



GS 112-6

Guidance for Specification 112-6

**ELECTRICAL REQUIREMENTS FOR
A.C. GENERATORS AND GENERATION
PACKAGES**

July 1994

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SCOPE AND PURPOSE This document comprises two parts. Part A specifies general recommendations for the electrical design of a.c. generators together with their associated exciter and automatic voltage regulation equipment. Part B specifies the general recommendations for the electrical equipment required for packaged power units. The document is split into 2 Parts to clearly detail the individual requirements for driving and driven units. The 2 Parts are contained in one document as provision of a.c. generating equipment is more effectively achieved by purchasing driving and driven units as a package from one vendor. Hence this document contains all electrical requirements for such a package.											
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FOREWORD

Introduction to BP Group Recommended Practices and Specifications for Engineering

The Introductory Volume contains a series of documents that provide an introduction to the BP Group Recommended Practices and Specifications for Engineering (RPSEs). In particular, the 'General Foreword' sets out the philosophy of the RPSEs. Other documents in the Introductory Volume provide general guidance on using the RPSEs and background information to Engineering Standards in BP. There are also recommendations for specific definitions and requirements.

Value of this Guidance for Specification

This Guidance for Specification gives full electrical requirements for a complete a.c. generation package. The Specification is structured as a complete document, but in a manner to allow easy identification of requirements for main sub components, i.e. main generator and auxiliaries, where this is required for ease of enquiry or procurement.

Application

This Guidance for Specification is intended to guide the purchaser in the use or creation of a fit-for-purpose specification for enquiry or purchasing activity.

Text in *italics* is Commentary. Commentary provides background information which supports the requirements of the Specification, and may discuss alternative options.

This document may refer to certain local, national or international regulations but the responsibility to ensure compliance with legislation and any other statutory requirements lies with the user. The user should adapt or supplement this document to ensure compliance for the specific application.

Specification Ready for Application

A Specification (BP Spec 112-6) is available which may be suitable for enquiry or purchasing without modification. It is derived from this BP Group Guidance for Specification by retaining the technical body unaltered but omitting all commentary, omitting the data page and inserting a modified Foreword.

Principal Changes from Previous Edition

This specification is an update of BP Engineering Standard 224 (last revised in 1988).

Feedback and Further Information

Users are invited to feed back any comments and to detail experiences in the application of BP RPSE's, to assist in the process of their continuous improvement.



For feedback and further information, please contact Standards Group, BP International or the Custodian. See Quarterly Status List for contacts.



1. INTRODUCTION

1.1 Scope

Part A of this Specification specifies the general requirements for the electrical design of a.c. generators together with their associated exciters and automatic voltage regulation equipment. Part B of this Specification specifies the general requirements for the design of the electrical equipment associated with a.c. generation packages. The complete Specification, together with the mechanical requirements for a prime mover will form the basis for a complete generation package.

1.2 Vendors Proposals and Exceptions

1.2.1 The vendor shall state in his tender that his proposed equipment complies without exception to the requirements of this Specification, or that it complies subject to certain exceptions. A detailed description of any exception together with reasons, cross referenced to the relevant section number of this Specification shall be given by the vendor.

1.2.2 The vendor may offer alternative proposals which will still meet the intent of this Specification, but such proposals shall form a supplement to the main tender.

1.3 Data Sheets

Data Sheets will be partially completed where relevant by the purchaser to specify requirements. The vendor shall complete the data sheets where required for inclusion in his tender.

Refer to BP Group [GS 112-16](#) for additional data sheets.

1.4 Painting

Details of the manufacturers standard paint specification shall be submitted to the purchaser at the time of the tender.

1.5 Documentation

1.5.1 All documents shall show the relevant purchase order and item number.

1.5.2 For all machines the following documents shall be submitted and the number of copies required for approval and for final issues shall be as indicated on the purchase order.

- General arrangement drawings showing main dimensions, weights, arrangement of components and the minimum space for the erection and future maintenance of all components.



- Foundation plan showing location and details of foundation bolts and static and dynamic foundation loadings.
- Electrical schematic, wiring and interconnection diagrams.
- Comprehensive data sheets.
- A description of the generator excitation system including AVR operation together with all necessary diagrams.
- Installation, operation and maintenance instructions for all equipment included in the purchase order.
- Generator open circuit and short circuit curves.
- Generator power, MVA_r, excitation chart giving limits of stability.
- Recommended list of commissioning spares and spares for two years operation. Recommended list of spares for five year operation.
- Test reports and test certificates.
- Drive list of equipment requiring black start power.
- Drive list of equipment requiring power when purchaser is providing motor control centre.
- Detailed test procedure.

1.6 Inspection and Testing

- 1.6.1 The equipment covered by this Specification will be subject to inspection by the purchaser or his nominated representative during manufacture and testing. The vendor shall provide access for this inspection.
- 1.6.2 The manufacturer shall include in his tender both for his own tests and for witnessed tests at his works. Unless otherwise specified, ten working days notice shall be given that the equipment is ready for witnessed tests.
- 1.6.3 As part of his proposal the vendor shall include details of the testing he proposed to undertake in order to ensure that the equipment meets the design requirements. These details will be reviewed as part of the bid review process and may be extended by the purchaser.



- 1.6.4 The vendor shall carry out his own tests to ensure the correct operation of equipment before witnessed tests.

1.7 Quality Assurance

Verification of the vendor's quality system is normally part of the pre-qualification procedure, and is therefore not specified in the core text of this specification. If this is not the case, clauses should be inserted to require the vendor to operate and be prepared to demonstrate the quality system to the purchaser. The quality system should ensure that the technical and QA requirements specified in the enquiry and purchase documents are applied to all materials, equipment and services provided by sub-contractors and to any free issue materials.

Further suggestions may be found in the BP Group RPSEs Introductory Volume.

PART A - A.C. GENERATORS

2. GENERAL

2.1 Machine Requirements

- 2.1.1 Care should be employed when applying this Specification to large machines in excess of 60 MVA rating.

Machines in excess of 60 MVA would generally be of hydrogen cooled type construction and this Specification would require modification.

- 2.1.2 Rotating machines shall comply with IEC 34 Parts 1 to 8 inclusive and Parts 10, 11 and 15.

Where this specification references British Standards or other standards, they may be substituted by an equivalent National Standard of the country of installation if that standard meets or exceeds the requirements of the referenced standard.

- 2.1.3 All machines shall be of continuous running duty S1 and continuous maximum rating. In addition diesel driven units shall be capable of running at 110% load for one hour in every twelve.

Diesel engines are permitted to develop for limited periods an output in excess of their rated output, this is normally 10%. As an electrical machine having a maximum continuous rating in accordance with IEC 34-1 has no specified sustained overload capacity it is necessary to make this provision. There are no temperature rise limits specified for this overload condition.

- 2.1.4 Unless otherwise specified in the Data Sheets all machines shall have Class F insulation with a design temperature rise limited to Class B insulation values.



IEC 341 gives detailed guidance for temperature rises, these will generally be 105°C rise for Class F insulation and 80°C rise for Class B insulation, based on a 40°C ambient. These rises are based on measurement of resistance of the winding and will hence give an average temperature for the whole winding. Measurement may also be made by embedded temperature detector which should be placed in the 'hot spots' in the winding and slightly increased allowable temperature rises take this into account. The practice of adopting Class F insulation and Class B rises gives additional margin between the rise by resistance and the limit of the material capability, to take account of the hot spot temperatures. This practice is widespread and ensures insulation materials do not age and hence fail prematurely. It is appropriate however that this margin is utilised for infrequent overload or peak load conditions.

- 2.1.5 Alternating current generators driven by reciprocating internal combustion engines shall comply with [BS 5000](#) Part 3.
- 2.1.6 When specified in the Data Sheets, rotating machines which are to be located in a hazardous area shall be provided with an appropriate type of protection in accordance with [IEC 79](#).
- 2.1.7 Rotating machines shall also comply with [IEC 72](#) Part 1 and 2 and [BS 4999](#) Part 144.
- 2.1.8 The degree of protection for rotating machines shall be IP 54 in accordance with [IEC 34-5](#).

The degree of protection for all other electrical equipment shall be in accordance with [IEC 529](#) and as the following:-

Offshore	Outdoor locations	IP 55
Onshore	Outdoor locations	IP 54
On/offshore	Indoor locations	IP 42
Between adjacent compartments in electrical apparatus		IP 40

3. SPECIAL DESIGN REQUIREMENTS

3.1 Machine Cooling

- 3.1.1 Machine cooling shall be by either air or water. Whenever water cooling is utilised, a leak detection system shall be provided and measures taken to prevent damage to the machine in the event of a leak.

Normally, the primary medium will be air and the secondary medium will be air or water.



3.1.2 Where the generator employs a closed circuit cooling system using heat exchangers, then the latter are to include temperature detectors in the internal air circuit with contacts for alarm annunciation.

3.1.3 Precautions shall be taken to ensure no corrosion occurs due to contact between dissimilar metals.

3.2 Built-In Temperature Detection

3.2.1 When specified in the data sheets, machines with rated voltage up to 660 V shall have built in thermal protection in accordance with IEC 34-11.

3.2.2 Machines with rated voltage above 660V shall have embedded temperature detectors in accordance with IEC 34-1. The detectors shall be wired to a dedicated terminal box and shall be protected from over voltages.

3.3 Main Terminals

3.3.1 Generator terminations shall be in accordance with BS 4999 Part 145.

Where a pressure relieving terminal arrangement is specified it shall be designed to minimise the potential for injury to personnel.

Where separable insulated connectors are specified they shall be contained in an enclosure (IP 21 minimum) to give mechanical protection, and an arrangement shall be provided to fully mechanically support the cables.

The only requirement is for connection of the generator to the bus system. The choice of arrangement will be governed by the service and environmental conditions, the method of connection to the bus system, the required level of security of supply (earth screening of the terminals to eliminate phase-phase faults) and maintenance considerations (separable insulated connectors offer a highly reliable and convenient method of connection).

3.3.2 Generators including the terminal box, windings and cable terminations shall be suitable for operation at the fault levels given on the Data Sheet when protected by means specified in the Data Sheet.

3.3.3 Means shall be provided for electrically isolating individual windings from each other and from the main incoming connections without involving major dismantling of the machine or risking damage to the windings or connections.

3.3.4 When specified in the Data Sheets, space shall be provided for the installation, at the manufacturers works, of current transformers to be supplied by the purchaser.



3.4 Earthing

The machine neutral shall be earthed as specified in the Data Sheets.

3.5 Bearings and Lubrication

3.5.1 Hydrodynamic radial bearings shall be fitted to all machines of 1 MVA rating and above.

3.5.2 Hydrodynamic radial bearings fitted to machines rated 2 MVA and above shall be fitted with resistance temperature detectors.

It is common practice to provide temperature sensing systems for complete packages (i.e. prime mover and generator). The provision of the overall system may not be by the generator vendor but he should provide the facilities for accommodating such a system. Provision of a complete temperature monitoring and protection system is outside the scope of this Specification but may be the subject of a related purchase Specification.

3.5.3 Measures shall be employed to eliminate the harmful flow of shaft current through the bearings. It shall be possible to test the effectiveness of insulation if this is utilised.

3.5.4 Machines shall be tested with their service bearings fitted. If transit bearings or other devices are employed for transport purposes, clear labels stating this shall be affixed to the machine.

3.6 Balancing

Following the overspeed test the rotor shall be check balanced. If the residual out of balance has increased by more than 10% then the rotor shall be re balanced and the overspeed test and the check balance repeated until the rotor is stable.

3.7 Critical Speeds

The manufacturer shall state the design value of the first critical speed on the Data Sheet.

3.8 Vibration

3.8.1 Bearing housings for hydrodynamic radial bearings shall have provision for the fitting of dual proximity type vibration probes.

3.8.2 Two pole machines rated 1.5 MVA and above shall be fitted with dual non contacting vibration probes at each bearing all in accordance with [API 670](#).



In a manner similar to temperature monitoring either a complete package vibration monitoring system may be required or a generator system alone may be required and will be separately specified. In either event the generator shall be capable of accepting the necessary probes, either at the time of supply or later.

3.8.3 Four pole machines rated 3 MVA and above shall be fitted with vibration monitoring devices at each bearing. Non-contacting vibration probes in accordance with [API 670](#), or accelerometers (rms velocity reading) in accordance with [API 678](#) are acceptable.

3.8.4 The vibration amplitude of machines fitted with non-contacting vibration monitoring equipment shall not exceed a peak to peak level (unfiltered) of 63 micrometers including mechanical and electrical run out. Total mechanical and electrical run out shall not exceed 13 micrometers.

3.8.5 The vibration limits for all machines not fitted with non contact vibration monitoring equipment shall meet the requirements of [BS 4999](#) Part 142 as follows:

- (a) for a shaft height less than 400 mm, Table 1, Quality R
- (b) for a shaft height 400 mm or greater, Table 2, Column 1

If vibration probes are fitted and if the complete vibration monitoring system can be made available at the manufacturers works during works test then these shall be employed for vibration testing. Otherwise the standard tests specified in [BS 4999](#) Part 142 shall be employed.

3.8.6 The vibration levels for machines fitted with flexible rotors when passing through the first critical speed shall be within the following limits:

- (a) Machines fitted with hydrodynamic bearings:

The peak to peak amplitude shall be less than 75% of the nominal bearing clearance.

- (b) Machines fitted with rolling element bearings:

Less than three times the limits given in 3.8.5

3.9 Couplings

3.9.1 The supplier of the driver shall be responsible for the provision of all couplings and speed reduction gears between the generator and the driver.



3.10 Plant Identification

In addition to the machine rating plate a separate machine plant equipment identification plate shall be attached to a non removable part of the frame in a readily visible position. The plate shall be fabricated from stainless steel and engraved with the Plant Tag Number given in the Data Sheet. The means by which the plate is attached to the frame shall allow the plate to be removed and replaced by a similar plate.

An additional permanently attached stainless steel plate shall be provided in a prominent position for inscription of the Works Identification Number (WIN).

The Plant Tag Number relates to the item occupying that physical position in the system and the Works Identification Number always remains with a particular item regardless of location and is used in an addressable maintenance system.

3.11 Mechanical Handling

3.11.1 Facilities shall be provided for the application of jacking screws in all three planes, and their location marked on the machine general arrangement drawing.

3.11.2 Where it is intended to use spreader bars for lifting all or part of the machine or where other special handling precautions are necessary these requirements shall be identified on a suitable plate attached to the external surface of the machine.

3.12 Rotors

3.12.1 Rotors shall be mechanically designed to withstand safely a momentary overspeed. This speed shall be the greater of the following.

- (a) 1.2 times the rated speed or,
- (b) 1.1 times the driver overspeed trip setting or,
- (c) 1.05 times the train fly-up speed following loss of full load with the fuel control valve jammed in the full open position.

4. NOISE

4.1 Limits

4.1.1 In the absence of any stated noise limits the maximum noise sound pressure level at 1 m from the machine surface shall not exceed 85 dB(A) when operating as an alternator at rated voltage, rated speed and at no load.



No load levels have been specified due to the difficulties in measuring levels for a loaded machine, as the driver will increase noise levels considerably.

It is acknowledged that when the generator is loaded, the noise level will generally increase, and this has been taken into account when selecting the limit stated above.

4.2 Measurement and Testing Procedures

4.2.1 The manufacturer shall provide details of the noise emissions from his equipment in octave bands. He shall also provide details of any narrow band noise emitted by his equipment that is noticeable to the ear, together with the octave band or bands in which it occurs.

4.2.2 Noise levels shall be measured and calculated in accordance with the procedures stated in [BS 4999](#) Part 109.

4.3 Noise Reduction

4.3.1 Where the noise limiting requirements of this Specification cannot be met without the provision of noise reducing features, the levels with and without these features shall be stated.

4.3.2 Details of any noise reduction features shall be provided.

5. EXCITATION SYSTEM

5.1 General

5.1.1 The excitation system shall normally be of the brushless type. A proven detection system to monitor the failure of any element in the rotating diode bridge shall be included.

5.1.2 The system should be complete without the need for external power supplies.

Power may of course be derived from the generator terminals.

5.1.3 The excitation system shall be capable of providing at least 3 times rated current under three phase terminal short circuit conditions for at least 10 seconds.

5.1.4 If a static thyristor exciter is required, a current limiting circuit shall be provided to prevent sustained overload. This circuit shall incorporate a timing unit to restrict the application of ceiling excitation for a specified time, after which the excitation is automatically reduced to the rated



value. A separate protective device shall also be provided to give ultimate rotor overcurrent protection.

Although it is necessary to initially provide a high excitation current during fault conditions to supply additional reactive power demanded during fault clearance, and to maintain a synchronous torque at low voltage levels, rotor current limitation is necessary to prevent the undesirable disconnection of the generator due to overload of the rotor circuit.

5.2 Automatic Voltage Regulator (AVR)

5.2.1 The AVR arrangement shall be as specified in the Data Sheets attached to this Specification.

5.2.2 The AVR shall be of solid state design and include protection against over voltage.

5.2.3 The AVR shall be provided with means to adjust the set point of the main generator output voltage over a range of plus or minus 10% of nominal voltage rating at full load.

5.2.4 The generator shall be provided with a manual control for the excitation system as standby to the AVR, and the system shall trip to manual excitation upon failure of the AVR. The manual control set point shall automatically follow the AVR in order that a stepless changeover will occur should the AVR fail.

It is often the case that failure of the AVR will be signified by an overvoltage demand which would make the AVR operate out of tolerance. If under this condition the manual follower would also track the AVR into the unacceptable operating region this would represent an undesirable situation and should be prevented.

5.2.5 If a standby AVR is specified then automatic changeover should occur on failure of the main AVR and setpoint tracking of the main AVR shall occur in the manner described in 5.2.4 for manual control.

5.2.6 The AVR system shall have an adjustable reactive current droop characteristic and be suitable for reactive load sharing.

Also known as Quadrature Current Compensation (QCC) this adjustment provides the ability for generators in parallel to share reactive current in equal or proportional amounts.

When indicated on the Data Sheets, facilities will also be provided for the separate automatic control of reactive current.

A separate control system may be utilised for reactive current control, this may be required for acceptable power system operation when for instance incoming generators are brought on to the system during take up of the load.



- 5.2.7 The AVR system shall allow 100% voltage to be generated at 80% speed under all conditions of operation.
- 5.2.8 Overfluxing control on both automatic and manual mode shall be provided. This shall not reduce excitation until frequency is less than 75% of rated frequency.
- 5.2.9 Maximum excitation limitation and maximum volts/hertz excitation limitation facilities shall be included within the AVR units.
- 5.2.10 The regulation capability of the main a.c. generation and AVR system under steady state and transient conditions shall be chosen from Voltage Regulation Grades 2.13 (VR2.13), 2.23 (VR2.23), 2.33 (VR2.33) or 3.11 (VR3.11) as defined in [BS 4999](#) Part 140. Transient performance is defined with rated kVA at 0.8 power factor rejected, for other conditions agreement is required between supplier and purchaser.
- The lowest voltage regulation grade tolerable should be selected as choice of a grade better than is necessary will result in a larger, more expensive generator with a higher fault level.*
- 5.2.11 The temperature stability of the voltage regulation shall be better than 0.5% for temperature between the maximum and minimum ambient.

6. MACHINE TESTING

(Also see 1.6)

6.1 Standard Tests

- 6.1.1 Tests shall be carried out as detailed in [BS 4999](#) Part 143 and in accordance with procedures described in [IEC 34](#).

6.2 Additional Tests

- 6.2.1 The following tests shall additionally be carried out.
- Vibration tests in accordance with section 3.8 of this Specification
 - Noise level test in accordance with [BS 4999](#) Part 109
 - Insulation level test on bearing pedestal/housing
 - Tests to determine the coil insulation quality in accordance with [BS 4999](#) Part 144



- Overspeed test in accordance with IEC 34-1
- Impulse voltage withstand test in accordance with IEC 34-15
- Where applicable, tests for turbine type synchronous machines in accordance with IEC 34-3
- Tests to determine synchronous machine quantities as shown in the Data Sheets in accordance with IEC 34-4
- Tests to determine AVR response to sudden load shedding for the selected Regulation Grade as paragraph 5.2.10

7. RATING PLATES

7.1 The following information, additional to the items listed in IEC 34-1 shall be included on the rating plate.

- Purchasers Order Number
- Weight of rotor
- Weight of stator

The rating plate shall be metallic and corrosion resistant.

PART B - GENERATION PACKAGES

8. GENERAL

8.1 Package Requirements

8.1.1 This Specification covers equipment installed in a safe area. When equipment is installed in a hazardous area, the requirements will be detailed in the Purchase Order.

This Specification should not be used to specify the requirements for emergency diesel generation packages for use offshore, BP Group GS 160-1 will be used for this purpose.

8.1.2 The vendor shall co-ordinate the design, and ensure the satisfactory functioning of the complete package. The satisfactory functioning of the complete package shall form part of the vendors guarantee.

The scope of supply shall include the following :-



- a.c. generator complete with associated excitation and voltage regulation equipment.
- generator synchronising equipment
- generator neutral earthing equipment
- generator unit transformer (if required)
- auxiliaries system motor control centre
- auxiliaries low voltage motors
- station battery and associated charging system
- generator control panel
- generator winding and cooling air temperature measurement and monitoring equipment
- generator bearing temperature and vibration, measurement and monitoring equipment
- auxiliary, main and emergency lighting, and small power distribution equipment
- alarm and trip annunciators

The above list is not exhaustive and should be amended as necessary.

When a unit transformer is included in the scope, it shall operate successfully with extremes of voltage and frequency which the AVR will permit i.e. 100% voltage at 80% frequency.

When the generator circuit breaker is included in the scope, electrical protection requirements should be identified in the Purchase Order.

- 8.1.3 The vendor shall declare at the tender stage a descriptive list of the materials comprising the package.
- 8.1.4 Reference shall be made to BP Group [GS 112-16](#), equipment shall be provided and installed in compliance with the requirements of that Specification.
- 8.1.5 Where the prime mover or generator are mounted in an acoustic enclosure which gives rise to a hazardous area, equipment installed inside the enclosure shall be suitably rated and certified in accordance



with IEC 79, taking into account the extremes of temperature experienced during normal and emergency ventilation conditions.

9. SPECIAL DESIGN REQUIREMENTS

9.1 A.C. Generator

- 9.1.1 The a.c. generator complete with the excitation equipment and automatic regulation equipment shall comply with Part A of this Specification.

9.2 Generator Neutral Earthing Equipment

- 9.2.1 Neutral earthing equipment shall be supplied as specified in the Data Sheets in Part A of this Specification.

- 9.2.2 Where an earthing transformer is specified it shall comply with BP Group GS 112-5.

An earthing transformer and resistor will be specified when the generator is to supply power through a unit transformer.

- 9.2.3 All earthing resistors shall be provided with insulation suitable for the phase to phase voltage of the systems to which they are connected. They shall be designed to carry their rated fault current for 10 seconds, without any destructive effect to their component parts.

The resistor shall be connected to the earthing grid directly.

The design and materials of the resistor shall ensure that vibration and temperature variations cannot cause rupture, and that corrosion is minimised.

The neutral earthing equipment may also include neutral switchgear where it is necessary to limit third harmonic current circulation between non identical parallel connected generators.

9.3 Transformers

- 9.3.1 When transformers are included in the scope they shall comply with BP Group GS 112-5.

9.4 Generator Control Instrumentation and Alarms

- 9.4.1 The control panel shall typically include the following:-

- a.c. generator synchronising and alarms



- a.c. generator voltage regulation
- a.c. generator protection
- speed raise/lower
- voltage raise/lower
- emergency stop pushbutton
- normal start/stop pushbuttons
- excitation manual/off/AVR selector
- trip/close switch and position indicator for generator circuit breaker
- local/remote control selector

9.4.2 The package shall be complete for correct protection and operation with all necessary control equipment, logic systems and alarm annunciations.

9.4.3 Controls shall be logically positioned and give ease of access when observing indicators and alarms during operation.

9.4.4 If manual synchronising facilities are included in the scope then check synchronising relays shall also be included in the scheme.

If automatic synchronising facilities are included then manual synchronising back up together with check synchronising relays shall also be provided.

9.4.5 The drivers of all machines shall be fitted with speed governing equipment.

Where the generator is to operate in isolation the governor shall provide isochronous control.

Where the generator is to operate in parallel with other generators then adjustable droop control shall be provided.

9.4.6 The following indication and alarms shall be included:-

- generator voltage
- generator current



- kW meter
- kVAr meter
- power factor meter
- frequency meter
- kWH meter
- hours run counter
- exciter field voltmeter
- exciter field ammeter
- AVR/manual excitation null balance meter
- running and incoming voltmeters
- running and incoming frequency meters
- synchroscope
- synchronising lamps
- alarm indication

9.4.7 Indicating instruments and alarm annunciations shall be easily visible and clearly audible and shall be located within the normal field of vision of an operator facing the control panel.

The alarm annunciation shall include all alarms generated within the package. Facilities shall be provided to repeat single alarms or group alarms to a remote point. Selection of repeated alarms shall be indicated in the Purchase Order.

As part of the bid the vendor shall identify all recommended indications and alarms that he considers necessary to monitor the performance of the package and to provide adequate protection of the equipment.

All abnormal conditions which would ultimately lead to a shut down shall have warning pre alarms. Where possible the interval between set points shall be sufficient for corrective action to be taken.

In the event of an equipment trip a 'first out' facility shall be provided to identify the original fault.



9.5 Lighting and Small Power

- 9.5.1 The preferred type of luminary is fluorescent. The emergency luminaries shall be supplied either from a central battery system or the integral battery type shall be used.

A lighting uninterruptible power supply may be available when this type of installation proves to be the most economic, or when an extended standby time is required. If a UPS supply is available it should be utilised but one should not be provided specifically for the package.

At least two normal lighting circuits shall be installed and both circuits shall be utilised in all areas. The design shall allow maintenance and modification of one circuit whilst the second circuit is in operation.

Enclosures which personnel may enter for operation or on-line maintenance shall have emergency lighting.

- 9.5.2 Small power outlets shall be provided as indicated in the Data Sheets in BP Group [GS 112-16](#). Distribution within the package shall be by the vendor.

9.6 Earthing

- 9.6.1 Connections to the bearing housings of generators having insulated bearing pedestals shall ensure that no connection, including that of the bearing sheath, provides a bypass around the insulation.

9.7 Black Start and Stopping Requirements

- 9.7.1 Unless specified otherwise there will be 'black start' power available for a main power generator driver from a 'black start' emergency generator.

The vendor shall supply full details of all equipment requiring 'black start' power to enable the purchaser to provide the correct feeders.

- 9.7.2 The vendor shall supply d.c. auxiliary power for the extended cooling down period when a gas turbine/generator unit is stopped to prevent thermal/mechanical damage. However, if the power requirements to achieve this would involve excessive battery requirements then a.c. power may be obtained from an emergency generator as detailed in 9.7.1.



10. PACKAGE TESTING

10.1 Testing

10.1.1 Included in the test programme shall be a combined test of prime mover and generator. The following tests shall be carried out:-

- Load test against resistive and reactive load banks for eight hours duration at full load current and design power factor.
- Rejection of full load current at the design power factor. Voltage, frequency and load current should be recorded on chart recorders.

A programme of further load acceptance and rejection tests should be devised and agreed including acceptance criteria during the bid analysis.

- Generator control tests to demonstrate all generator trips and alarms and changeovers from duty to standby equipment.
- Where applicable, trip of main auxiliaries from generator fully loaded conditions to demonstrate ability of emergency run down equipment. Temperatures should be monitored in the vicinity of electrical equipment, especially if certified, to ensure design and certification limits are not exceeded.



INDENT/PURCHASE ORDER NUMBER													
To be completed in block capitals													
TO BE COMPLETED BY PURCHASER													
1	INSTALLATION SITE				21	COOLING WATER QUALITY	FRESH	SALINE					
2	PLANT TAG NUMBER						CORROSIVE						
3	RATING	V	Hz	kVA	22	COOLING TEMPERATURE	WATER	HIGH °C LOW °C					
4	POWER FACTOR	0.8 lag			23	COOLING QUANTITY	WATER	LIMITED TO m ³ /hr	UNLIMITED				
5	SPEED	rpm			24	EXCITATION	BRUSHLESS EXCITER	STATIC THYRISTOR EXCITER					
6	MAX. SYSTEM SYMMETRICAL FAULT CURRENT	kA			25	AUTOMATIC VOLTAGE REGULATOR TYPE	ADJUSTABLE QUADRATURE DROOP 0-6 % AUTOMATIC VAr SHARING						
7	SYMMETRICAL FAULT CURRENT CONTRIBUTION ASSOCIATED WITH GENERATOR SUB-TRANSIENT REACTANCE	kA			26	AUTOMATIC VOLTAGE REGULATOR CONFIGURATION		SINGLE DUAL					
					27	TERMINAL ARRANGEMENT (BS 4999 Part 145)							
					28	HAZARDOUS AREA INSTALLATION		NO	YES (details in purchase order)				
8	GENERATOR NEUTRAL EARTHING	DIRECT	TRANSFORMER/RESISTOR		29	DRIVER DETAILS ATTACHED		NO YES					
9	SERVICE CONDITIONS IF EXCEEDING IEC 34-1	RESISTANCE		UNEARTHED	30	CABLE TYPE	MAIN						
		ALTITUDE m					HEATER						
		TEMP. °C					AUX.						
10	DUTY	S1			31	CABLE RATING AND CONDUCTOR MATERIAL	MAIN	V	Cu	Al			
11	ROTATION FACING DRIVE END	CLOCK		ANTICLOCK			HEATER	V	Cu	Al			
12	INSULATION CLASS	F					AUX.	V	Cu	Al			
13	MAX. TEMPERATURE RISE	80 °C			32	CABLE CONDUCTOR SIZE AND NUMBER OF CORES	MAIN	mm ²	3	4			
14	COOLING	IC0151					HEATER	mm ²					
15	GENERATOR ENCLOSURE PROTECTION	IP 54					AUX.	mm ²					
16	WINDING TEMPERATURE DETECTORS	RESISTANCE THERMOMETERS			33	CABLE GLAND PATTERN AND THREAD (BS 6121)	MAIN	mm					
		THERMISTORS					HEATER	mm					
17	MAXIMUM NOISE LEVEL (NO LOAD)	85 dB(A)					AUX.	mm					
18	SHORT CIRCUIT WITHSTAND TEST REQUIRED	NO		YES	34	REMARKS							
19	HEATER REQUIRED	NO	YES	V	35	SIGNATURE							
						NAME (Print)							
20	CURRENT TRANSFORMERS	NONE				ORGANISATION							
					DATE								
Rev	Date	Remarks			By	App.	DATA SHEET 1 OF 4						



INDENT/PURCHASE ORDER NUMBER									
To be completed in block capitals									
TO BE COMPLETED BY MANUFACTURER									
1	MANUFACTURER				15	PERFORMANCE TYPE TEST CERTIFICATE			
2	MANUFACTURERS TENDER REFERENCE				16	COPY OF CERTIFICATE ATTACHED	YES	NO	
3	MANUFACTURERS WORKS ORDER NUMBER				17	STATOR COIL QUALITY ASSURANCE STANDARD	BS 4999 Part 144		
4	FRAMESIZE				18	WINDING DATA ATTACHED	YES	NO	
5	FULL LOAD CURRENT	A			19	WINDING DATA REFERENCE			
6	1st CRITICAL/ SYNCH SPEED	rpm	rpm		20	RE LUBRICATION INTERVAL	Hrs		
7	EFFICIENCY 1: 3/4 : 1/2				21	BASIS OF RE LUBRICATION INTERVAL CALCULATION			
8	POWER FACTOR				22	NOISE LEVEL WITH ACOUSTIC TREATMENT	dB(A)		
9	RATING CLASS					NOISE LEVEL WITHOUT ACOUSTIC TREATMENT	dB(A)		
10	RATING	kVA	AT	PF	23	SPECIFICATION MET IN FULL EXCEPT FOR CLAUSES LISTED	NONE		
11	STATOR CONNECTION	STAR							
12	NUMBER OF STATOR WINDING TERMINALS				24	REMARKS			
13	INSULATION CLASS	F			25	SIGNATURE			
14	TEMPERATURE RISE	°C		NAME (Print)					
				ORGANISATION					
				DATE					
				DATA SHEET 2 OF 4					



INDENT/PURCHASE ORDER NUMBER			
To be completed in block capitals			
THE FOLLOWING DATA FOR ALL A.C. GENERATORS SHALL BE PROVIDED PER UNIT VALUES (PU) SHALL BE RELATED TO THE MVA RATING OF THE MACHINE			
TO BE COMPLETED BY MANUFACTURER			
GENERATOR PARAMETERS			TOLERANCE %
1	MOMENT OF INERTIA OF ROTOR (GD ²)	kgm ²	
2	INERTIA CONSTANT OF MOTOR (H)	MJ/MVA	
3	POSITIVE SEQUENCE RESISTANCE (R ₁)		
4	ZERO SEQUENCE RESISTANCE (R ₀)		
5	NEGATIVE SEQUENCE RESISTANCE (R ₂)		
6	ZERO SEQUENCE REACTANCE (X ₀)		
7	NEGATIVE SEQUENCE REACTANCE SAT/UNSAT (X ₂)		
8	DIRECT AXIS SYNCHRONOUS REACTANCE SAT/UNSAT (X _d)		
9	DIRECT AXIS TRANSIENT REACTANCE (X' _d)		
10	DIRECT AXIS SUB-TRANSIENT REACTANCE (X'' _d)		
11	SHORT CIRCUIT RATIO		
AVR PARAMETERS			
12	MANUFACTURER OF AVR		
13	MANUFACTURERS TYPE REFERENCE		
14	SIGNATURE		DATA SHEET 3 OF 4
	NAME (Print)		
	ORGANISATION		
	DATE		



INDENT/PURCHASE ORDER NUMBER							
To be completed in block capitals							
THE FOLLOWING DATA FOR MACHINES RATED 1 MVA AND OVER SHALL BE PROVIDED PER UNIT VALUES (PU) SHALL BE RELATED TO THE MVA RATING OF THE MACHINE							
TO BE COMPLETED BY MANUFACTURER							
GENERATOR PARAMETERS							
		VALUE	TOLERANCE %			VALUE	TOLERANCE %
1	QUADRATURE AXIS SYNCHRONOUS REACTANCE (Xq)			9	QUADRATURE AXIS SHORT CIRCUIT TRANSIENT TIME CONSTANT (T'qs)	S	
2	QUADRATURE AXIS TRANSIENT REACTANCE (X'q)			10	QUADRATURE AXIS OPEN CIRCUIT SUBTRANSIENT TIME	S	
3	QUADRATURE AXIS SUBTRANSIENT REACTANCE (X''q)			11	QUADRATURE AXIS SHORT CIRCUIT SUBTRANSIENT TIME CONSTANT (T''qs)	S	
4	DIRECT AXIS OPEN CIRCUIT TRANSIENT TIME CONSTANT (T'do)	S		12	POTIER REACTANCE (Xp)		
5	DIRECT AXIS SHORT CIRCUIT TRANSIENT TIME CONSTANT (T'ds)	S		13	DAMPING FACTOR		
6	DIRECT AXIS OPEN CIRCUIT SUBTRANSIENT TIME CONSTANT (T''do)	S		14	SATURATION FACTOR		
7	DIRECT AXIS SHORT CIRCUIT SUBTRANSIENT TIME CONSTANT (T''ds)	S		15	BASIC IMPULSE LEVEL		
8	QUADRATURE AXIS OPEN CIRCUIT TRANSIENT TIME CONSTANT (T'qo)	S					
AVR 'S' PLANE DATA FOR IEEE MODELS TYPE 1 AND 2							
		VALUE				VALUE	
16	FORWARD GAIN (KA)			24	EXCITER GAIN (KE)		
17	FEEDBACK GAIN (KF)			25	EXCITER TIME CONSTANT (TE)	S	
18	REGULATOR AMPLIFIER TIME CONSTANT (TA)	S		26	EXCITER OUTPUT (E MAX)		
19	REGULATOR FEEDBACK TIME CONSTANT (TF1)	S		27	EXCITER OUTPUT (E MIN)		
20	MAXIMUM REGULATOR OUTPUT (VR MAX.)			28	EXCITER SATURATION AT 75% E MAX (SE75)		
21	MINIMUM REGULATOR OUTPUT (VR MIN)			29	EXCITER SATURATION AT 100% E MAX (SE100)		
22	MAXIMUM RATE OF CHANGE OF REGULATOR OUTPUT (VR RATE)			30	IEEE MODEL TYPE	1	2
23	INPUT FILTER TIME CONSTANT (TR)	S		31	REGULATOR FEEDBACK TIME CONSTANT (TF2)		S
32	SIGNATURE	DATA SHEET 4 OF 4					
	NAME (Print)						
	ORGANISATION						
	DATE						



DEFINITIONS AND ABBREVIATIONS**Definitions**

Standardised definitions may be found in the BP Group RPSEs Introductory Volume

Abbreviations

API	American Petroleum Institute
AVR	Automatic Voltage Regulator
BS	British Standard
dB	Decibel
IEC	International Electrotechnical Commission
IP	Ingress Protection
rms	Root Mean Square
UPS	Uninterruptible Power Supply



LIST OF REFERENCED DOCUMENTS

A reference invokes the latest published issue or amendment unless stated otherwise.

Referenced standards may be replaced by equivalent standards that are internationally or otherwise recognised provided that it can be shown to the satisfaction of the purchaser's professional engineer that they meet or exceed the requirements of the referenced standards.

International Standards**IEC 34**

Rotating electrical machines

34-1, Part 1: Rating and performance

34-2, Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles)

34-3, Part 3: Rating and characteristics of three phase, 50 Hz turbine type machines

34-4, Part 4: Methods for determining synchronous machine quantities from tests

34-5, Part 5: Classification of degrees of protection provided by enclosures for rotating machines

34-6, Part 6: Methods of cooling rotating machinery

34-7, Part 7: Symbols for types of construction and mounting arrangements of rotating electrical machinery

34-8, Part 8: Terminal markings and direction of rotation of rotating machines

34-10, Part 10: Conventions for description of synchronous machines

34-11, Part 11: Built in thermal protection, chapter i: rules for protection of rotating electrical machines

34-15, Part 15: Impulse voltage withstand levels of rotating a.c. machines with form wound stator coils



IEC 72	Dimensions and output series for rotating electrical machines
	Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1080
	Part 2: Frame numbers 355 to 1000 and flange numbers 1180 to 2360
IEC 79	Electrical apparatus for explosive gas atmospheres
IEC 529	Degrees of protection provided by enclosures (IP Code)

British Standards

BS 4999	General requirements for rotating electrical machines
	Part 109: Specification for noise levels, including test methods
	Part 140: Specification for voltage regulation and parallel operation of a.c. synchronous generators
	Part 142: Specification for mechanical performance: vibration
	Part 143: Specification for tests
	Part 144: Specification for the insulation of bars and coils of high voltage machines, including test methods
	Part 145: Specification for winding terminations
BS 5000	Specification for rotating electrical machines of particular types or for particular applications
	Part 3: Generators to be driven by reciprocating internal combustion engines
BS 6121	Mechanical cable glands

American Standards

API 670	Vibration, axial position, and bearing temperature monitoring systems
API 678	Accelerometer based vibration monitoring system



BP Group Documents

BP Group [GS 112-5](#) Transformers and Reactors

BP Group [GS 112-16](#) Electrical Requirements for Packaged Equipment

BP Group [GS 160-1](#) Emergency Generator Package

