated power and total consumption.

6.1.2.1.2 Single line diagram and equipment layout with earthing / grounding *shall* be prepared for the complete temporary power system including the mobile generator set.

6.1.2.1.3 Description of operation, plan running hours, competent electrical personnel etc.

6.1.2.2 Non-paralleling system, with no grid connection from DES / BPC.

6.1.3 Generator set requirement

6.1.3.1 For mobile and temporary service, the generator set shall be self-contained with the engine, generator and associated equipment, controls and battery charger mounted on a single skid/frame not limited to the following:

6.1.3.1.1 Engine complete with all necessary auxiliaries.

6.1.3.1.2 Synchronous AC generator including excitation equipment.

6.1.3.1.3 Engine and generator control panel(s).

6.1.3.1.4 Noise Suppression Equipment.

6.1.3.1.5 Vibration / shock absorber.

6.1.3.1.6 Engine Starting System.

6.1.3.1.7 Engine and generator cooling system.

6.1.3.1.8 Lubrication system.

6.1.3.1.9 Air intake and exhaust system.

6.1.3.1.10 Engine fuel systems and day tanks.

6.1.3.1.11 Shut down system.

6.1.3.1.12 Gauge and instrumentation.

6.1.3.1.13 Starting batteries and battery charger.

6.1.5 Generator Electrical Requirement

6.1.5.1 Figure 6-1 below shows the basic electrical concept for a mobile generator set.

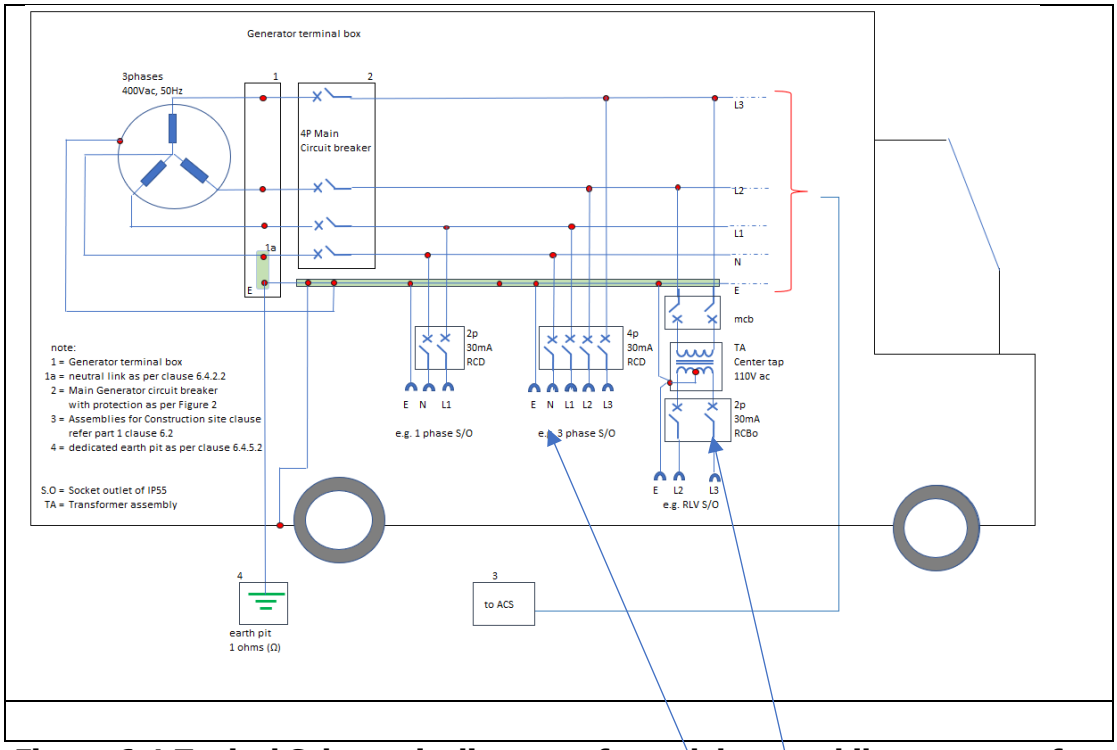

Figure 6-1 Typical Schematic diagram of standalone mobile generator for Temporary Construction Site

30mA or lower is applicable to protect the user in the final circuits, if the final circuit is fed from another distribution board, 100mA RCD is acceptable for the purpose of discrimination.

Reply:

1) Where discrimination is required, the terminal connection shall be used, see Figure 2 below.
2) For S/O
   a. It is subjected to a discussion that this outlet can be a final circuit when the construction team connected to hand tools like grinder, power tools etc.
   b. 30 mA is the maximum allowed by regulation, EIR and BS7671.
   c. If the site requires higher, they can submit to change during which will be accessed, approved and tested by a competent qualified person as per clause 6.2.1.

6.1.5.2 Main generator output voltages as per clauses 1.3 EIR "Electrical Installation requirement"

6.1.5.2.1 3phases + N + E, 400Vac, 50Hz.

6.1.5.2.2 1phase + N + E, 230Vac, 50Hz.

6.1.5.3 Local generator set shall: -

6.1.5.3.1 COMPLIED and supplied to LV electrical distribution system with TNS system network configuration.

6.1.5.3.2 be provided with an external earthing terminal complete with a removable copper link with its neutral terminal at the generator terminal box.

6.1.5.3.3 has a generator neutral connection taken from the star point and earthed to an independent earthing pit on a three (3) phase output.

6.1.5.3.4 have it neutral of the generator winding connected to the generator frame/chassis and earthed to an independent earthing pit on a single (1) phase output.

6.1.5.3.5 maintain one (1 Ω) ohm electrode resistance for generator earthing pit as per clause 8.6 EIR "Electrical Installation Requirement-2011 1st editions.

6.1.5.3.6 neither be parallel nor interconnected to other electrical systems.

6.1.5.4 Local generator set *shall* not:

6.1.5.4.1 be resistance or impedance earthed.

6.1.5.4.2 be used with floating or isolated earth configuration or without reference to the general mass of earth.

6.1.5.5 Interconnection

Irrespective of the number of sources of supply, the phase and neutral conductors from different sources shall not be interconnected downstream to prevent back-feed. This is in accordance with IEC 60364-7-717 clause 551.6 states "Units with different power supply systems and different earthing systems shall NOT be interconnected".

6.1.5.6 Electrical panel (Generator control panel / batteries charger)

6.1.5.6.1 Where electrical panels (generator control panel and battery charger system) are mounted on a skid and NOT in any enclosed room/container.

6.1.5.6.1.1 It shall be weatherproof against water splashing from all directions i.e., minimum IP55 shall be provided.

6.1.5.6.1.2 Shall be protected against heavy shock, vibration and transient.

6.1.5.7 Electrical panel shall be:

6.1.5.7.1 Free-standing, self-supported manufactured from 2-mm thick sheet steel.

6.1.5.7.2 Front access for operation, maintenance and repair.

6.1.5.7.3 Minimum IP3XB with the door open.

6.1.5.7.4 Barricaded from any exposed live.

6.1.5.8 All electrical wiring of less than 4mm^2 shall be terminated with tin-plated insulated lugs/ferrules. All wiring shall be multi-strained and solid wire is NOT recommended due to vibration during generator running.

6.1.5.9 Each control panel, sub-panel, indicating instrument, control handle, alarm, signal lamp, etc., shall be clear using self-explanatory and unambiguous labels.

6.1.5.10 Generator main circuit braker shall not be auto closed nor auto reset or via any remote signal/or control.

6.1.5.11 Where RLV is required at the site, it is acceptable to have a centre tap isolating transformer set integrated as part of the electrical panel and equipped with appropriate rated current and rated residual current of 30 mA RCD for each socket outlet. Refer to Figure 6-1 above.

6.1.6 All socket outlets shall be of industrial type of IP55 and have a current rating of at least 16A.

6.1.7 Colour of Plugs, socket-outlets/receptacles and couplers as per Table 6-1 IEC 60309-1 and BS 7375 below:

Table 6-1 Colour coding of plugs, socket-outlets and couplers

Operating voltage	Colour
100 to 130	Yellow
200 to 250	Blue
380 to 480	Red

6.1.8 Electrical protection

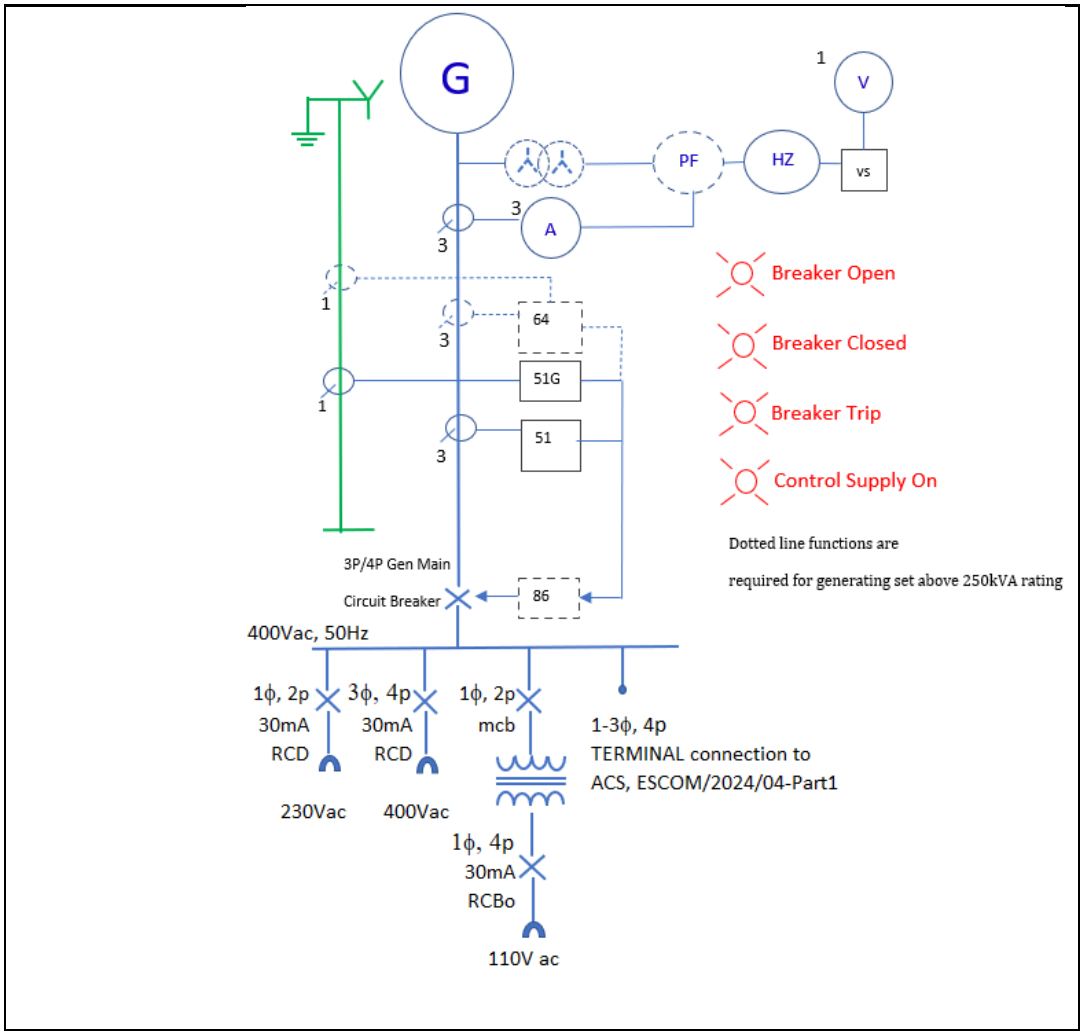

Figure 6-2 Typical single-line diagram for island/non-parallel generating set

Table 6-2 Protection, Monitoring and Control

Item	Function	Action		
		Indication	Trip Generator MCB	Stop Engine
1	Emergency Stop Push button		X	X
2	Lamp test/reset button	X		
3	Ammeter (A)	X		
4	Power Factor (PF)	X		
5	Frequency (HZ)	X		
6	Voltmeter (V) (c/w 7-positions phase selector switch)	X		
7	Restricted Earth Fault (64)		X	X
8	Standby Earth Fault (51G-Inverse time)		X	X
9	Over current (51-Inverse time)		X	
10	Lockout Relay (86)		X	
11	Earth Fault Protection (Residual Current Circuit Breaker, RCBO*)		X	
12	Status-Breaker Open	X		
13	Status-Breaker Closed status	X		
14	Status-Breaker Trip	X		
15	Status-Control Supply On	X		
* for smaller set generator of output Current =125A, RCBO is acceptable				

6.1.9 Construction and Installation requirement

6.1.9.1 Generator set shall:

6.1.9.1.1 be provided with well-ventilated semi-enclosed shelter comprising a roof and sidewalls as appropriate to protect the unit's severe weather

6.1.9.1.2 fenced with not less than 1 m space, use of barricade tape is not acceptable.

6.1.9.1.3 separated from any storage area for fuel (i.e., diesel, petrol) and containment.

6.1.9.1.4 fire extinguisher of type CO^2 or chemical.

6.1.9.1.5 Signboard.

6.1.9.2 Generator set shall NOT be:

6.1.9.2.1 located /or installed adjacent to any pressurized gas cylinder(s) e.g., LPG, oxygen and/or acetylene gas cylinder, etc.; or

6.1.9.2.2 located in a storage area for any paint, oil base solvent e.g., thinner.

6.1.10 Installation requirement

6.1.10.1 Beside electrical shock, a generator set shall be arranged and installed to prevent danger and injury to people from non-electrical danger through inadvertent contact with

6.1.10.1.1 Hot surfaces;

6.1.10.1.2 Danger rotating part;

6.1.10.1.3 Poisonous fumes;

6.1.10.1.4 Slip trip and fall due to oil spill, uneven surface, obstacles etc.; or

6.1.10.1.5 Consequences related to vibration, loose /not fully tightening.

6.1.10.2 Proper support and mounting shall be provided for both the air intake and exhaust system to prevent excessive stress, shock, vibration and transient.