TECHNICAL SPECIFICATION

PACKAGED UNIT AC GENERATOR SETS

DEP 33.65.11.32-Gen.

October 1994

DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of:

Shell International Oil Products B.V. (SIOP)
and
Shell International Exploration and Production B.V. (SIEP)
and
Shell International Chemicals B.V. (SIC)

The Hague, The Netherlands,

and other Service Companies.

They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use DEPs they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will expect them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal or its technical advisor.

The right to use DEPs is granted by SIOP, SIEP or SIC, in most cases under Service Agreements primarily with companies of the Royal Dutch/Shell Group and other companies receiving technical advice and services from SIOP, SIEP or SIC. Consequently, three categories of users of DEPs can be distinguished:

1) Operating companies having a Service Agreement with SIOP, SIEP, SIC or other Service Company. The use of DEPs by these Operating companies is subject in all respects to the terms and conditions of the relevant Service Agreement.

2) Other parties who are authorized to use DEPs subject to appropriate contractual arrangements.

3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, SIOP, SIEP and SIC disclaim any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any DEP, combination of DEPs or any part thereof. The benefit of this disclaimer shall inure in all respects to SIOP, SIEP, SIC and/or any company affiliated to these companies that may issue DEPs or require the use of DEPs.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of SIOP and SIEP, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of SIOP and SIEP. The copyright of DEPs vests in SIOP and SIEP. Users shall arrange for DEPs to be held in safe custody and SIOP or SIEP may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

All administrative queries should be directed to the DEP Administrator in SIOP.

NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

TABLE OF CONTENTS

APPENDICES

1. INTRODUCTION

1.1 SCOPE

This is a new DEP which gives the minimum requirements for the design, manufacturing, assembly, inspection and testing of packaged unit AC generator sets, hereafter referred to as generator sets. A generator set consists of a synchronous AC generator, an engine driving the generator, their control, protection and relay panels, auxiliary equipment and a baseplate. Drivers applied to these generator sets may be either gas or diesel engines.

The range of applicability intended is from approximately 100 kVA to 1250 kVA. In exceptional circumstances the Principal may approve the application of this DEP to generator sets outside this range.

The applicable technical specification shall be given in the requisitions: DEP 33.65.11.94-Gen., DEP 31.29.80.93-Gen. and DEP 33.65.11.93-Gen. The type of engine shall be specified in requisition DEP 33.65.11.94-Gen. The Packager shall provide the information requested by completing the data sheets.

In the case of conflict between documents the following hierarchy shall apply:

upper level:	purchase order and variations thereto
second level:	requisition sheets and project specification
third level:	this DEP

The extent of equipment and services to be provided against this DEP excludes the supply of:

- civil engineering such as buildings, cable floors, trenches, foundations and protective fences
- cabling between skids
- cable tray systems, except as fitted on the package
- switchboards, including generator circuit breaker

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIPM, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them (i.e. the distribution code is "F" as described in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, gas plants, chemical plants, oil and gas production facilities (both onshore and offshore) and supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 PRE-MANUFACTURING MEETING

If deemed necessary, a pre-manufacturing meeting shall be arranged with all parties concerned. This shall be stated on the requisition or may be initiated by the Packager.

The purpose of this meeting is to define the scope and parameters of the order and the responsibilities of each party involved. The final list of deviations to the specification shall be agreed. Agreement shall be reached with respect to administrative, production and test procedures.

Minutes of the pre-manufacturing meeting shall be made by a mutually agreed party and be sent to the Principal for approval within 14 days. The final minutes shall be issued within 14 days of notification by the Principal of approval of the draft.

1.4 DEFINITIONS

1.4.1 General Definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Packager** is the party that designs, manufactures, assembles, inspects and tests the complete generator set.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.4.2 Technical definitions

Air to air cooled machine 411-14-24, IEC 50
A closed machine with integral or machine mounted heat exchanger, using air as the primary and secondary coolant.

Air to water cooled machine 411-14-25, IEC 50
A closed machine with a heat exchanger using air as primary coolant and water as secondary coolant.

Certificate
Document issued by a recognised authority certifying that it has examined a certain type of apparatus and, if necessary, has tested it and concluded that the apparatus complies with the relevant standard for such apparatus.

Certificate of conformity
Certificate stating that the electrical apparatus complies with the relevant standards for apparatus for potentially explosive atmospheres.

Declaration of compliance
Document issued by the manufacturer stating that the electrical apparatus complies with the requirements of IEC 79-15.

Hazardous area 423-03-01, IEC 50
An area in which an explosive gas mixture is or may be expected to be present in a quantity such as to require special precautions for the construction, installation and use of electrical apparatus.

Land installation
An installation located at sufficient distance from open saliferous water to minimize the effect of a salt-laden atmosphere.

Lifetime
The lifetime of a generator set is the time during which the generator set remains suitable for the application for which it was made, provided it is regularly inspected, examined and serviced in accordance with the manufacturer's instructions, with replacement of lubricants and of parts subject to wear.

Low voltage 601-01-26, IEC 50
A set of voltage levels used for the distribution of electricity and whose upper limit is 1000 V AC.

Marking
Data put on the electrical apparatus by the Manufacturer giving information for safe use of the apparatus.

Rated value 151-04-03, IEC 50
A quantity value assigned, generally by the Manufacturer, for a specific operating condition of a component, device or equipment.

Site conditions
The external factors, e.g. altitude, air temperature, wind velocity, vibration, earthquake, black body temperature and relative humidity, which may influence the operation of a machine or apparatus.

Test report
Document prepared by the Manufacturer indicating in detail the tests and verifications to which the apparatus has been subjected, and their results.

Vital service
A service which, when failing in operation or when failing if called upon, can cause an unsafe condition of the process and/or electrical installation, jeopardize life, or cause major damage to the installation.

Voltage deviation 604-01-17, IEC 50
The difference, generally expressed as a percentage, between the value at a given instant at a point in the system, and a reference voltage such as a nominal voltage, a mean value of operating voltage or a declared supply voltage.

Zone 1 (In the classification of hazardous gas areas), 426-03-04, IEC 50
An area in which an explosive gas atmosphere is likely to occur in normal operation.

Zone 2 (In the classification of hazardous gas areas), 426-03-05, IEC 50
An area in which an explosive gas atmosphere is not likely to occur in normal operation and if it does occurs it will exist for a short period only.

1.4.3 Frequently used Expressions

Emergency generator sets
Generator sets which have an infrequent and relative short duration of operation. They will only operate in case of a power failure of the main grid system for a relative short period, e.g. 24 hours. When the main grid system is available the starting ability of these generators will be tested at regular intervals, e.g. once every week.

Generator sets for continuous operation
Generator sets which provide power to the connected installation and may run in single operation, in parallel with the main grid system or in parallel with other generators on a continuous basis. The nature of the operation shall be specified in the requisition.

Generator sets for island operation
Generator sets which are not connected to any supply grid with external generating capacity.

Generator sets for parallel operation
Generator sets with an ability to operate without permanent supervision in parallel with the main grid system, in parallel with other generators, or both.

Generator sets supplying large non-linear loads
Generator sets with an ability to supply large non-linear loads (e.g. rectifiers), while operating within its temperature limits.

1.5 ABBREVIATIONS

AC	:	Alternating current
AISI	:	American Iron and Steel Institute
ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for the Testing of Materials
AVR	:	Automatic Voltage Regulator
AWS	:	American Welding Society
BS	:	British Standard
CT	:	Current transformer
ESD	:	Emergency shut down
IEC	:	International Electrotechnical Commission
IP	:	The degree of ingress protection of an enclosure according to IEC 529 (for example: IP 41)
ISO	:	International Organisation for Standardization
LED	:	Light emitting diode
SI	:	International System of Units
VDE	:	Verbandes Deutscher Elektrotechniker
VT	:	Voltage transformer

1.6 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP are listed in (13).

1.7 UNITS

Technical units, quantities etc. are and shall be expressed, used and abbreviated according to the SI system and DEP 00.00.20.10-Gen.

2. BASIC REQUIREMENTS

2.1 GENERAL

The generator set shall be the product of a Packager regularly engaged in their production. The generator set shall be of modern design and proven performance. Design and construction of the generator set shall provide accessibility for all components requiring routine operational attention and maintenance.

The requirements in (2) to (7) apply to all generator sets. The requirements for specific modes of operation are given in (8).

For certain special applications it may be necessary to deviate from this DEP. Any special requirements shall be stated in the requisition.

2.2 SAFETY

The generator set shall be designed to minimize any risk of internal short circuits and to ensure personnel and plant safety under all prescribed conditions of operation, inspection and maintenance.

The generator set shall be designed to withstand the thermal and dynamic stresses and transient mechanical torques such as those resulting from a short circuit and circuit switching operations. Damage arising from component failure should be confined to the component concerned.

Products that are persistent or toxic to the environment or are considered potential carcinogens shall not be used, e.g. polychlorinated biphenyls (PCB's), asbestos, cadmium plating.

All exposed rotating or moving parts shall be protected by guards in accordance with BS 5304 or equivalent national standard. The guards shall be readily removable for plant maintenance purposes.

Exposed surfaces which attain a temperature in excess of 70 °C under normal operation and which are a potential hazard to personnel shall be screened.

All flexible drive belts shall be of anti-static material to ISO 1813.

2.3 SERVICE CONDITIONS

The equipment shall in all respects be suitable for operation in a saliferous and dusty atmosphere. The possibility of condensation on equipment surfaces shall be taken into account. The site environmental conditions shall be given in the requisition.

The generator set shall be suitable for unattended operation.

Unless otherwise specified in the requisition, the following conditions shall apply:

2.3.1 Seismic conditions

Generator sets for installation offshore shall be designed for shock accelerations of 20 m/sec^2 whilst in operation, without interference to operation.

2.3.2 Hazardous areas

The Principal should install generator sets in a non-hazardous area. However, if the circumstances of the installation dictate that the installation will be in a hazardous area, it shall be stated in the requisition. All equipment in the package shall then be suitable for operation in the hazardous area.

See DEP 31.29.90.30-Gen. for gas engine fuel gas systems with respect to hazardous areas.

2.4 MATERIALS

All components shall be of a quality commensurate with the requirements of a secure power supply system. Component materials shall be flame retardant, moisture and fungus resistant whenever practicable. Equipment destined for humid tropical environments shall be compatible with these environments.

2.5 SCOPE OF SUPPLY

The generator set shall in general consist of:

- engine complete with all necessary auxiliaries
- synchronous AC generator complete with excitation equipment
- combined baseplate
- engine and generator control panel(s)
- all necessary noise and vibration suppression equipment
- engine starting system
- engine and generator cooling systems
- lubrication system
- combustion air intake system
- exhaust system
- engine fuel system
- fuel day tank (diesel engines)
- couplings and guards
- all necessary interconnecting pipe work and valves, including drain connections terminating at the edge of the baseplate
- local gauge panel and instrumentation
- all CT's and VT's (incl. those for installation in the switchboard).

The Packager shall advise any deviation from this DEP in his tender.

3. PERFORMANCE REQUIREMENTS

3.1 RATING

The rating of the generator set shall be the total net output rating at the generator terminals. The component (e.g. engine, generator, coolers, etc.) with the lowest individual rating shall provide the limit for defining the net output of the generator set. The rating of any significant electrical auxiliaries, such as electric cooling fans, shall be deducted from the output rating. The generator set shall have a continuous power rating as stated on the requisition, at a power factor of 0.8 lagging.

3.2 NOISE

Noise control requirements as given in DEP 31.10.00.31-Gen. shall be adhered to. The Principal shall specify the noise limitations of the generator set, using data sheet DEP 31.10.00.94-Gen., which forms part of the requisition.

The Packager shall submit guaranteed sound power levels and sound pressure levels of the packaged unit, together with any other relevant information as requested in DEP 31.10.00.94-Gen. The Packager shall indicate what special silencing measures, if any, are proposed in order to meet the specified levels.

3.3 TORSIONAL VIBRATIONS

A torsional vibration analysis shall be performed by the Packager. The necessary remedial measures shall be implemented in accordance with DEP 31.29.90.30-Gen. or DEP 31.29.80.30-Gen.

3.4 LATERAL VIBRATIONS

The lateral vibration severity of the complete generator set shall not exceed 4.5 mm/s RMS as defined in ISO 2372.

The vibration levels of individual auxiliary low voltage electric motors shall be as per DEP 33.66.05.31-Gen.

4. ENGINE REQUIREMENTS

4.1 GENERAL

The requirements for the engine driving the generator are be described in either DEP 31.29.80.30-Gen., or DEP 31.29.90.30-Gen., as specified in the requisition. In general, the engine Supplier will furnish the engine with all necessary auxiliaries and accessories for operation of the engine. This section describes the packaging requirements for installation of the engine. This section is intended for application where these auxiliaries and accessories are not mounted directly on the engine but require assembly by the Packager as part of his scope of work.

4.2 AIR INTAKE SYSTEM

Where an air intake filter has been supplied loose by the engine Supplier, the Packager shall provide the mounting for the air filter and all piping and ductwork between the air filter and the engine.

Intake ducting or piping shall be properly supported to prevent excessive strains being applied to the intake nozzle on the engine. Expansion bellows provided by the engine Supplier shall be installed in the locations approved by the engine Supplier.

All intake ductwork shall be swabbed and blown clean of any debris before final assembly.

4.3 EXHAUST SYSTEM

Where the engine Supplier has supplied an exhaust silencer the Packager shall provide the mounting for the silencer and all piping and ductwork between the silencer and the engine.

Exhaust ducting or piping shall be properly supported to prevent excessive strains being applied to the exhaust nozzle on the engine. Due account shall be taken of thermal expansion and the expansion bellows provided by the engine Supplier shall be installed in the locations approved by the engine Supplier.

The orientation of the exhaust shall be agreed with the Principal, taking account of the location of adjacent equipment and the prevailing wind.

4.4 FUEL SYSTEM

Shutoff valves for fuel gas will be supplied loose by the engine Supplier. These valves shall be installed in locations agreed with the Principal, taking account of the hazardous area classification. The routing and point of emission of all fuel gas vents shall not infringe the hazardous area classification.

4.5 COOLING SYSTEM

If the engine Supplier has supplied engine and lube oil coolers loose, these shall be installed by the Packager.

If the cooler location is remote from the engine, e.g. in the wall of an enclosure or free-standing adjacent to the baseplate, the piping shall be installed by the Principal.

The orientation of the air flow from the cooling fan shall be away from the package. The Packager shall ensure continued adequate cooler performance when the wind is blowing directly against the cooler with a maximum wind velocity as stated in the requisition.

NOTE: If wind data are not available, a maximum velocity of 50 knots shall be used.

If a remotely located cooler has a fan which is mechanically driven from the engine, the Packager shall provide lineshafting and belt drive as necessary.

4.6 SHAFT COUPLINGS

Non-lubricated couplings for auxiliaries and accessories shall be supplied by the Packager as required for driving separately mounted accessories.

4.7 FREQUENCY STABILITY

The requirements for isochronous operation, speed droop operation, or single operation mode shall be given in the requisition.

The total kinetic energy of the rotating train in combination with the governor gain and the stability adjustment of the total generator set shall provide frequency stability in accordance with governing class A2 as defined in ISO 3046/IV for generators operating in single mode.

The governor shall be of an electronic type.

5. GENERATOR REQUIREMENTS

5.1 GENERAL

The generator shall be designed, manufactured and tested in accordance with DEP 33.65.11.31-Gen., except as modified herein.

5.2 GENERATOR IMPEDANCES

The requisition shall specify the requirements for minimum and maximum subtransient and transient impedances, together with the maximum tolerances.

5.3 EXCITATION SYSTEM

5.3.1 General

The generator shall be self-exciting, i.e. it shall generate its nominal voltage without the use of external power sources, even after long idle periods or after a short circuit.

The excitation system shall comprise at least the following:

- excitation equipment
- AVR
- voltage adjuster (rheostat)
- AVR voltage failure relay (alarm).

In addition to brushless excitation, static excitation consisting of voltage and current transformer circuits, where the generator rotor current is supplied via sliprings and brushes, is also acceptable.

The AVR shall be of the electronic type provided with a fine voltage adjuster. It shall include frequency sensing circuitry to limit the ceiling voltage and to prevent damage to components when the generator is driven at reduced speeds, such as when starting or when the engine is at idling speed.

Where excitation power is derived from terminal voltage, current boost circuitry shall be included to provide excitation under short circuit conditions and to maintain a short circuit current greater than 300% of the nominal current for 3 seconds.

The AVR shall be matched to the generator characteristics and shall be of adequate construction and design to fully meet all operational and performance requirements.

The AVR shall be equipped with frequency dependent constant voltage (U = constant down to 90% rated frequency) and adjustable slope (U/f) facilities.

The AVR should be installed in the generator control panel. Installation of the AVR at the generator is subject to approval by the Principal, or may be specified in the requisition. In this case the AVR shall be located in a separate housing or in a clearly segregated section of the main terminal box.

For generator sets operating in parallel with other generators, or with a grid system, see (8.5).

5.3.2 Excitation - Rated current

The rated excitation current shall be at least 110% of the excitation current at the rated output of the generator under the most stringent operating conditions.

The excitation system shall be able to cope with any field forcing conditions that the generator is required to supply, e.g. starting large motors. The field forcing capability shall be sufficient to enable adequately graded relay settings to be made for system fault current protection.

5.3.3 Excitation - Rated voltage

The rated voltage of the excitation system shall be at least 110% of the rotor voltage at the

rated output of the generator under the most stringent conditions. The ceiling voltage shall be not less than 120% of the rated voltage of the exciter.

5.4 OUTPUT VOLTAGE VARIATIONS

The voltage regulation of the generator shall be grade VR2.31 in accordance with BS 4999 Part 140. If a more stringent voltage regulation is required, as dictated by the connected loads, this shall be specified in the requisition.

5.5 EFFICIENCY

The generator efficiency at nominal load and a power factor of 0.8 shall be not less than:

Rated output	Efficiency
50 - 100 kVA	90%
125 - 300 kVA	91%
330 - 600 kVA	92%
630 -1250 kVA	93%

Guaranteed values for the efficiency shall be given by the Packager for 50%, 75% and 100% of rated output.

5.6 RADIO FREQUENCY INTERFERENCE

The production of radio frequency interference voltages shall not exceed the value of suppression grade 'N' as defined in VDE 0875.

5.7 GENERATOR COOLING

The preferred methods of generator cooling are:

- self cooled open-IC 01
- air to air-IC 0141/0151/0161/0166
- air to water-IC W 37 A 81

The designations are in accordance with IEC 34-6.

The required method of cooling shall be specified in the requisition.

5.8 GENERATOR HOUSING

5.8.1 General

The degree of ingress protection of the enclosures for a generator and for its auxiliaries intended for outdoor installation shall be at least IP 55.

The generator and exciter enclosures shall be fitted with suitable inspection plates and access covers which shall be designed for quick and simple removal. Access covers to the rotating excitation rectifier equipment shall be adequately sized to permit easy maintenance by personnel using both hands.

The generator shall be provided with an external earthing terminal bolt, which shall be clearly marked with the appropriate symbol.

5.8.2 Stator frame

The generator frame and bearing end-shields shall be constructed of ferrous metals.

All welding shall comply with ANSI/AWS D1.1 or the relevant local code.

5.9 WINDINGS

The windings of the generator, and if stalled of the exciter and the pilot exciter, shall be designed in accordance with DEP 33.66.05.31-Gen.

5.10 BUSHINGS AND TERMINALS

The common neutral connection point shall be taken from the star point and brought into the main terminal box.

The copper earth terminal bolt inside the main terminal box shall have a removable copper link connection with the neutral terminal.

5.11 BEARINGS

The bearing design shall be in accordance with DEP 33.66.05.31-Gen.

If bearings are of the grease-lubricated rolling element type, grease nipples and appropriate grease relief devices shall be fitted. Bearings shall have a minimum greasing interval of 4000 operating hours, but should have a greasing interval of greater than 8000 operating hours. The required greasing intervals shall be indicated on the rating plate.

If sleeve bearings are fitted, a lubricating oil overflow shall be provided which prevents the bearing from holding an excess of oil while still permitting efficient lubrication when the machine is running. Measures shall be taken to prevent lubricant from creeping along the shaft or otherwise gaining access to the insulation of the machine or to any live part thereof.

Bearing insulation shall be provided on all bearings unless the generator Manufacturer can demonstrate that rotor stray currents are too low to damage the bearings.

6. CONTROL AND PROTECTION EQUIPMENT

6.1 GENERAL

Unless otherwise specified in the requisition, the generator set shall be provided with the following monitoring, control and protection equipment:
- local gauge panel for the engine
- engine control panel
- generator control panel.

If specified in the requisition, the engine control panel may be combined with the generator control panel into one freestanding cubicle. Clear physical segregation between engine and generator controls shall be provided.

6.2 ENGINE CONTROL PANEL

The engine control panel shall be manufactured in accordance with DEP 31.29.80.30-Gen. or DEP 31.29.90.30-Gen. and the construction requirements of this DEP (6.4).

6.3 GENERATOR CONTROL PANEL

Unless otherwise specified in the requisition, the generator control panel shall comply with the requirements of (6.3) and (6.4).

6.3.1 Generator control panel features

The generator control panel shall include the following:
- all control and protection devices required for the safe and reliable operation of the generator
- AVR, see (5.3.1)
- complete AC sub-distribution for the generator space heater, panel space heater and any other generator auxiliary items
- battery backed up DC power supply distribution for the generator protection systems (may be combined with the engine protection systems)
- raise/lower voltage adjuster (behind the panel door)
- generator status, alarm and trip functions as specified in the requisition, see also Appendix 1
- generator voltage meter (including 7 step selector switch)
- generator line current meters (1 in each phase)
- power meter
- frequency meter
- power factor meter
- kWh meter (*)
- exciter current meter (*)
- exciter voltage meter (*)
- control panel supply voltage meter (*).

NOTE: * If specified in the requisition.

Standard drawing S 67.055 is a single line diagram of the generator protection, control and indication functions. It shall be considered as typical only; the exact requirements shall be given in the requisition.

The Principal shall provide information regarding the proposed actual lay-out of the generator set and its auxiliaries, the preferred location of the necessary current and voltage transformers and the location of the control and protection cubicles.

All meters shall be a minimum of 72 mm square, and to minimum accuracy class 1.5 according to IEC 51.

6.3.2 Electrical protection requirements

The Packager shall prepare a proposal for the settings of the protection relays. The final setting of the relays shall be agreed between Packager and Principal.

All protection relays shall be of the digital electronic type and shall be installed in such a way that they are clearly visible. Components requiring inspection or adjustment shall be accessible from floor level. Protection relays shall be clearly labelled and shall be equipped with visible flag indicators or other means of indication used on electronic type relays, e.g. LED's. Protection relays shall have manual reset facilities and shall not be sensitive to vibration, shocks or transients. Dust proof flush mounted protection relays of the removable type and provided with calibrating and testing facilities, should be provided. For withdrawable protection relays the terminals connected to CT's shall be automatically short circuited on withdrawal of the relays. Multiple function elements such as tripping and alarm duties shall have separate operating contacts for each function and shall be brought out to separate terminals. CT's for overcurrent protection shall have an appropriate VA rating and accuracy to energise the relays, without causing damage to the latter, over the range of short circuit currents that can arise. Contact rating and performance shall be in accordance with IEC 255.

6.4 CONTROL PANEL CONSTRUCTION

6.4.1 Enclosure and accessibility

All control equipment specified in (6.2) and (6.3) shall be installed in a free standing, self-supporting sheet steel cabinet forming an enclosure. The enclosure shall be suitable for operation and maintenance with its rear panel against a wall, requiring only front access.

The control panel shall be manufactured from sheet steel not less than 2 mm thick. If specified in the requisition the panel shall be manufactured from AISI 316L stainless steel, all panel hardware shall then be stainless steel in compatible grades.

The enclosure shall provide a degree of ingress protection at least equal to IP 41 if the panels are for installation in an enclosed building. The degree of ingress protection shall be at least IP 55 if the panels are for installation outdoors under a rain canopy. The installation floor shall not form part of the enclosure. Internal cooling shall be by natural ventilation. The working temperature of any components shall not have a detrimental effect on any other component.

Equipment and components installed within the enclosure shall not be mounted directly on the enclosure walls. The location and grouping of components and auxiliary equipment shall permit easy identification and access for operation, maintenance and repair. Suitable partitioning between AC power and control sections shall be provided where necessary to allow adjustment and inspection to be carried out safely.

All live terminals of door-mounted equipment having a maximum voltage greater than 24 V shall be shrouded or otherwise protected by barriers to a degree of ingress protection of at least equal to IP 30, to prevent inadvertent contact by personnel when the enclosure door is open. Barriers shall be of rigid transparent insulating material to enable the screened components to be identified. Any relays which can cause tripping of the unit shall not be installed on the enclosure door.

To prevent inadvertent contact or short circuit by personnel when performing control circuit adjustments or when resetting/replacing protective devices, all bare busbars and live terminals of equipment and components located within the enclosure shall be similarly protected by barriers or shrouds to a degree of ingress protection of at least IP 20, unless adequately recessed within the enclosure.

NOTE: Outdoor panels shall always be provided with a rain/sun canopy to make access possible under adverse weather conditions.

6.4.2 Sub-distribution

Each incoming supply to the panel shall have an appropriate padlockable type disconnecting device. Any sub-distribution shall be via miniature circuit breakers, manufactured in accordance with IEC 898. Switches, including miniature circuit breakers, shall simultaneously de-energize and isolate all phases and the neutral.

6.4.3 Anti-condensation heaters

Adequate provisions shall be made to avoid deterioration of the panel interior caused by condensation.

The requirement for anti-condensation heaters shall be indicated in the requisition.

Anti-condensation heaters shall be of a fully insulated design and suitable for 220 - 254 volts single phase supply, unless otherwise specified. Anti-condensation heaters shall be arranged to provide uniform heating of the control panel and shall maintain the panel interior at approximately 5 °C above ambient temperature.

The surface temperature of the heater elements shall not exceed the limiting temperature specified. The heater elements shall be protected against accidental touching by personnel performing tasks in the control panel.

6.4.4 Internal wiring and terminations

Insulated stranded copper conductors shall be used for secondary wiring. The size and type shall be selected on current carrying capacity, voltage and mechanical strength. Wiring between terminals shall be continuous and without joints.

Wires shall be held in position by means of insulated tubes, channels, cleats or plastic strips and shall be routed so as to avoid mechanical damage. Channels, tubes, etc. shall not be filled to more than 75% capacity during manufacture. Wiring between fixed portions and hinged doors shall in addition to the electrical insulation have protection against abrasion or entrapment and not be carried over or bent around sharp edges.

Individual wires or cables terminating at fixed (not plug-in) components shall be identified by means of ferrules of insulating material marked in accordance with the manufacturer's drawings. Wrap around, adhesive type markers shall not be used.

Terminals shall be of the non-loosening type and only accept one wire, unless the terminals are specially designed to accept more than one wire. Terminals shall be constructed in such a way that direct contact between screws, bolts or nuts and the conductor is prevented. Partitions shall be placed between terminals of different voltages. Stranded wiring ends which are to be connected into butt type contacts and terminals shall be provided with compression type pre-insulated wire pins with insulation support.

Terminals to accommodate wiring supplied by the Principal shall be sized to accept minimum 2.5 sq mm wires for control and minimum 4 sq mm wires for power and current transformer secondaries. A minimum of 25% spare control terminals shall be provided in each panel.

6.4.5 External cabling and terminations

All panels and enclosures shall have facilities for the entry of cables from the top or bottom as specified on the requisition. Control cables shall be accessible from the front of the enclosure.

All connection material, cable supporting system and clamping shall be supplied and suitable for the size and the number of conductors. Ample space for terminating the external cables shall be provided. All outgoing cable compartments shall be provided with fully gasketed removable gland plates for termination using cable glands. A minimum of 25% spare entries shall be provided. Compression type cable glands suitable for the cables specified on the requisition shall be included in the scope of supply.

A separate compartment shall be supplied for the terminal strips for all incoming and outgoing cables. Separate sections shall be provided for digital, analogue, pneumatic and power cables. Interconnecting cables to remotely located equipment shall be installed by the Principal.

6.4.6 Earthing

Where a number of electrical components are to be earthed, parallel earthing shall be employed and not series looping of equipment.

An earth rail with a suitable number of earthing bolts or screws shall be provided in a

position close to the external cable glands to facilitate termination of cable earth braids or armouring. Individual connections for all earth wires shall be provided.

A threaded brass earth stud of not less than 6 mm diameter, with nuts and spring washers, shall be provided within the enclosure for termination of a separate single-core earth cable.

Earth conductor connections on equipment which is regularly disconnected for maintenance shall be made with screw type solderless connectors. All other connections shall be made with crimp type connectors.

Electrical conductivity between the exposed non-current-carrying conductive parts of the control panel components and the enclosure and between the enclosure and the earth rail and the earth stud shall be such as to maintain effective continuity of earth circuits.

The minimum size of earth conductors shall be 2.5 sq mm for internal earth connections. Earth connections shall be yellow/green coloured insulated copper flexible wires.

Removable metal parts, including doors, shall be earthed.

All electrical connections made for earthing shall be accessible to allow checking of tightness and electrical contact.

6.4.7 Marking

All external operating, measuring and indicating components shall be clearly identified with permanent descriptive labels that facilitate easy recognition by the operator. Descriptive labels shall be white with black lettering.

All components shall be identified by labels inscribed in accordance with the system of identification as used on the manufacturer's reference drawings and documents.

All labels shall be of corrosion resistant material with indelible inscriptions in the language specified in the requisition.

Rail-mounted terminals of equipment and components shall be identified by numerical or alphabetical markings in accordance with the manufacturer's drawings. Terminals of input and output supply cables shall be clearly marked to indicate the nominal system voltage and the phase/polarity of the supply. The identification of terminals shall be in accordance with IEC 445.

7. PACKAGE REQUIREMENTS

7.1 BASEPLATE

The generator/engine combination shall be mounted on a common baseplate, made of structural steel beams and with flat top plates, suitable for stationary installation.

The baseplate shall be designed to resist transport and lift conditions. A horizontal force equal to the total transport weight may be assumed for transport forces in the design of the package. Consideration shall be given to lifting shock forces, in particular for offshore installation.

All welding shall comply with ANSI/AWS D1.1 or the relevant local code. Intermittent welds or stitch welds are not allowed on any structural part of the skid.

The baseplate shall be designed to support the mass of the components and resist the torque reaction imposed by any operating condition. It shall also be capable of withstanding the shock loads defined in (2.3.1).

The baseplate shall be constructed such that it does not interfere with maintenance or routine servicing of the engine and the generator. No fuel piping shall be concealed within the baseplate.

The baseplate shall have a drip pan and rim with DN 50-Class 150 ANSI/ASME B16.5 flanged drain connections in strategic locations.

The Packager shall supply suitable anti-vibration mounts to limit the engine vibrations transmitted to the foundations or surroundings where a vibration analysis study reveals that the package requires isolation from the supporting structure. Mounts shall be located between the baseplate and the supporting structure. Anti-vibration mounts shall be of a totally enclosed design suitable for the environment and possess an isolation efficiency of at least 90% in respect of all induced vibrations. Full details, including drawings, of the anti-vibration mounts shall be submitted together with the frequency and magnitude of any unbalanced forces and moments that will be transmitted through the mounts into the Principal's supporting structure.

The baseplate shall be designed to withstand any dynamic forces arising from action of the anti-vibration mounts. Inertias of the complete baseplate with the mounted equipment shall be such that stresses in the rotating components arising from motion of the complete assembly on the anti-vibration mounts are minimised. The Packager shall furnish the Principal with calculations of resonant frequencies and the stresses arising on the rotating components.

The Packager shall provide earth bonding conductors from the engine, generator and all other skid mounted equipment to the baseplate. Two earth bosses in accordance with standard drawing S 68.004 shall be mounted diagonally on the baseplate for external earth bonding by others.

Lifting lugs shall be attached to the baseplate. The positioning of the lugs shall take account of the centre of gravity of the complete assembly and be such that lifting slings, etc. do not interfere with any equipment mounted on the baseplate. If a spreader bar is required to meet this requirement, it shall be supplied by the Packager. Lifting lugs shall be designed for a load equal to twice the complete assembly and shall comply with ANSI/AWS D1.1 or the relevant local code. The area of material where lifting lugs are to be welded shall be tested ultrasonically for laminations prior to welding.

7.2 ROOM VENTILATION

Unless otherwise specified in the requisition, the ventilation requirements for a generator set installed in a closed room shall be provided by the Principal. See (4.2) for combustion air and (4.3) exhaust requirements. See (7.8) for a generator set installed in an acoustic enclosure.

7.3 ELECTRIC MOTORS

Electric motors for auxiliary systems shall comply with DEP 33.66.05.31-Gen.

7.4 CABLES AND JUNCTION BOXES

Interconnecting cables between the equipment supplied by the Packager and those devices furnished by the Principal shall be supplied and installed by the Principal. The associated cable glands on the equipment supplied by the Packager shall be furnished and fitted by the Packager. All glands shall be equipped with shrouds.

Power cabling to the generator and to electric motors shall be supplied and installed by the Principal and connected directly to the generator and motor terminal boxes upon installation in the field. The Packager shall provide trays and supports within the confines of the baseplate as necessary to accept these cables. All other electrical equipment supplied by the Packager and requiring external connections shall be wired by the Packager to terminal blocks in junction boxes located at the edge of the baseplate or to terminals in the control panel.

Cabling on the baseplate and the engine cooler assembly shall be flame retardant and oil resistant type, complete with galvanized steel wire braiding and interwoven copper earth wires. The insulation level shall be 600/1000 V.

All cabling shall be mounted on ANSI 316L stainless steel cable trays. The cable trays shall be properly insulated from the steel structure to prevent corrosion caused by dissimilar materials. The cable trays shall have equipotential bonding with the baseplate. Cable extensions from cable trays to equipment shall be supported and protected against mechanical damage. The cables shall be fastened to the cable tray with UV resistant ties.

Cables shall be properly marked by stainless steel tags or by Critchley 'K' type cable markers mounted on a carrier strip with ties. Cable markers shall be installed at each gland at both sides of the gland plate.

All junction boxes shall have a minimum degree of ingress protection of IP 55. Junction box wire identification, terminal partitions, terminal execution, wire pin requirements, and spare terminal requirements and earthing provisions shall comply with (6.4.3) through (6.4.6).

7.5 NAMEPLATES

A list of nameplates, including sizes and character dimensions, shall be submitted to the Principal for approval. Text on the nameplates shall be in the language specified in the requisition.

The components of the generator set shall have nameplates in accordance with the respective specifications. The nameplate described herein shall apply to the complete package.

The following information shall be clearly marked on a non-destructible, corrosion-resistant, indelible name/rating plate attached to a permanent part of the generator control panel:

- purchaser's order number
- year of manufacture
- name of Packager
- type and serial number of the package
- nominal output power of the package.

7.6 PIPING AND INTERFACE CONNECTIONS

The Packager shall supply all on-baseplate piping for fuel, lubricating oil, starting systems and coolants. Connections to the Principal's piping shall be by appropriately rated ANSI/ASME B16.5 flanged connections at the baseplate edge. The Packager shall provide flexible elements for all the Principal's piping connections. For fuel piping, these flexible elements shall be stainless steel convoluted sections with stainless steel reinforcing braid.

All package piping shall be carbon steel to ASTM A106 Grade B and shall be pickled, flushed and passivated after fabrication.

If sea water cooling is used, pipework shall conform to a minimum of ANSI Class 150 and shall be manufactured in duplex stainless steel, UNS S31803 to ASTM A790.

Interconnecting piping between the baseplate edge and remotely installed auxiliaries shall be supplied and installed by the Principal. The Packager shall clearly indicate all piping termination points on the baseplate for separately mounted auxiliaries to be connected by the Principal.

Fuel gas piping shall comply with DEP 31.29.90.30-Gen.

7.7 PAINTING

The engine and generator shall be supplied painted according to the respective specifications. The control panels, baseplate and auxiliaries shall be painted in accordance with the Packager's standard for a marine environment, subject to approval by the Principal. The Packager shall submit the painting specification for approval upon request. The specification shall include surface preparation, paint materials, application, film thickness and the paint Supplier's data sheets. Stainless steel components shall not be painted.

7.8 ACOUSTIC ENCLOSURE

If the emitted noise level of the generator set exceeds permitted levels at the installation site, the Packager shall provide an acoustic enclosure over all the equipment requiring noise limitation treatment in accordance with DEP 31.10.00.96-Gen., which forms part of the requisition.

The acoustic enclosure shall allow access for routine on-line maintenance and for overhaul of the enclosed equipment. All doors shall be fitted with emergency opening bars on the inside. Opening any door for access during generator set operation shall provide an alarm, but shall not cause a shutdown of the generator set.

If approved by the Principal a "close fit" acoustic enclosure may be applied for packaged units with lower ratings. This type of enclosure shall allow easy access for maintenance by means of maintenance doors. For overhaul of the equipment easy removal of the enclosure, by the lifting off or taking apart of panels, is required.

Mechanically induced ventilation shall be installed, such as to provide not less than 20 changes of air per hour within the enclosure, or to limit the temperature rise within the enclosure to not more than 5 °C above the ambient air temperature, whichever requires the greater flow rate. Either failure of the air flow to the enclosure or excessive temperature rise in the enclosure shall shut down the generator set. Ventilation air shall be filtered by a two-stage filter comprising an inertial stage followed by a viscous impingement stage.

An enclosure surrounding a gas fuelled engine installed in a non-hazardous area shall have extractor fans maintaining a negative pressure within the enclosure.

The enclosure shall be fitted with two heat detectors above the engine, either of which shall shut down the engine upon fire detection. Initiation of a shutdown shall cause a release of extinguishant into the enclosure and simultaneously cause shutting of a damper in the exhaust air from the enclosure and shutdown of the ventilating fans.

For free access to the enclosure the fire extinguishing system shall be inhibited when using carbon dioxide or other asphyxiating gases. An alarm shall be provided to indicate that the system has been inhibited. For fire extinguishing systems using water fog, inhibition is not

required.

An enclosure surrounding a gas fuelled engine shall be fitted with gas detectors on the ventilation air outlet, utilising a two out of three voting system to shut down the engine upon gas detection. The ventilation shall remain in operation and extinguishant shall not be released upon gas detection.

8. SPECIAL REQUIREMENTS FOR DIFFERENT MODES OF OPERATION

8.1 GENERAL

In addition to the requirements given in (2) through (7) which apply to generator sets in single operation, the following requirements apply to other modes of operation. A combination of operation modes is also possible.

8.2 EMERGENCY GENERATOR SETS

Standard drawing S 67.070 gives single line and schematic diagrams of control circuits; these shall be regarded as typical only, the exact requirements shall be given in the requisition.

A low voltage emergency generator set with 3 phase/4 wire connections shall be capable of operating continuously with unbalanced load current of up to 20%, or the value specified in the requisition. The unbalance is defined as:

$$\frac{I_{max} - I_{min}}{I_{max}} \times 100\%$$

where:

I_{max} = maximum phase current

I_{min} = minimum phase current

The maximum time allowed for the emergency generator set to accept the nominal load after initiation of a start command from cold shall be 10 seconds.

For an emergency generator set in an acoustic enclosure, failure of the ventilating air flow shall not shut down the set, but shall initiate an alarm.

For an emergency generator set which is periodically tested in parallel with the main grid system, the same control and protection requirements shall apply as for parallel operating generators. If installed, under/overvoltage protection and under/over-frequency protection shall be disabled during emergency operation.

8.3 GENERATOR SETS FOR CONTINUOUS OPERATION

The generator set shall run for a minimum of 25000 hours between major overhauls and shall have an expected lifetime of at least 20 years.

The stator winding of the generator shall have 2 embedded temperature detectors per phase for alarm and trip functions, in accordance with DEP 33.66.05.31-Gen.

An indirect cooling system, e.g. air to air or air to water, for the generator is preferred. The exact requirements shall be specified in the requisition.

8.4 GENERATOR SETS SUPPLYING LARGE NON-LINEAR LOADS

The generator shall operate within its temperature limits under conditions of non-sinusoidal loads, as specified in IEC 34-1.

If loads with a large harmonic content, e.g. from rectifiers, need to be supplied the magnitude of the individual harmonic currents shall be advised in the requisition. The generator shall then operate within its temperature limits under the specified harmonic current conditions.

NOTE: The distribution system to which the generator is connected shall be designed to limit the harmonic voltage to the values stated in DEP 33.64.10.10-Gen.

The Principal shall indicate the maximum acceptable level of voltage waveform distortion for the installation.

8.5 GENERATOR SETS FOR PARALLEL OPERATION

Generators for parallel operation shall be equipped with a damper winding on the rotor. If more than one star point of parallel operating generators will be earthed, the Supplier shall ensure that third harmonic currents circulating through the star point connections are minimised. If specified in the requisition, the Manufacturer shall reduce the third harmonic currents and their multiples by chording ($^2/_3$ pitch stator winding).

Where parallel operation with other generator sets is required, quadrature droop compensation of maximum 5% shall be provided.

For a generator operating in parallel with the main grid system the reactive power generated shall be controlled by an automatic power factor controller. Either the power factor of the grid coupling or the power factor of the generator set shall be controlled, as specified in the requisition.

A droop current transformer and droop rheostat shall be provided.

Manual synchronising equipment, with check synchroniser and dead bus override, shall be provided. Automatic (active) synchronising equipment is only required if specified in the requisition.

The Principal shall provide data regarding the voltage and speed control characteristics of existing generator sets which are required to operate with the one being purchased.

Frequency stability in accordance with governing class A1, as defined in ISO 3046/IV, shall be provided for the engine.

8.6 GENERATOR SETS FOR HAZARDOUS AREAS

The requirement of the generator set to be suitable for installation in a hazardous area shall be specified in the requisition.

The generator set and all its accessories shall comply with the recommendations of IEC 79.

The requirements for certificate of conformity and declarations of compliance shall be met in accordance with DEP 33.64.10.10-Gen.

If a generator set provided with an acoustic enclosure is installed in a hazardous area, the ventilation air intake shall be taken from a safe area.

NOTE: Generator sets shall be installed in a non-hazardous area unless this is unavoidable. In that case the generator set and its accessories shall be installed in a zone 2 location. Installation in a zone 1 location shall not be contemplated.

9. INSPECTION AND TESTING

9.1 GENERAL

Inspection and acceptance tests shall be carried out on the complete generator set at the Packager's works and may be witnessed by the Principal. The Packager shall submit a detailed proposed inspection and testing schedule to the Principal.

9.2 WORKS TEST OF THE COMPLETE GENERATOR SET

The completed and individually tested engine and generator shall be assembled onto the baseplate with all auxiliaries, instruments and controls for a complete test of the generator set. The works test shall include, as a minimum, the tests described in this section.

9.2.1 Static load test

During this test the generator set shall run for at least four hours under the following conditions:
- 30 minutes at 25% rated output
- 30 minutes at 50% rated output
- Two hours at 100% rated output
- One hour at 110% rated output.

During the load test all engine and generator parameters shall be recorded. These shall include, but not be limited to:
- Generator power output
- Generator phase currents
- Generator voltages and variations
- Generator power factor
- Generator frequency
- Engine oil pressure
- Cooling water temperatures
- Fuel consumption
- Noise level
- Engine speed and variations
- Vibration levels.

9.2.2 Dynamic load test

The frequency and voltage regulation of the generator set shall be verified against the requirements given in (4.8) and (5.4). Voltage and frequency variations shall be recorded on oscillograms. The requirement for special dynamic load tests to simulate motor starting will be indicated in the requisition.

9.2.3 Functional test

The Packager shall perform functional tests on the complete generator set including the generator and engine control panels.

The functional tests to be performed shall be subject to approval by the Principal and shall include, but not be limited to, the following tests:
- engine start-up system, including measurement of the starting time. A minimum of two start and stop tests shall be performed
- automatic start-up system, if provided
- for emergency generator sets verification of the time between initiation of a start command and acceptance of the nominal load for a cold start
- all engine alarm and shutdown functions (*)
- all generator alarm and trip functions, including the verification of protection relay operation (*)
- operation of the battery charger
- the status/alarm/trip/shutdown indication of the control panels
- local manual start/stop/emergency stop functions
- remote start/stop/emergency stop functions (input signals)

- the remote signalling contacts for Principal's use
- operation of the AVR
- operation of the AVR automatic transfer system (if provided)
- operation of the automatic power factor controller (if provided)
- operation of synchronising equipment (if provided)
- calibration of measuring and protective devices.

NOTE: (*) These functions do not all have to be tested with a running generator set.

9.2.4 Insulation resistance tests

These tests shall be performed on the generator, exciter, space heaters, temperature detectors, control panel and skid cabling.

9.2.5 Hydrostatic testing

All pressure containing parts, including auxiliaries, shall be tested hydrostatically in accordance with the relevant design codes.

9.2.6 Final inspection

The following inspection and checks shall be performed:
- verification against the approved drawings
- overall dimensions of the skid and the location of all equipment
- location of all piping and electrical interfaces
- enclosure degree of protection of all equipment concerned
- accessibility of components
- lifting arrangement, including spreader bar, if applicable
- non-interference of the lifting arrangement
- availability of eye bolts for lifting heavy components
- terminal and wiring marking
- available space for cable termination, the size and number of terminals, the cable supporting devices
- earthing and bonding
- marking of components according to the relevant drawings
- all rating plates of main components
- construction materials of auxiliaries, such as: baseplate, piping, fittings, coolers, fuel day tank (for diesel engines) and control panels
- hook-up of local instruments
- Packager's welding procedures and welder qualifications
- welding by non-destructive testing, where specified
- weld inspection reports
- quality assurance documentation.

9.3 ON-SITE ACCEPTANCE TESTING

Acceptance testing shall include static load tests, functional tests and visual inspection as specified in (9.2.1), (9.2.3) and (9.2.6).

NOTE: The Packager may be required to assist with the installation and commissioning of the generator set, as specified in the purchase order.

10. PREPARATION FOR SHIPMENT AND STORAGE

10.1 GENERAL

The generator set shall be prepared for shipment after all testing and inspections have been completed, and the equipment has been painted.

The generator set shall be prepared for the type of shipment specified, including blocking of rotors where necessary. Blocked rotors shall be identified by corrosion-resistant tags attached with stainless steel wire. The preparation shall make the equipment suitable for 6 months (or for a period as stated in the requisition) outdoor storage from the time of shipment, with no disassembly required before operation. If storage for a longer period is contemplated, the Principal shall consult with the Packager regarding the recommended preservation procedures to be followed.

Internal bracing or supports for shipping shall be clearly identified, preferably by painting in a distinctive colour.

Lifting points and the centre of gravity shall be clearly identified on the equipment packages. A recommended lifting arrangement shall be provided by the Packager.

The equipment shall be identified by item and serial number. Materials shipped separately shall be identified by securely attached corrosion-resistant metal tags indicating the item and serial number of the equipment for which it is intended. Crated equipment shall be shipped with duplicate packing lists, one inside and one on the outside of the crate.

10.2 PRESERVATION

The Packager shall provide instructions for maintaining the integrity of the preservation for the period between arrival at site and startup of the generator set.

Exterior machined surfaces shall be coated with a rust preventative.

The interior of all equipment shall be clean, free from scale, welding spatter, and foreign objects. Mechanical equipment shall be sprayed or flushed with a rust preventative that can be removed with solvent. The rust preventative shall be applied through all openings while the engine is slow-rolled.

Internal steel areas of bearing housings and carbon steel oil systems, auxiliary equipment and piping (except for cooling water piping) shall be coated with an oil-soluble rust preventative. Preservation agents containing calcium and/or silicone compounds shall not be used as they cause subsequent foaming of the lubricating oil.

All coolants shall be drained from the engine, coolers and piping. The interior of the coolant system shall be preserved by a water soluble film.

All flanged openings shall be closed with metal closures 5 millimetres thick, with elastomer gaskets and at least four full-diameter bolts. Plastic or wooden plates/closures are not acceptable. All open ends of drains, vents, instrument tubing and small bore piping connections shall be capped or plugged with metal caps or plugs, as applicable. Threaded caps or plugs shall be used for threaded connections. Grease fittings shall be protected with plastic caps. Auxiliary piping connections on the generator set shall be die stamped or permanently tagged to agree with the Packager's connection table or general arrangement drawing.

Exposed shafts and shaft couplings shall be wrapped with waterproof, mouldable waxed cloth or vapour phase inhibitor paper. The seams shall be sealed with oil-proof adhesive tape.

If vapour phase inhibitor compounds in bags are inserted into large cavities the bags shall be attached in an accessible area for ease of removal. Vapour phase inhibitor locations shall be clearly identified by corrosion resistant tags and metal wire.

All demountable internal components of control panels shall be separately packed in secure waterproof crates. Non-demountable equipment shall be braced for transport. External surfaces of the panels shall be protected from abrasion during transport. Desiccants shall be inserted where necessary for preservation.

10.3 BATTERIES

Nickel-cadium batteries shall be supplied dry and discharged, with the electrolyte packed separately. Lead-acid recombination type batteries must receive a commissioning charge within a period after leaving the factory, as specified by the Manufacturer.

11. SPECIAL TOOLS

All special tools necessary for assembly, dismantling and service of the generator set shall be assembled by the Packager from all the equipment Suppliers. The special tools shall be supplied in lockable steel cabinets.

One set of special tools will be necessary for multiple generator sets to be installed on the same site.

A list of the special tools and their application shall be included in the operating manual.

12. DOCUMENTS

12.1 GENERAL

All documents shall be marked in the right-hand bottom corner with the principal's order and item number together with the Packager's references. All documents shall be in English and be distributed as specified in DEP 40.10.01.93-Gen.

12.2 TECHNICAL INFORMATION

The Packager shall submit as a minimum the following information and data:

- completed data sheets
- piping layout
- instrument diagram
- general arrangement drawing of all equipment also showing dry and operating masses, arrangement of components, cable entry details, minimum space required for erection and maintenance
- schedule and drawing of electrical, instrument and mechanical termination points
- foundation design data
- baseplate construction data
- dynamic performance calculations
- torsional and lateral vibration data
- structural dynamic calculations for generator set vibration, taking account of anti-vibration mounts
- schematic and connection diagrams of main, control, status indication, alarm, metering, protection, trip, shutdown and auxiliary circuits
- alarm and trip setting schedules
- material specifications
- equipment lists/parts lists
- recommended spare parts lists
- preservation for shipment procedures
- operating manuals incorporating unpacking, depreservation, installation, commissioning, operating and maintenance instructions and fault finding procedures
- manufacturer's proposed service and repair support after warranty
- test and inspection procedures
- testing programme
- certificates of conformity and declarations of compliance for equipment used in hazardous areas
- reports of all tests performed.

13. REFERENCES

In this DEP reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Index to standard drawings	DEP 00.00.06.06-Gen.
The use of SI quantities and units (Endorsement of ISO 31 and ISO 1000)	DEP 00.00.20.10-Gen.
Requisitioning (binder)	DEP 30.10.01.10-Gen
Noise control	DEP 31.10.00.31-Gen.
Data sheet for equipment noise limitation *	DEP 31.10.00.94-Gen.
Requisition for rotating equipment acoustic enclosures *	DEP 31.10.00.96-Gen.
Diesel fuelled compression ignition engines	DEP 31.29.80.30-Gen.
Requisition for internal combustion engines *	DEP 31.29.80.93-Gen.
Spark ignited gas fuelled engines	DEP 31.29.90.30-Gen.
Electrical engineering guidelines	DEP 33.64.10.10-Gen.
Synchronous AC generators 1250 kVA and above	DEP 33.65.11.31-Gen.
Requisition for synchronous for AC generators *	DEP 33.65.11.93-Gen.
Requisition for packaged unit AC generator sets *	DEP 33.65.11.94-Gen.
Electric motors - Cage-induction and synchronous type	DEP 33.66.05.31-Gen.
Requisition for engineering documents *	DEP 40.10.01.93-Gen.

NOTE:* The latest revisions of data/requisition sheets are identified in DEP binder 30.10.01.10-Gen.

STANDARD DRAWINGS

NOTE: The latest revisions of Standard Drawings are identified in DEP 00.00.06.06-Gen.

Typical HV single line diagram - generator directly connected (voltage $\leq$ 11kv)	S 67.055
Typical single line and schematic diagram of control circuits for LV emergency generator	S 67.070
Earthing boss for steel structures, tanks, vessels, etc.	S 68.004

AMERICAN STANDARDS

Pipe flanges and flanged fittings	ANSI/ASME B16.5
Structural welding code-steel	ANSI/AWS D1.1

Issued by:
American National Standards Institute
United Engineering Center
345 East 47th Street
New York, NY 10017
USA.

Carbon steel	ASTM A106
Standard specification for seamless and welded ferritic/austenitic stainless steel pipe	ASTM A790/A790M

Issued by :
American Society for the Testing of Materials
1916 Race Street
Philadelphia
Pa. 19013-1187
USA.

BRITISH STANDARDS

General requirements for rotating electrical machines Part 140. Specification for voltage regulation and parallel operation of a.c. synchronous generators	BS 4999
Code of practice for safety of machinery	BS 5304

Issued by:
British Standards Institution
389 Chiswick High Road
London W4 4AL
England
United Kingdom.

GERMAN STANDARDS

Specification for radio interference suppression of electrical appliances and systems	VDE 0875

Issued by:
Beuth Verlag GmbH
Burggrafenstrasse 4 - 10
D-1000 Berlin 30
Germany.

INTERNATIONAL STANDARDS

Rotating electrical machines	
Part 1: Rating and performance	IEC 34-1
Part 6: Methods of cooling rotating machinery	IEC 34-6
International electrotechnical vocabulary	IEC 50
Recommendations for indicating electrical measuring instruments and their accessories	IEC 51

Electrical apparatus for explosive gas atmospheres	IEC 79
Electrical relays	IEC 255
Identification of apparatus terminals and general rules for an uniform system of terminal marking, using an alphanumeric notation	IEC 445
Classification of degrees of protection provided by enclosures	IEC 529
Circuit breakers for overcurrent protection for household and similar installations	IEC 898

Issued by:
Central Office of IEC (sales dept.)
3, Rue de Varembé
1211 Geneva 20
Switzerland.
Copies can also be obtained from national standards organizations

Antistatic endless V-belts-electrical conductivity - characteristics and methods of test	ISO 1813
Mechanical vibration of machines with operating speeds from 10 to 200 rev./s.; Basis for specifying evaluation standards	ISO 2372
Reciprocating internal combustion engines: Performance Part 4: Speed governing	ISO 3046/IV

Issued by:
Central Secretariat of International
Organisation for Standarization (ISO)
1, Rue de Varembé
P.O. Box 56
CH-1211 Geneva 20
Switzerland.

Copies can also be obtained from national standards organizations

APPENDIX 1 GENERATOR STATUS, ALARM, TRIP AND SHUTDOWN REQUIREMENTS

The table below is intended to cover all types of application. It does not imply that all the alarms, trips and shutdowns listed herein are required on every application. The actual requirements shall be given in the requisition.

NOTE: The reliability of a generator set may be seriously compromised by improper selection of generator trips and engine shutdowns.

DESCRIPTION	STATUS	ALARM	TRIP	
Overcurrent - voltage restraint			X	
Overcurrent			X	
Stator earth fault (*1)			X	(*3)
Differential			X	(*3)
Under voltage		X	X	
Over voltage		X	X	(*3)
Under frequency		X	X	
Over frequency		X	X	(*3)
Reverse power (*2)			X	(*3)
Negative phase sequence			X	
Loss of excitation			X	
Stator winding temperature - high		X	X	
Diode failure		X	X	
Rotor earth fault			X	(*3)
Bearing temperature - high		X	X	(*3)
Local ESD			X	(*3)
Remote ESD			X	(*3)
AVR failure		X		
Cooler water leakage (air to water)		X		
Cooler generator air outlet temperature - high		X		
Control panel general (including control/trip supply failure)		X		
Lock-out general		X		
Generator circuit breaker 'open' (*4)	X			
Generator circuit breaker 'closed' (*4)	X			
Control/trip supply 'on' (*4)	X			
On acoustic enclosures: (*5)				
- enclosure door(s) open		X		
- ventilation air flow-low			X	(*3)
- ventilation air temperature-high			X	(*3)
- fire (heat) detection			X	(*3)
- inhibition of carbon dioxide extinguishing system		X		
- gas detection on gas fuelled engines			X	(*3)

NOTES:
*1. Where a restricted earth-fault relay is used for generator differential protection the separate stator earth-fault relay may be omitted.

*2. To be provided only where there is continuous parallel operation with public grid or other generator sets.

*3. Shutdown of engine required in addition to generator trip.

*4. Status indication required on each application.

*5. Mandatory functions.

APPENDIX 2 TYPICAL BLOCK DIAGRAM FOR A PACKAGED UNIT AC GENERATOR SET